



Sunnybrook Health Sciences Centre

2075 BAYVIEW AVENUE, TORONTO, ONTARIO, M4N 3M5

Emergency Department Renovations

'A' Wing, Ground Floor

Construction Documents Project Manual

Architectural Specifications

Issued for Tender: August 19, 2026

HDR Project No.: 10428557 (sw25842)

1.1 Document Responsibility

- .1 Refer to Project Manual, Document 00 01 10 - Table of Contents, for indication of responsibility for listed documents preparation (DR), as follows:
 - .1 A - Denotes documents prepared by Architect.
 - .2 E - Denotes documents prepared by Electrical Engineer.
 - .3 H - Denotes documents prepared by Architectural Hardware Consultants.
 - .4 M - Denotes documents prepared by Mechanical Engineer.
 - .5 O - Denotes documents prepared by Owner.

1.2 Project Directory

- .1 Owner:

Sunnybrook Health Sciences Centre
2075 Bayview Avenue
Toronto, Ontario
M4N 3M5

Tel: 416-480-6100

- .2 Architect:

HDR Architecture Associates Inc.
70 University Avenue, Suite 800
Toronto, Ontario
M5J 2M4

Tel: 647-777-4900

- .3 Mechanical Engineer

H.H. Angus & Associates Ltd.
1176 Eglinton Avenue East, Suite 800
Toronto, Ontario
M3C 0S1

Tel: 416-443-8200

- .4 Electrical Engineer

H.H. Angus & Associates Ltd.
1176 Eglinton Avenue East, Suite 800
Toronto, Ontario
M3C 0S1

Tel: 416-443-8200

.5 Hardware Consultant

Spyder SC Inc.
26 Dale Crescent
Bradford West Gwillimbury, Ontario
L0L 1L0

Tel: 647-271-6489

END OF SECTION

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11 70 00 Healthcare Equipment	A	4	August 19, 2026

END OF SECTION

Stipulated Price Bid Form

Project/Contract: Sunnybrook Health Sciences Centre Emergency Department Renovations

From (Bidder):

company name

street address or postal box number

city/town, province and postal code

Email address

To (Owner): Sunnybrook Health Sciences Centre
2075 Bayview Avenue
Toronto, Ontario
M4N 3M5

- A. We, the undersigned, having examined the *Bid Documents* for the above named project/contract, including Addendum Number(s) _____, and having visited the *Place of the Work*, hereby offer to perform the *Work* in accordance with the *Bid Documents*, for the stipulated (base bid) price of:

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

\$ _____
amount in words
in Canadian dollars, excluding *Value Added Taxes*.

- a. For this project the value added taxes shall mean HST at 13% and any other applicable taxes.

B. We declare that:

- ii. we will attain the following dates for completion of the *Work* as follows:
- a. *Substantial Performance of the Work* within _____ weeks after receiving notice of Contract award.
 - b. *Total Completion Date* within _____ weeks after receiving notice of Contract award.

Stipulated Price Bid Form

C. We understand and declare that:

- a. we have arrived at the bid without collusion with any competitor,
- b. the bid is open to acceptance by the *Owner* for a period of 90 days from the date of bid closing,
- c. all bid form supplements called for by the *Bid Documents* form an integral part of this bid,
- d. we accept and agree that we shall perform work expeditiously and with adequate forces to attain *Substantial Performance of the Work*, and *Total Completion Date* within the completion time specified in *Bid Documents*. In order to maintain schedule we have allowed for overtime work in our bid price,
- e. we agree to assign _____ (name) as the Mechanical *Subcontractor*, for the price of \$_____, and they will assign _____ (name) as their full-time mechanical site superintendent for duration of the *Contract*.
- f. we agree to assign _____ (name) as the Electrical *Subcontractor*, for the price of \$_____, and they will assign _____ (name) as their full-time electrical site superintendent for duration of the *Contract*.
- g. we agree to assign _____ (name) as our full-time project manager for duration of the *Contract*.
- h. we agree to assign _____ (name) as our full-time superintendent for duration of the *Contract*.
- i. we agree to assign _____ (name) as our full-time site coordinator for mechanical and electrical work for duration of the *Contract*.
- j. we agree to assign _____ (name) as our full-time Security *Subcontractor*, for the price of \$_____, and they will assign _____ (name) as their full-time security site superintendent for duration of the *Contract*.
- k. we agree to assign _____ (name) as our full-time Fire Protection *Subcontractor*, for the price of \$_____, and

Stipulated Price Bid Form

they will assign _____ (name) as their full-time fire protection site superintendent for duration of the *Contract*.

- I. We have carefully reviewed and fully understand the *Bid Documents* (including the *Instructions to Bidders*), and, in particular, acknowledge the rights of the *Owner* expressly reserved in the *Instructions to Bidders*, to accept or reject any or all of the bids.

Stipulated Price Bid Form

Signatures:

Signed and submitted by:

company name

name and title of authorized signing officer

signature of authorized signing officer

name of witness

signature of witness

name and title of authorized signing officer

signature of authorized signing officer

name of witness

signature of witness

Dated this _____ day of _____, 20_____.

Note: Affix corporate seal as required by *Bid Documents*.

END OF SECTION

Emergency Department Renovations
Sunnybrook Health Sciences Centre
HDR Architecture Associates Inc.
Project No.: 10428557

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List of Subcontractors and Cost Breakdown Bid Form

Project/Contract: Sunnybrook Health Sciences Centre Emergency Department Renovations

From (Bidder): _____
company name

We, the above named bidder, propose to use for the above named *Project* the *Subcontractors* named herein, and have included the respective costs associated with the below named *Subcontractors* in our bid price.

Once Section 00 43 36 - List of Subcontractors and Cost Breakdown Bid Form Supplement has been submitted in accordance with the requirements of Section 00 21 13, the *Subcontractors* listed may not be changed.

List of Subcontractors and Cost Breakdown Bid Form

Sunnybrook Health Sciences Centre Emergency Department Renovations

<u>Divisions/Sections</u> (List identified Subcontractors)	<u>Name of Subcontractor</u>	<u>Contractor's Cost</u>	<u>Hourly Rate</u>
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DIVISION 5

05 50 00-Metal Fabrication	\$_____	\$_____
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DIVISION 6

06 10 53-Rough Carpentry	\$_____	\$_____
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06 40 00-Architectural Woodwork	\$_____	\$_____
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DIVISION 7

07 84 00-Firestopping and Smoke Seals	\$_____	\$_____
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DIVISION 8

08 42 43-ICU Sliding Doors.....	\$_____	\$_____
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08 71 00-Finish Hardware	\$_____	\$_____
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08 80 00-Glass and Glazing	\$_____	\$_____
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DIVISION 9

09 29 00-Gypsum Board	\$_____	\$_____
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09 51 23- Ceilings Systems	\$_____	\$_____
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09 65 17-Resilient Flooring	\$_____	\$_____
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09 67 00-Epoxy Floor System	\$_____	\$_____
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09 91 00-Painting.....	\$_____	\$_____
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DIVISION 11

11 70 00-Healthcare Equipment.....	\$_____	\$_____
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END OF SECTION

Contract Security

PART 1 - GENERAL

1.1 Section Includes

- .1 Contract security requirements.

1.2 Administrative Requirements

- .1 The *Contractor* shall provide to the *Owner* any *Contract* security specified in Section 00 73 63. *Contract* security specified shall be submitted to the *Owner* prior to commencement of the *Work* or within the timeframe specified below, whichever is earlier.
 - .1 Submit bond to the *Owner* within 7 days after date of issuance of conditional notification of award of *Contract*.

1.3 Contract Performance Security

- .1 The *Contractor* shall provide a performance bond, and a labour and materials payment bond, each issued by a bonding company acceptable to *Owner* and licensed to issue such instruments in the Province of Ontario, in the amounts and forms as follows:
 - .1 Performance bond:
 - .1 Amount of performance bond shall be equal to not less than 50% of the *Contract Price*.
 - .2 The form of performance bond shall be Form 32 Performance Bond under Section 85.1 of the Construction Act.
 - .2 Labour and material payment bond:
 - .1 Amount of Labour and material payment bond shall be equal to not less than 50% of the *Contract Price*.
 - .2 The form of Labour and material payment bond shall be. Form 31 Labour and Material Payment Bond under Section 85.1 of the Construction Act.

PART 2 - PRODUCTS

Not applicable.

PART 3 - EXECUTION

Not applicable.

END OF SECTION

GENERAL REFERENCE

The Standard Construction Document, CCDC 2 2020, Stipulated Price Contract, consisting of the Agreement between *Owner* and *Contractor*, Definitions and the General Conditions of the Stipulated Price Contract, and these Supplementary Conditions, are part of the *Contract Documents*.

The following Supplementary Conditions shall be read in conjunction with the Canadian Standard Construction Document, CCDC 2 2020.

Section and paragraph references below are to the corresponding sections and paragraphs of the Agreement between *Owner* and *Contractor*, Definitions and General Conditions of the Stipulated Price Contract all forming part of Standard Construction Document, CCDC 2 2020, Stipulated Price Contract. The Stipulated Price Contract, CCDC 2 2020, is amended as follows:

- **GENERAL**

- These Supplementary Conditions and Amendments shall modify, delete and/or add to the Agreement between *Owner* and *Contractor*, Definitions and General Conditions of the Stipulated Price Contract CCDC 22020.
- Where any article, paragraph or subparagraph in the Agreement, Definitions or General Conditions is supplemented by one of the following, the provisions of such article, paragraph or subparagraph shall remain in effect and the supplemental provisions shall be considered as added thereto.
- Where any article, paragraph or subparagraph in the Agreement, Definitions or General Conditions is amended, deleted, voided, or superseded by any of the following, the provisions of such article, paragraph or subparagraph not so amended, voided, deleted or superseded, shall remain in effect, and the numbering of the deleted item will be retained, unused.

- **AGREEMENT BETWEEN OWNER AND CONTRACTOR**

- ARTICLE A1 THE WORK

- Delete paragraph 1.3 and inserting new paragraph 1.3 to read as follows:

“1.3 commence the *Work* by the _____ day of _____ in the year _____ and, subject to adjustment in the *Contract Time* as provided for in the *Contract Documents* attain *Ready-for-Takeover*, by the *Scheduled Ready-to-Takeover Date*; and attain the *Total Completion of the Work* by the *Scheduled Total Completion Date*.”

- ARTICLE A5 PAYMENT

- Amend paragraph 5.2.1(1) by deleting “for the first 60 days”.
- Delete paragraph 5.2.1(2) and substitute the following: “Intentionally deleted”.

- ARTICLE A8 SUCCESSION

- Amend paragraph 8.1 by in line 4, inserting “permitted” before “assigns”.

- ARTICLE A9 TIME OF THE ESSENCE

- Add new Article A9 as follows:

- “9.1 *Contractor* acknowledges and agrees that one of the reasons *Contractor* was selected for the *Work* is *Contractor’s* representation and warranty that it will attain *Ready-for-Takeover* and the *Total Completion of the Work* by the dates set out in Article A1, paragraph 1.3. *Contractor* acknowledges and agrees that it has been advised by *Owner* that it is critical to *Owner* that *Ready-for-Takeover* be achieved by the prescribed dates and that time is of the essence of this *Contract*.
- 9.2 No approval or consent of, or certification, inspection, review, comment, verification, confirmation, acknowledgement or audit by, any governmental authority, *Owner*, or *Consultant*, or anyone on their behalf, shall relieve *Contractor* from performing or fulfilling any of its obligations under the *Contract*. Without limitation, whenever any drawings, plans, procedures, programs or other work product of *Contractor* requires any review, inspection, comment or approval by any governmental authority, *Owner*, or *Consultant*, or anyone on their behalf, any such review, inspection, comment or approval shall not, in any way, reduce or modify any of *Contractor’s* obligations under the *Contract*.
- 9.3 If any part of the *Contract* or the application of such part to any party, person or circumstance shall, to any extent, be invalid or unenforceable, the remainder of the *Contract*, or the application of such part to any other party, person or circumstance, shall not be affected thereby and each provision of the *Contract* shall be valid and enforceable to the fullest extent permitted by law.
- 9.4 The terms of the *Contract*, which by their nature are continuing, shall survive the termination or other expiration of the *Contract*.
- 9.5 This Agreement, including the *Contract Documents* described herein and the attachments, documents and other agreements to be furnished or executed in connection herewith, supersede all prior negotiations, representations or agreements, either written or oral, with respect to the subject matter hereof. No modification to the *Contract* shall be effective unless made in writing signed by both *Owner* and *Contractor*, unless otherwise provided for herein.
- 9.6 This Agreement may be executed in counterparts, each of which when executed and delivered, including any counterpart executed by a Party and transmitted by email by way of pdf attachment or facsimile transmission, shall be deemed an original, but all of which together will constitute one instrument binding upon the parties hereto, notwithstanding that all such parties may not have executed the same counterpart.”

- **DEFINITIONS**

- Add the following new definitions:

“Commissioning

Commissioning means the process of putting the *Work* or any part thereof into operation and includes StartUp, Verification and Performance Testing as described in the *Contract Documents*.

Completion of Commissioning

Completion of Commissioning means the point in time at which *Owner* and *Consultant* are satisfied that *Contractor* has successfully completed *Commissioning*.

COVID-19

COVID-19 means the novel coronavirus infectious disease SARS-CoV-2 as referenced by the World Health Organization, including all related viruses, diseases, or variants, and any subsequent waves.

Deficiency List

Deficiency List means the deficiency list prepared by *Consultant* and/or *Owner*, acting reasonably, listing itemized deficiencies in the *Work* and errors and/or omissions in the *Design Services*.

Dispute

Dispute has the meaning ascribed in GC 8.1.1.

Key Personnel

Key Personnel means the project managers, superintendents, coordinators or other personnel of *Contractor*, if any, identified in Schedule “A” – Key Personnel to the *Contract*.

OHSA

OHSA means the *Occupational Health and Safety Act*, R.S.O. 1990 c. O.1, as amended, and all regulations passed thereunder.

Scheduled Ready-for-Takeover Date

Scheduled Ready-for-Takeover Date means [insert date].

Scheduled Total Completion Date

Scheduled Total Completion Date means [insert date].

- **Submittals**

Submittals are documents or other forms of information which *Contractor* is required to submit to *Owner* or *Consultant* and include, without limitation, *Shop Drawings*, samples, models, record drawings, test reports, certificates, diagrams and manuals.

Total Completion of the Work

Total Completion of the Work Date means the date that the *Work* is fully complete as prescribed by the *Contract Documents*, including, without limitation, the rectification of all defects and deficiencies.”

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

- Amend paragraph 1.1.3 by inserting “Applying the standard of care described in paragraph 1.5.1.1 of GC 1.5 - PROJECT REQUIREMENTS,” at the beginning of the first sentence.
- Amend paragraph 1.1.4 by inserting “Except for its obligations to review under GC 1.1.3 and to report under this GC 1.1.4,” at the beginning of the first sentence and by adding “Neither *Owner* nor *Consultant* will be responsible for oral instructions.” after the second sentence.
- Amend paragraph 1.1.5.1 by moving the reference to “Supplementary Conditions” to the top of the order of priority.
- Amend paragraph 1.1.5.1 by adding a new bullet called “Advance Payment Agreement” as the 2nd bullet point in the order of priority.
- Amend paragraph 1.1.9 by adding the following to the end of the paragraph:
- “The *Specifications* may be divided into Divisions and the Divisions into Sections for the purpose of convenience, but a Section may consist of work of more than one *Subcontractor* or *Supplier*. The *Specifications* are intended to be read as a whole.”
- “Drawings are intended to be read as a whole”.
- Delete paragraph 1.1.10 in its entirety and substitute new paragraph 1.1.10 as follows:

“The design information furnished to *Contractor* as part of the *Contract Documents*, including the *Drawings* and *Specifications*, are the property of *Owner* and/or *Consultant*, and are to be used by *Contractor* only for the purposes of performing the *Work*. *Contractor* shall not copy, alter or utilize the aforesaid design information for any purpose unrelated to the *Work* without written authorization from *Owner* and *Consultant*.”
- Add new paragraph 1.1.12 as follows:
 - “1.1.12 The table of contents, titles, section headings, running headlines and marginal notes contained in the *Contract Documents* are solely to facilitate reference to various provisions of the *Contract Documents* and in no way affect or limit the interpretation or construction of the provisions to which they refer.”

GC 1.4 ASSIGNMENT

- Delete paragraph 1.4.1 in its entirety and insert the following:

“1.4.1 *Contractor* shall not assign the *Contract* or any of its rights or interest in the *Contract*, nor shall *Contractor* subcontract all or substantially all of the *Work* or *Contractor’s* responsibilities under the *Contract* to a single

Subcontractor or any other person, without the prior written consent of *Owner*, which consent may not be unreasonably withheld. *Owner* may assign the *Contract* without the consent of *Contractor* upon providing *Notice in Writing* to *Contractor*.”

GC 1.5 PROJECT REQUIREMENTS

- Add new paragraph 1.5.1:
 - “1.5.1 *Contractor* represents, covenants and warrants to *Owner* that:
 - it has the necessary high degree of experience and expertise required to perform the *Work* and it will in the performance of the *Work* exercise a standard of care, skill and diligence that would normally be provided by an experienced and prudent *Contractor* providing similar services for hospital projects of a similar nature;
 - the personnel it assigns to the *Project* are experienced and it has a sufficient staff of qualified and competent personnel to replace its designated *Contract* personnel referred to in GC 3.5, subject to *Owner’s* approval, in the event of death, incapacity, termination or resignation. The reference to *Owner’s* approval includes all named Subcontractors and their personnel.
 - there are no pending, threatened or anticipated claims or litigation involving *Contractor* that would have a material adverse effect on the financial ability of *Contractor* to perform the *Work*, and
 - it will achieve *Read-for-Takeover* and the *Total Completion Date* by the date set out in Article A1, paragraph 1.3.”

• GC 2.2 ROLE OF THE CONSULTANT

- Add the following sentence to the end of paragraph 2.2.3:
 - “The presence of such project representatives at the *Place of the Work* or the *Work* shall not relieve *Contractor* from any responsibility to perform the *Work* as required by the *Contract Documents*.”
- Amend paragraph 2.2.5 by (a) adding the word “, schedules” after the word “techniques”, (b) adding the words “to *Contractor*” after the words “*Consultant* will not be responsible” in the first sentence, (c) adding to the following to the end of the second sentence “or to adhere to the construction schedule”, and (d) adding the following sentence to the end of the paragraph: “*Consultant* will not have control over, charge of or be responsible for the acts or omissions of *Contractor*, *Subcontractors*, *Suppliers*, or their agents, employees, or any other person performing any portion of the *Work*.”
- Amend paragraph 2.2.6 by deleting “Except with respect to GC 5.1 — FINANCING INFORMATION REQUIRED OF THE OWNER” and capitalizing “the”.

- Amend paragraph 2.2.7 by inserting “*Contractor* or *Owner* on its own behalf or on behalf of” after the word “by” in the second line.
- Amend paragraph 2.2.12 by (a) deleting the word “will” and replacing with “may”, and (b) adding the following sentence to end of the paragraph:
 - “*Contractor* shall be responsible for requesting any additional instructions or clarifications that may be required from *Consultant* which are needed for the performance of the *Work*, and shall request such instructions or clarifications in time to avoid any delay or additional cost of the *Work*.”
- Amend paragraph 2.2.13 by deleting “submittals” and replacing with “*Submittals*”.
- Amend paragraph 2.2.18 by deleting the words “immediately engage a *Consultant* against whom the *Contractor* makes no reasonable objection and” and replace with “engage a *Consultant*”.

• **GC 2.3 REVIEW AND INSPECTION OF THE WORK**

- Amend paragraph 2.3.2 by inserting in line 1 “, *Commissioning*” after “inspections,”, and inserting in line 3 “and *Commissioning*” after “inspection”.
- Amend paragraph 2.3.3 by inserting in line 1 “, *Commissioning*” after “certificates”.
- Amend paragraph 2.3.4 by inserting in line 2 “*Commissioning*” after “inspections,”, and inserting in line 3 “or *Commissioning*” after “tests”.
- Amend paragraph 2.3.5 by inserting “Subject to paragraph 2.3.4” at the beginning of the third sentence.
- Amend paragraph 2.3.6 and paragraph 2.3.7 by inserting “or *Commissioning*” after “inspection” in all instances.

• **GC 2.4 DEFECTIVE WORK**

- Amend paragraph 2.4.1 by (a) adding the words “or *Owner*” after the word “*Consultant*” in the first line, and (b) by adding the following to the end of the paragraph:

“*Contractor* shall rectify in a manner acceptable to *Owner* all other defective work and like deficiencies throughout the *Work* whether or not they are specifically identified by *Consultant*.”
- Amend paragraph 2.4.3 by deleting the words “the difference in value between the work as performed and that called for by the *Contract Documents*” and inserting the words “the value of such work as is necessary to correct any non-compliance with the *Contract Documents*.”
- Add new paragraphs 2.4.4, 2.4.5 and 2.4.6:

- “2.4.4 *Contractor* shall prioritize the correction of any defective work which, in the sole discretion of *Owner*, adversely affects the day to day operation of *Owner*.”
- 2.4.5 Upon notification of a defect in the *Work*, *Contractor* shall promptly, and no later than five (5) *Working Days*, provide a written statement outlining the proposed remedial measures and a schedule for implementation. Once approved by *Consultant*, *Contractor* shall proceed with the remedial measures without adversely affecting the construction schedule.
- 2.4.6 Notwithstanding any rejection of the *Work* by *Consultant* or *Owner*, or the deduction of an amount otherwise due to *Contractor* by *Owner* as a result of defective work, *Contractor* is required to continue the *Work* in accordance with the *Contract Documents*.”

• **GC 3.1 CONTROL OF THE WORK**

- Amend paragraph 3.1.1 by inserting the words “schedule, coordinate and” after the word “effectively”.
- Amend paragraph 3.1.2 by adding the word “, schedules” after the word “techniques” and by adding the following to the end of the sentence: “and shall coordinate the *Work* so as not to interfere with, interrupt, obstruct, delay, or otherwise affect, the work of others”.
- Add new paragraph 3.1.3:
 - “3.1.3 Prior to commencing procurement, or fabrication construction activities, *Contractor* shall verify, at the *Place of the Work*, all relevant measurements and levels necessary for proper and complete fabrication, assembly and installation of the *Work* and shall further carefully compare such field measurements and conditions with the requirements of the *Contract Documents*. Where dimensions are not included or exact locations are not apparent, *Contractor* shall immediately notify *Consultant*, in writing, and obtain written instructions from *Consultant* before proceeding with any part of the affected work.”

• **GC 3.2 CONSTRUCTION BY THE OWNER OR OTHER CONTRACTORS**

- Delete subparagraph 3.2.2.1 in its entirety and substitute the following: “Intentionally deleted”.
- Add new subparagraph 3.2.3.5:
 - “3.2.3.5 Subject to **GC 9.4 CONSTRUCTION SAFETY**, for *Owner’s* own forces and for *Other Contractors*, assume overall responsibility for compliance with all aspects of the applicable health and safety legislation in the *Place of the Work*, including all of the responsibilities of the constructor under the *OHSA*.”

- Delete the last sentence of paragraph 3.2.5.
- Delete paragraph 3.2.6 in its entirety and substitute the following:
- “Entry by *Owner*, *Owner’s* forces and/or by *Other Contractors* does not indicate acceptance of the *Work* and does not relieve *Contractor* of any responsibility under the *Contract* including the responsibility to complete the *Work*.”
- Add new paragraph 3.2.7 as follows:
 - “3.2.7 Placing, installing, application and connection of work by *Owner*, *Owner’s* own forces, and/or by *Other Contractors*, on and to the *Work* will not relieve *Contractor’s* responsibility to provide and maintain the specified warranties unless a defect has been created by *Owner*, *Owner’s* own forces or *Other Contractors*.”

• **GC 3.3 TEMPORARY WORK**

- Add new paragraph 3.3.4 as follows:
 - “3.3.4 Temporary or trial usage of any mechanical device, machinery, apparatus, equipment or materials shall not be construed as evidence of acceptance of the same and no claim for damage shall be made by *Contractor* for damage to or breaking of any part of such work which may be used.”

• **GC 3.4 CONSTRUCTION SCHEDULE**

- Delete paragraph 3.4.1 in its entirety and substitute new paragraph 3.4.1:
 - “3.4.1 *Contractor* shall,
 - unless it is required to be submitted earlier in accordance with the *Specifications*, then prior to submitting the first application for payment, submit to *Owner* and *Consultant* for their review and acceptance a construction schedule in electronic format and in hard copy, indicating the critical path for the *Project* demonstrating that the *Work* will be performed in conformity with the *Contract Time* and the *Contract Documents*. Once accepted by *Owner* and *Consultant*, the construction schedule submitted by *Contractor* shall become the baseline construction schedule;
 - provide the necessary expertise and resources (including, without limitation, personnel and equipment) as are necessary to maintain progress under the accepted baseline construction schedule referred to in paragraph 3.4.1.1 or any successor or revised schedule accepted by *Owner* pursuant to this GC 3.4;
 - monitor the progress of the *Work* on a weekly basis relative to the construction schedule, reviewed and accepted pursuant to paragraph 3.4.1.1, or any successor or revised schedule accepted

in writing by *Owner* pursuant to GC 3.4, update the construction schedule on a monthly basis and advise *Consultant* and *Owner* in writing of any variation from the baseline construction schedule or slippage in the baseline construction schedule; and

- if, after applying the expertise and resources required under paragraph 3.4.1.2, *Contractor* forms the view that the slippage in baseline construction schedule reported in paragraph 3.4.1.3 cannot be recovered by *Contractor*, it shall, in the same notice provided under paragraph 3.4.1.3, indicate to *Consultant* and *Owner* if *Contractor* intends to apply for an extension of *Contract Time* as provided in PART 6 CHANGES IN THE WORK.”

- Add new paragraph 3.4.2:

- “3.4.2 If at any time it should appear to *Owner* or *Consultant* that the actual progress of the *Work* is behind schedule or is likely to become behind schedule, or if *Contractor* has given notice to that effect to *Owner* or *Consultant* pursuant to 3.4.1.3, *Contractor* shall take appropriate steps to cause the actual progress of the *Work* to conform to the schedule and shall produce and present to *Owner* and *Consultant* a recovery plan demonstrating how *Contractor* will achieve the recovery of the schedule. *Owner* may instruct *Contractor*, at *Contractor’s* expense, to employ additional labour and equipment or work overtime or employ any other reasonable procedures, at no expense to *Owner*, to bring the *Work* back to conform with the schedule.”

- **GC 3.5 SUPERVISION**

- Add new paragraphs 3.5.3 and 3.5.4 as follows:

- “3.5.3 *Contractor* shall employ competent *Key Personnel* who will not be removed or replaced during the course of the *Work* without the prior written consent of *Owner*, which approval shall not be unreasonably withheld. Should any of *Contractor’s* personnel prove to be unacceptable to *Owner*, *Owner* shall give written notice to *Contractor* who shall, within seven (7) days of receipt of the written notice, make arrangements to appoint a replacement acceptable to *Owner*.
- 3.5.4 *Contractor’s* site superintendent for the *Contract* shall devote their full time during working hours to the *Project* and remain at the *Place of the Work* until a final certificate of payment has been issued by *Consultant* and all deficiencies in the *Work* have been rectified to the satisfaction of *Owner*. The fulltime site superintendent for the *Contract* shall be named in Schedule “A” – *Key Personnel* and any acceptable replacement shall represent *Contractor* at the *Place of the Work* and notices and instructions given to the site superintendent for the *Contract* by *Consultant* shall be held to have been received by *Contractor*.”

- **GC 3.6 SUBCONTRACTORS AND SUPPLIERS**

- Amend paragraph 3.6.2 by inserting the following at the end of the paragraph:
 - “*Contractor* agrees not to change those *Subcontractors* without prior written approval of *Owner*, acting reasonably. Where *Contractor* wishes to change any identified *Subcontractors* or *Suppliers*, *Contractor* shall set out in writing to *Owner* sufficient reasons for the desired change. *Owner* or *Consultant* shall advise *Contractor* if *Owner* agrees to the proposed change. If *Owner* is not satisfied with *Contractor*’s reason for wanting to change an identified *Subcontractor* or *Supplier*, *Contractor* shall be required to proceed with the identified *Subcontractor* or *Supplier*.”
- Amend 3.6.4 by inserting the following at the end of the paragraph:
 - “unless the request to change a proposed *Subcontractor* or *Supplier* is a result of issues with the ability of the *Subcontractor* or *Supplier* to complete the *Work* in a proper manner, in which case *Contractor* will not be entitled to any change in the *Contract Price* or *Contract Time*”.

• **GC 3.7 LABOUR AND PRODUCTS**

- Add new paragraph 3.7.4:
 - “3.7.4 *Contractor* is responsible for the safe onsite storage of *Products* and their protection (including *Products* supplied by *Owner* and *Other Contractors* to be installed under the *Contract*) in such ways as to avoid dangerous conditions or contamination to the *Products* or other persons or property and in locations at the *Place of the Work* to the satisfaction of *Owner* and *Consultant*. *Owner* shall provide all relevant information on the *Products* to be supplied by *Owner*.”

• **GC 3.8 SHOP DRAWINGS**

- Add the words “AND OTHER SUBMITTALS” to the title of GC 3.8 after “SHOP DRAWINGS”.

Add “and *Submittals*” after the words “*Shop Drawings*” in clauses 3.8.1, 3.8.2, 3.8.3, 3.8.3.2, 3.8.5, and 3.8.6.
- Amend paragraph 3.8.2 by adding the following sentence at the beginning of the paragraph:
 - “Prior to the first application for payment, *Contractor* and *Consultant* shall jointly prepare a schedule of the dates for submission and return of *Shop Drawings* and any *Submittals*.”
- Delete subparagraph 3.8.3.1 in its entirety and substitute new subparagraph 3.8.3.1:

“3.8.3.1 *Contractor* has determined, verified and correlated all field measurements with the *Shop Drawings* and any *Submittals* and field

construction conditions, *Product* requirements, catalogue numbers and similar data, or will do so if not possible at that time, and”

- Delete paragraph 3.8.7 and substitute the following:
 - “3.8.7 *Consultant* will review and return *Shop Drawings* and *Submittals* in accordance with the schedule agreed upon in paragraph 3.8.2, or, in the absence of such schedule, within fifteen (15) *Working Days*. If, for any reason, *Consultant* cannot process the *Shop Drawings* or *Submittals* within the agreedupon schedule or within fifteen (15) *Working Days*, *Consultant* shall notify *Contractor* and they shall meet to review and arrive at an acceptable revised schedule for processing. *Contractor* shall update the *Shop Drawings* and *Submittals* schedule to correspond to changes in the construction schedule.”

- **GC 3.9 DOCUMENTS AT THE SITE**

- Add a new GC 3.9 DOCUMENTS AT THE PLACE OF THE WORK as follows:
- **“GC 3.9 DOCUMENTS AT THE PLACE OF THE WORK**
 - 3.9 *Contractor* shall keep one copy of the current *Contract Documents*, *Supplemental Instructions*, *Contemplated Change Orders*, *Change Orders*, *Change Directives*, reviewed *Shop Drawings*, *Submittals*, reports and records of meetings at the *Place of the Work*, in good order and available to *Owner* and *Consultant*.” Should have progressive/current red line as-built drawings (double check).

- **GC 3.10 CLEAN UP**

- .1 Add a new GC 3.10 CLEAN UP as follows:
- **“GC 3.10 CLEAN UP**
 - 3.10.1 *Contractor* shall maintain the *Work* and *Place of the Work* in a safe and tidy condition and free from the accumulation of waste products and debris, other than that caused by *Owner*, *Other Contractors*, or their employees.
 - 3.10.2 Before applying for *Substantial Performance of the Work* as provided in GC 5.4 – SUBSTANTIAL PERFORMANCE OF THE WORK AND PAYMENT OF HOLDBACK, *Contractor* shall remove waste products and debris, other than that resulting from the work of *Owner*, *Other Contractors*, or their employees, and shall leave the *Place of the Work* clean and suitable for use or occupancy by *Owner*. *Contractor* shall remove products, tools, *Construction Equipment*, and *Temporary Work* not required for the performance of the remaining work.

- 3.10.3 Prior to application for the final payment, *Contractor* shall remove any remaining products, tools, *Construction Equipment*, *Temporary Work*, and waste products and debris, other than those resulting from the work of *Owner*, *Other Contractors*, or their employees.”
- **GC 3.11 USE OF THE WORK**
- .1 Add new GC 3.11 USE OF THE WORK as follows:
- **“GC 3.11 USE OF THE WORK**
 - 3.11.1 *Contractor* shall confine *Construction Equipment*, *Temporary Work*, storage of *Products*, waste products and debris, and operations of employees and *Subcontractors* to limits indicated by laws, ordinances, permits, or the *Contract Documents* and shall not unreasonably encumber the *Place of the Work*.
 - 3.11.2 *Contractor* shall not load or permit to be loaded any part of the *Work* with a weight or force that will endanger the safety of the *Work*.
 - 3.11.3 Except for those normally used during the performance of the *Work*, such as elevator, mechanical, electrical, hydro, *Contractor* shall not use any service plant or equipment installed as part of the *Work* without prior written consent from *Owner*. On receipt of such consent, *Contractor* shall be subject to any conditions set out as part of such consent and shall be responsible for all costs, damage and compensation for wear and tear.
 - 3.11.4 If storage or other areas are required for the *Work* in addition to the *Work Site*, *Contractor* shall be responsible for making arrangements to obtain the additional areas and obtaining any necessary permits, permission or authorization and, if required, for making permit, rental or other payments that may be required for such purpose.”
- **GC 4.1 CASH ALLOWANCES**
 - Delete paragraph 4.1.4 in its entirety and substitute new paragraph 4.1.4:
 - “4.1.4 Any surpluses in one or more cash allowance may at the election of *Owner* be expended pursuant to paragraph 4.1.3 in respect of other cash allowances or to fund changes in the *Work* by way of *Change Order* or *Change Directive*, as the case may be, but without the imposition of *Overhead* or profit in respect *Work* pertaining to such other cash allowances or changes.”
 - Delete paragraph 4.1.5 in its entirety and substitute new paragraph 4.1.5:
 - “4.1.5 Where the value of the *Work* under cash allowances exceeds the aggregate amount of all the cash allowances stated in the *Contract Documents*, *Contractor* shall be compensated for the approved amount of such excess and for *Overhead* and profit on such approved amount, with

the *Contract Price* being adjusted to reflect such excess, all pursuant to, and only to the extent permitted under, GC 6.1 - CHANGES, 6.2 - CHANGE ORDER and GC 6.3 - CHANGE DIRECTIVE.”

- Delete paragraph 4.1.7 in its entirety and substitute new paragraph 4.1.7:
 - “4.1.7 *Contractor* shall provide a schedule prior to the first application for progress payment that shows when the items called for under cash allowances must be ordered to avoid delaying the progress of the *Work*.”
- Add new paragraph 4.1.8:

“4.1.8 *Owner* reserves the right to call, or to have *Contractor* call, competitive bids for portions of the *Work*, to be paid for from cash allowances. If *Owner* determines to proceed with competitive bids, *Contractor* shall comply with the directions of *Owner*.”

• **GC 5.1 FINANCING INFORMATION REQUIRED OF THE OWNER**

- Amend the heading, “GC 5.1 FINANCING INFORMATION REQUIRED OF THE OWNER” to read, “GC 5.1 FINANCING INFORMATION REQUIRED”.
- Delete paragraph 5.1.1 in its entirety and substitute new paragraph 5.1.1:
 - “5.1.1 *Contractor* shall provide *Owner* with timely *Notice in Writing* of any material change in its financial ability to (a) properly complete the *Work* in accordance with the *Contract Documents* or (b) fulfil its obligations under the *Contract*.”
- Delete paragraph 5.1.2 in its entirety and substitute the following: “Intentionally deleted”.

• **GC 5.2 APPLICATIONS FOR PAYMENT**

- Amend paragraph 5.2.2 by adding the following sentence to the end of the paragraph: “Applications for payment shall be made in a form that is mutually acceptable to *Owner* and *Contractor*.”
- Amend paragraph 5.2.3 by deleting “delivered to” and substitute “incorporated into”.
- Amend paragraph 5.2.4 by inserting the following after the word “*Work*” in the second line: “in a format acceptable to *Owner* and *Consultant*”.
- Delete paragraph 5.2.7 in its entirety and substitute new paragraph 5.2.7:
 - “5.2.7 *Contractor* shall submit, with each application for payment, as a true conditions precedent to *Contractor’s* right to payment under this *Contract*:

- .1 evidence of compliance with workers' compensation legislation at the *Place of the Work*, including a Workplace Safety & Insurance Board Clearance Certificate;
- .2 after the first payment, a statutory declaration by *Contractor* as to the distribution made of the amounts previously received, on an original form of Statutory Declaration CCDC Document 9A-2001, stating that payments in connection with the *Work*, as noted in the statutory declaration, have been made to the end of the period immediately preceding that covered by the current application; and
- .3 if the application is for payment of the lien holdback amount, a written request for release of holdback including a declaration that no written notices of lien have been received by *Contractor*."
- Add to the end of paragraph 5.2.8 the following new sentence:

"Any *Products* delivered to the *Place of the Work* but not yet incorporated into the *Work* shall remain at the risk of *Contractor* until *Ready-for-Takeover* notwithstanding that title has passed to *Owner* pursuant to GC 14.1 OWNERSHIP OF MATERIALS."
- Add new paragraph 5.2.9:

• "5.2.9 *Contractor* shall prepare and maintain current asbuilt *Drawings* which shall consist of the *Drawings and Specifications* revised by *Contractor* during the *Work*, showing changes to the *Drawings and Specifications*, which current asbuilt *Drawings* shall be maintained by *Contractor* and made available to *Consultant* for review with each application for progress payment. *Consultant* reserves the right to retain a reasonable amount for the value of the asbuilt *Drawings* not presented for review."

• **GC 5.4 SUBSTANTIAL PERFORMANCE OF THE WORK AND PAYMENT OF HOLDBACK**

- Amend paragraph 5.4.1 by deleting the words "20 calendar days" in the second line and substituting the words "fifteen (15) *Working Days*" therefor, and by adding the following at the beginning of the paragraph:

• "When *Contractor* considers that the *Work* is substantially performed, or if permitted by the lien legislation applicable to the *Place of the Work* a designated portion thereof which *Owner* agrees to accept separately is substantially performed, *Contractor* shall, within one (1) *Working Day*, deliver to *Consultant* and *Owner* a written application for payment of the lien holdback amount, in accordance with GC 5.3, for review by *Consultant* to establish *Substantial Performance of the Work* or substantial performance of the designated portion of the *Work*."

- Delete paragraph 5.4.2 in its entirety and substitute the following: “Intentionally deleted”.
- Delete paragraph 5.4.3 in its entirety and substitute new paragraph 5.4.3:
 - “5.4.3 Subject to the terms and conditions of the *Contract*, the requirements of any *Payment Legislation*, and any Notice of Non-Payment of Holdback, the holdback amount authorized by the certificate for payment of the holdback shall be due and payable on the first (1st) *Working Day* following the expiration of the holdback period stipulated in the *Payment Legislation* applicable to the *Place of the Work*. *Owner* may retain out of the holdback amount any sums required by law to satisfy any liens against the *Work* or, if permitted by the lien legislation applicable to the *Place of the Work*, other third party monetary claims against *Contractor* which are enforceable against *Owner*.”
- Amend paragraph 5.4.5 by deleting “hereby agrees to release, and shall release,” and substituting “may agree to release”.
- Add new paragraph 5.4.7 as follows:

“5.4.7 *Contractor* shall publish a copy of the Certificate of *Substantial Performance of the Work* within seven (7) days of receiving a copy of the Certificate of *Substantial Performance of the Work* signed by *Consultant*, and *Contractor* shall provide suitable evidence of the publication to *Consultant* and *Owner*. If *Contractor* fails to publish such notice, *Owner* shall be at liberty to publish and back charge *Contractor* its costs for doing so.”
- Add new paragraph 5.4.8 as follows:

“5.4.8 For the purposes of obtaining *Substantial Performance of the Work* and the lien legislation applicable to the *Place of the Work* relating to the meaning of substantial performance, the *Contractor* acknowledges that the improvements required by this *Contract*, cannot be considered “substantially completed” or “ready for use” until all items listed in paragraphs a) through j) below have been completed and/or provided in full. The *Contractor* agrees that its failure to submit all of the listed materials and documentation in conformance with the *Contract Documents* shall constitute proper grounds for the *Consultant* to reject the *Contractor’s* application for *Substantial Performance of the Work*.

 - (a) Submission of Warranties, Data Manuals and As-Built Drawings and Specifications in acceptable manner;
 - (b) Instruction of *Owner* in the operation of systems;
 - (c) Approval to occupy completed work, from authorities having jurisdiction;

- (d) Insurance advisory organization approval of sprinkler system received by *Consultant*;
- (e) Submission to and acceptance by the *Consultant* of interim accounts of the *Work* showing all additions and deletions to the *Contract Price*;
- (f) Elevator inspection and approval by governing authority received by *Consultant*;
- (g) All systems and equipment started up and tested including final balancing;
- (h) All life safety systems verified by *Contractor* and *Consultant* as complying with the requirements of the *Contract Documents*;
- (i) Local fire authority has inspected and confirmed that life safety systems are acceptable.
- (j) All spare parts and maintenance materials.

and any other materials or documentation required to be submitted under the *Contract*, together with written proof acceptable to the *Owner* and the *Consultant* that the *Work* is substantially performed in accordance with the requirements of the *Contract Documents*, lien legislation applicable to the *Place of the Work*, and the municipal government, utilities and other authorities having jurisdiction.”

- **GC 5.5 FINAL PAYMENT**

- Delete paragraph 5.5.1 in its entirety and substitute new paragraph 5.5.1:
 - “5.5.1 When *Contractor* considers that the *Work* is completed and satisfies the requirements of *Total Completion of the Work* and *Completion of Commissioning*, *Contractor* shall submit an application for final payment. *Contractor’s* application for final payment shall be accompanied by any documents or materials not yet delivered as agreed to in writing by *Owner* pursuant to paragraph 12.1.2 of GC 12.1 - READY-FOR-TAKEOVER together with fully complete asbuilt *Drawings*. Should *Contractor* fail to deliver any of the said documents, or other documents required to be delivered pursuant to the *Contract Documents*, *Owner* shall be at liberty to withhold from amounts otherwise payable to *Contractor*, an amount, in the discretion of *Owner*, up to the full amount otherwise payable to *Contractor* as security for the obligation of *Contractor* to deliver the undelivered documents.”
- Delete from the first line of paragraph 5.5.2 the words, “calendar days” and substitute the words “*Working Days*”.

- Delete paragraph 5.5.4 in its entirety and substitute new paragraph 5.5.4:
 - “5.5.4 Subject to the other requirements of the *Contract*, the unpaid balance of the *Contract Price* shall become payable to *Contractor* on the tenth (10th) *Working Day* following the issuance of *Consultant’s* final certificate for payment, subject to *Owner’s* right to withhold payment from the unpaid balance of the *Contract Price* for any amounts required pursuant to GC 5.6 DEFERRED WORK, and any sums required to satisfy any lien or trust claims arising from the *Work*”.
- Add new paragraph 5.5.5:
 - “5.5.5 As additional preconditions for release of the final payment, *Contractor* shall submit the following documentation:
 - *Contractor’s* written request for release of final payment, including a declaration that no written notices of lien have been received by it;
 - *Contractor’s* Statutory Declaration CCDC 9A2001; and
 - *Contractor’s* Workplace Safety & Insurance Board Clearance Certificate.”

• **GC 5.6 DEFERRED WORK**

- Add new paragraph GC 5.6.2:
 - “5.6.2 Notwithstanding the provisions of GC 5.3 PAYMENT, GC 5.4 SUBSTANTIAL PERFORMANCE OF THE WORK AND PAYMENT OF HOLDBACK and GC 5.5 FINAL PAYMENT, *Owner* may withhold payment of any amounts otherwise due under the *Contract* on account of any costs or damages *Owner* has incurred or, is likely to incur, by reason of:
 - defective or incomplete portions of the *Work* or damage to the work of *Other Contractors* not rectified in accordance with the *Contract*;
 - failure of *Contractor* to indemnify *Owner* in accordance with the terms of the *Contract*;
 - failure of *Contractor* to fulfil its obligations in respect of construction liens in accordance with GC 14.2 CONSTRUCTION LIENS;
 - evidence of *Contractor’s* failure to make payments to *Subcontractors* or *Suppliers*;
 - unsatisfactory prosecution of the *Work* by *Contractor* or any *Subcontractor*, and

- failure to attain the *Contract Time*.”

Add new paragraph GC 5.6.3:

“5.6.3 Where *Owner* has withheld payment of any portion of the *Contract Price* pursuant to the provision of paragraphs 5.6.1 or 5.6.2, *Owner* shall be entitled to apply such withheld portion towards any costs or damages suffered by *Owner*.”

• **GC 6.1 OWNER’S RIGHT TO MAKE CHANGES**

- Add the following new paragraphs:

- “6.1.3 *Contractor* shall not be entitled to receive any compensation or extension of *Contract Time*, and *Owner* shall have no obligation or liability to pay compensation to *Contractor*, unless a *Change Order* or *Change Directive* has been issued to *Contractor*, in writing, and before *Contractor* commences with any work in respect of such *Change Order* or *Change Directive*.

- 6.1.4 There shall be no adjustment to the *Contract Time* should *Contractor* fail to present a request for a specific adjustment to the *Contract Time*, if any:

- .1 at the time of first presenting a request for adjustment to the *Contract Price* in response to a *Contemplated Change Order*; or
- .2 within ten (10) *Working Days* of receipt of a *Change Directive*.

- 6.1.5 There shall be no adjustments to the *Contract Time* or *Contract Price* or compensation or payment of any kind whatsoever including potential or contingent costs for matters such as loss of profit, loss of productivity, loss of opportunity or any other such losses based on the quantity, scope or cumulative value or number of changes in the *Work* whether resulting from one or more *Change Orders* or *Change Directives*, unless agreed in writing by the parties in a *Change Order*.

- 6.1.6 There shall be no adjustments to the *Contract Time* or *Contract Price* or compensation or payment of any kind whatsoever relating to a *Contractor* claim unless notice in writing of the claim is given to *Owner*, through *Consultant* not later than twenty (20) *Working Days* after *Contractor* becomes aware of the claim.

- 6.1.7 Any *Change Order* or *Change Directive* shall clearly set out what, if any, extension of the *Contract Time* is anticipated as a result thereof and failing the inclusion of the same, *Contractor* shall be barred in making a claim for extension of the *Contract Time* in respect thereof.

- 6.1.8 With respect to the valuation of any adjustment in the *Contract Price*, subject to any different or additional requirements contained in the *Contract Documents*, the following shall apply:
 - if applicable, unit prices included in the *Contract*, or prices pro rata thereto, will be used to value changes;
 - proposed methods of adjustment should contain itemized breakdowns describing the net actual value of the *Work* (excluding *Value Added Taxes*), *Contractor's* markup for overhead and profit, the markup for overhead and profit of *Subcontractors*, and where appropriate, detailed quotations or cost vouchers from *Subcontractor* and *Suppliers*;
 - all overhead costs are deemed to include both site and head office overhead costs, as well as any applicable insurance and bonding costs;
 - labour costs shall be the actual labour costs based upon rates prevailing at the *Place of the Work* and payable to workers, plus applicable statutory charges such as Workplace Safety & Insurance Board coverage, Employment Insurance, Canada Pension, vacation pay, and hospitalization and medical insurance; and
 - if a change involves both additions and deletions to the *Work*, the value of the change will be determined based upon the net difference to the *Work* occasioned by the change. For greater certainty, *Contractor's* markup for overhead and profit only will be applied to the net value of the change.
- 6.1.9 *Owner*, through *Consultant*, reserves the right to authorize payment for a change in the *Work* by means of *Cash Allowance*. For greater certainty, *Contractor* is not entitled to any markup for overhead and profit on such amounts.”

GC 6.2 CHANGE ORDER

- Delete paragraph 6.2.1 inserting new paragraph 6.2.1 as follows:
 - “6.2.1 When a change in the *Work* is proposed or required, *Consultant* or *Owner* shall provide a notice describing the proposed change in the *Work* to *Contractor*. *Contractor* shall provide:
 - a quotation from the *Contractor*, on the *Contractor's* letterhead and with *Contractor's* signature;
 - quotations from all *Subcontractors*, each on *Subcontractor's* respective letterhead and with *Subcontractor's* respective signature; and

- the following information in quotations from *Subcontractors* and *Contractor*:
 - (1) a complete breakdown for all items of material;
 - (2) a total number of hours for labour;
 - (3) a dollar rate applied against individual material items and labour quantities;
 - (4) stipulated adjustment in the *Contract Time*, if any, for the proposed change in the *Work*;
 - (5) percentage values for overhead and profit by *Contractor* and *Subcontractors*; and
 - (6) all mathematical calculations, which shall be complete.
- Quotations submitted with any of the above items or information in this paragraph 6.2.1 missing or incorrect will be returned for revision.”
- Add new GC 6.2.3 as follows:
- “6.2.3 *Owner* and *Contractor* acknowledge and agree that *Contractor* shall not be entitled to any mark-ups for overhead and profit on any changes in the *Work*, save and except for the following:
 - .1 for changes to the *Work* with a value of less than or equal to \$50,000, *Contractor* shall be entitled to mark-ups for overhead and profit of ten percent (10%) on work performed by *Contractor’s* own forces plus five percent (5%) on work performed by *Subcontractors*; and
 - .2 for changes to the *Work* with a value greater than \$50,000, *Contractor* shall be entitled to mark-ups for overhead and profit of seven and a half percent (7.5%) on work performed by *Contractor’s* own forces plus five percent (5%) on work performed by *Subcontractors*.”
 - .3 for changes to the *Work* for any value, a *Subcontractor* shall be entitled to mark-ups for overhead and profit of ten percent (10%) on work performed by *Subcontractor’s* own forces.
 - .4 If *Subcontractor* retains another subcontractor (“sub-subcontractor”), no additional mark-up shall be charged to the *Owner* for the sub-subcontractor’s work.

- **GC 6.3 CHANGE DIRECTIVE**

- Amend paragraph 6.3.7.1 by (a) adding the following to the end of sub-paragraph (1) “carrying out the *Work*, including necessary supervisory services”, and (b) deleting sub-paragraphs (2), (3) and (4) in their entirety.
- Delete paragraphs 6.3.7.5, 6.3.7.11, 6.3.7.15 and 6.3.7.19.

- **GC 6.4 CONCEALED OR UNKNOWN CONDITIONS**

- Amend paragraph 6.4.1 by (a) deleting the first line and replacing with “If *Contractor* discovers conditions at the *Place of the Work* that, in *Contractor’s* opinion, are:” and (b) deleting the final two lines and replacing with “then *Contractor* shall give *Notice in Writing* to *Owner* and *Consultant* of such conditions before they are disturbed and in any event no later than two (2) *Working Days* after first observance of the conditions.”
- Add new paragraphs 6.4.5 and 6.4.6 as follows:
 - “6.4.5 *Contractor* confirms that, prior to entering into the *Contract*, applying the standard of care described in paragraph 1.5.1.1 of GC 1.5 - PROJECT REQUIREMENTS, it carefully investigated the *Place of the Work*. Notwithstanding any other provision in the *Contract*, *Contractor* is not entitled to compensation or to an extension of the *Contract Time* for conditions which could reasonably have been ascertained by *Contractor* by such investigation undertaken prior to the submission of the bid.
 - 6.4.6 *Contractor* shall not be entitled to claim, and waives its rights to make a claim, for any additional compensation or any increase to the *Contract Time* or *Contract Price*, if *Contractor* fails to provide notice to *Owner* as required in paragraph 6.4.1.”

- **GC 6.5 DELAYS**

- Add the following to the end of paragraphs 6.5.1 and 6.5.2: “but excluding any special, indirect or consequential losses or damages, including but not limited to, loss of use, loss of productivity, loss of revenue, overhead and/or profit”.
- Add the following to the end of paragraph 6.5.3: “and provided that such costs are reasonable (and, in any event, shall exclude any special, indirect or consequential losses or damages, including but not limited to, loss of use, loss of productivity, loss of revenue, overhead and/or profit).”
- Amend paragraph 6.5.3.3 by adding “epidemics or pandemics (except for *COVID-19*),” after the word “conditions,”
- Add new paragraphs 6.5.6, 6.5.7 and 6.5.8:
 - “6.5.6 *Contractor* shall assume any and all known conditions of *COVID-19* at the time of the execution of this *Contract* during and throughout the performance of the *Work*. Where there is any delay to the *Contract Time*

and/or *Project* or increase to the cost of the *Work*, caused by, resulting from, or related to any stop work order, legislation, measures, or direction, issued by any governmental authority having jurisdiction over the *Project*, in respect to, related to, or resulting from *COVID-19* which arises after the execution of this *Contract*, then:

- .1 *Contractor* shall be entitled to an extension of the *Contract Time* for a reasonable time caused by such stop work order, other order, measure, or direction; and
- .2 *Contractor* shall not be entitled to any increase in compensation whatsoever, including, without limitation, any (a) increase to the *Contract Price*, payment of (b) costs, expenses or damages, and/or (c) any indirect, consequential, or special damages, such as loss of profits, loss of opportunity or loss of productivity.
- 6.5.7 *Contractor* shall at all times perform the services required to perform the *Work* in accordance with the *Contract Documents* diligently and expeditiously, to maintain an orderly progress of the *Work*, and in conformity with the *Contract Time* and any revisions made thereto in accordance with the *Contract Documents*. *Contractor* shall at all times provide sufficient personnel to accomplish its services within the *Contract Time*.
- 6.5.8 If *Contractor* is delayed in the performance of the *Work* by an act or omission of *Contractor* or anyone employed or engaged by *Contractor* directly or indirectly, or by any cause within *Contractor's* control, then *Contractor* shall take appropriate steps, in accordance with paragraph 3.4.2 of GC 3.4 - CONSTRUCTION SCHEDULE, to recover any lost time, and the costs of such recovery efforts shall be to *Contractor's* account. To the extent that *Contractor* caused delay results in *Owner* incurring additional costs and expenses and/or a change in the *Contract Time*, *Contractor* shall be liable to *Owner* for *Owner's* cost and damages arising therefrom, including but not limited to, all services required by *Owner* from *Consultant* as a result of such delay by *Contractor* and, in particular, the cost of *Consultant's* services during the period between the date of *Ready-for-Takeover* stated in Article A1 herein as the same may be extended through the provision of these General Conditions and any later, actual date of *Ready-for-Takeover* achieved by *Contractor*."

• **GC 6.6 CLAIMS FOR A CHANGE IN CONTRACT PRICE**

- In paragraph 6.6.5, delete "claim" in the second line and substitute "necessary claim information".
- Add new paragraphs 6.6.7 and 6.6.8 as follows:
 - "6.6.7 *Owner* may make claims arising out of the costs incurred for additional services provided by *Consultant* resulting from *Contractor's* failure to perform the *Work* in accordance with the terms and conditions

of the *Contract*, including *Contractor's* issuance of unnecessary requests for information. *Consultant* will notify *Owner* and *Contractor* where it has been determined that additional services will be required or have been provided in order not to cause a delay. *Owner* shall make claims against *Contractor* based on *Consultant's* invoices.

- 6.6.8 *Contractor* shall not make claims arising out of any *COVID-19* conditions known at the time of the execution of this *Contract*.”

- **GC 7.1 OWNER’S RIGHT TO PERFORM THE WORK, TERMINATE THE CONTRACTOR’S RIGHT TO CONTINUE WITH THE WORK OR TERMINATE THE CONTRACT**

- .1 Amend paragraph 7.1.2 by (a) adding the words “or *Owner* determines that sufficient cause exists to justify such action,” in line three after the words “substantial degree”, and (b) deleting the words “including references to applicable provisions of the *Contract*”.
- .2 Delete paragraph 7.1.5.2 and insert new paragraph 7.1.5.2 as follows:
“7.1.5.2 withhold further payment to *Contractor* until *Owner* has completed all *Work* required by the *Contract Documents* and satisfied any of its costs or damages resulting from *Contractor's* default,”
- .3 Amend paragraph 7.1.5.3 by deleting the words “as certified by the *Consultant*”.

- **GC 7.2 CONTRACTOR’S RIGHT TO SUSPEND THE WORK OR TERMINATE THE CONTRACT**

- Amend paragraph 7.2.2 by (a) adding the words “or related to *COVID-19*” after the first instance of the word “*Contractor*” in the third line, and (b) adding the following second sentence at the end of the paragraph: “If the *Work* is suspended or otherwise delayed as a result of *COVID-19* for a period of ninety (90) *Working Days*, *Contractor* may, upon giving *Owner* twenty (20) days *Notice in Writing*, terminate the *Contract*.”
- Delete subparagraph 7.2.3.1 in its entirety and substitute the following: “Intentionally deleted”.
- Delete subparagraph 7.2.3.3 in its entirety and substitute the following:
“7.2.3.3 *Owner* fails to pay *Contractor* when due the amount certified by *Consultant* or awarded by adjudication, arbitration or a court, except where *Owner* has a bona fide claim for set off, or”
- Delete from line 2 of subparagraph 7.2.3.4, the words, “except for GC 5.1 – FINANCING INFORMATION REQUIRED OF THE OWNER”.
- Amend paragraph 7.2.4 by deleting “5” and substitute “fifteen (15)”.

- Amend paragraph 7.2.5 by (a) deleting “reasonable profit” in line 2, (b) deleting the words “damages” in line 3 and replace with the words “direct and demonstrable costs and expenses”, and (c) by adding the following to the end of the paragraph: “but excluding any special, indirect or consequential losses or damages, including but not limited to, loss of use, loss of productivity, loss of revenue, overhead and/or profit”.
- Add the following new paragraph 7.2.6:
 - “7.2.6 *Owner’s* withholding of progress payments, holdback payment and/or final payments pursuant to GC 5.6 shall not constitute a default under paragraph 7.2.3 permitting *Contractor* to stop the *Work* or terminate the *Contract*.”

• **GC 8.1 AUTHORITY OF THE CONSULTANT**

- Delete paragraphs 8.1.1, 8.1.2 and 8.1.3 and substitute the following:
 - “8.1.1 Differences between *Owner* and *Contractor* as to the interpretation, application, or administration of this *Contract*, or any failure to agree where agreement between the parties is called for in the *Contract* (the “*Dispute*”) which are not resolved in the first instance by finding of *Consultant* pursuant to the provisions of GC - 2.2 ROLE OF THE CONSULTANT, paragraphs 2.2.6 and 2.2.7 shall be settled in accordance with the requirements of this GC 8.1.
 - 8.1.2 The claimant shall give written notice of the *Dispute* (“*Notice of Dispute*”) to the other party no later than seven (7) days after the receipt of *Consultant’s* finding given under paragraphs 2.2.7 or 2.2.8 of GC 2.2 ROLE OF THE CONSULTANT. The *Notice of Dispute* shall set forth particulars of the matters in dispute, the probable extent and value of the damage, and the relevant provisions of the *Contract Documents*. The other party shall reply within seven (7) days of receipt of the *Notice of Dispute*, or such longer period as mutually agreed by the parties in writing, setting out the response and any relevant provisions of the *Contract Documents*.
 - 8.1.3 The parties shall make all reasonable efforts to resolve the *Dispute* by amicable negotiations and agree to provide, without prejudice, full, frank, candid, and timely disclosure of relevant facts, information and documents to facilitate the negotiations.
 - 8.1.4 If the *Dispute* is not resolved promptly by amicable negotiations in accordance with GC 8.1.3, *Consultant* may provide instructions that, in *Consultant’s* opinion, are necessary for the proper performance of the *Work* and to prevent delays pending settlement of the *Dispute*. The parties shall act immediately according to such instructions, it being understood that by so doing neither party will jeopardize any claim they may have. If it is subsequently determined that such instructions were in error or at variance with the *Contract Documents*, *Owner* shall pay *Contractor* verifiable costs incurred by *Contractor* in carrying out such instructions, which *Contractor* was required to do beyond what the *Contract*

Documents correctly understood and interpreted would have required *Contractor* to do including costs resulting from interruption of the *Work*.

- 8.1.5 It is agreed that no act by either party shall be construed as a renunciation or waiver of any of their rights or recourses, provided the party has given the notices in accordance with paragraph 8.1.2 and has carried out the instructions as provided in paragraph 8.1.4, if any.
- 8.1.6 If the parties have not been able to resolve the *Dispute* in accordance with paragraph 8.1.3, the parties may agree to submit the *Dispute* to be finally resolved by arbitration under the rules of arbitration as provided in CCDC 40 in effect at the time of the execution of the *Contract*.
- 8.1.7 If no agreement is made for arbitration, then either party may submit the *Dispute* to such judicial tribunal as the circumstances may required.”

- **GC 8.3 NEGOTIATION, MEDIATION AND ARBITRATION**

- Delete 8.3 in its entirety and substitute the following: “Intentionally deleted”.

- **GC 8.4 RETENTION OF RIGHTS**

- Amend paragraph 8.4.2 by deleting “paragraph 8.3.6 of GC 8.3 – NEGOTIATION, MEDIATION AND ARBITRATION” and substituting “GC 8.1 – AUTHORITY OF THE CONSULTANT”.
 - Add new paragraph 8.4.3:
 - “8.4.3 If the parties agree under paragraph 8.1.6 of GC 8.1 - AUTHORITY OF THE CONSULTANT to have a *Dispute* resolved by arbitration, *Contractor* agrees that this paragraph 8.4.3 shall be construed as a formal consent to the stay of any lien proceedings until an award is rendered in the arbitration or such *Dispute* is otherwise resolved between the parties; provided, however, that in no event shall *Contractor* be deprived of its right to enforce its lien against the *Project* should *Owner* fail to satisfy any arbitral award. For greater certainty, nothing in this paragraph 8.4.3 shall prevent *Contractor* from taking the steps required by the *Construction Act*, RSO 1990, c C.30 to preserve and/or perfect a lien to which it may be entitled.”

- **GC 9.1 PROTECTION OF WORK AND PROPERTY**

- Delete subparagraph 9.1.1.1 in its entirety and substitute new subparagraph 9.1.1.1:
 - “9.1.1.1 errors or omissions in the *Contract Documents* which *Contractor* could not have reasonably discovered applying the standard of care described in paragraph 1.5.1.1 of GC 1.5 - PROJECT REQUIREMENTS;”

- Delete paragraph 9.1.2 in its entirety and substitute the following new paragraph 9.1.2:
 - “9.1.2 Before commencing any *Work*, *Contractor* shall determine the locations of all underground utilities and structures indicated in or reasonably apparent or determinable from the *Contract Documents* or that are reasonably discoverable by applying an inspection of the *Place of the Work* to the degree of care and skill described in paragraph 1.5.1.1 of GC 1.5 - PROJECT REQUIREMENTS.”
- Add new paragraph 9.1.5:
 - “9.1.5 *Contractor* shall neither undertake to repair and/or replace any damage whatsoever to the *Work* of *Other Contractors*, or to adjoining property, nor acknowledge the same was caused or occasioned by *Contractor*, without first consulting *Owner* and receiving written instructions as to the course of action to be followed from either *Owner* or *Consultant*. However, where there is danger to life or public safety, *Contractor* shall take such emergency action as it deems necessary to remove the danger.”

• **GC 9.2 TOXIC AND HAZARDOUS SUBSTANCES**

- Add new paragraph 9.2.5.5 as follows:
 - “.5 comply with *Owner’s* requirements and specifications for *hazardous substances* contained in the *Contract Documents*.”
- Add to paragraph 9.2.6 after the words “is responsible”, the following:
 - “or whether any toxic or *hazardous substances* or materials already at the *Place of the Work* (and which were then harmless or stored, contained or otherwise dealt with in accordance with legal and regulatory requirements) were dealt with by *Contractor* or anyone for whom *Contractor* is responsible in a manner which does not comply with legal and regulatory requirements, or which threatens human health and safety or the environment, or material damage to the property of *Owner* or others,”
- Add to paragraph 9.2.7 after the words “is responsible”, the following:
 - “or that any toxic or *hazardous substances* or materials already at the *Place of the Work* prior to *Contractor* commencing the *Work* (and which were then harmless or stored, contained or otherwise dealt with in accordance with legal and regulatory requirements) were dealt with by *Contractor* or anyone for whom *Contractor* is responsible in a manner which does comply with legal and regulatory requirements,”
- Add to paragraph 9.2.8 after the words “is responsible”, the following:
 - “or that any toxic or *hazardous substances* or materials already at the *Place of the Work* prior to *Contractor* commencing the *Work* (and which

were then harmless or stored, contained or otherwise dealt with in accordance with legal and regulatory requirements) were dealt with by *Contractor* or anyone for whom *Contractor* is responsible in a manner which does not comply with legal and regulatory requirements, or which threatens human health and safety or the environment, or material damage to the property of *Owner* or others,”

- Add “and *Consultant*” after the word “*Owner*” in subparagraph 9.2.8.4.

- **GC 9.4 CONSTRUCTION SAFETY**

- Delete paragraphs 9.4.1 to 9.4.5 and substitute the following:
 - “9.4.1 *Contractor* shall be solely responsible for construction safety at the *Place of the Work* and for compliance by it and its *Subcontractors* and *Suppliers* with the applicable construction health and safety legislation, and *Owner’s* Safety and Infection Control Regulations, Guidelines and Instructions for *Contractors*. *Contractor* shall be responsible for initiating, maintaining and supervising all safety precautions and programs in connection with the performance of the *Work*. *Contractor* shall be deemed to be the, accepts the designation of, “constructor” as defined in the *OHSA* for the *Project*, and responsibility for the obligations and liabilities associated therewith. Prior to the commencement of the *Work*, *Contractor* shall submit to *Owner* a copy of the Notice of Project filed with the Ministry of Labour in respect of the *Work*.
 - 9.4.2 Prior to the commencement of the *Work*, *Contractor* shall submit to *Owner*:
 - a current Workplace Safety & Insurance Board Clearance Certificate;
 - copies of *Contractor’s* insurance policies having application to the *Project* or certificates of insurance, at the option of *Owner*;
 - documentation of *Contractor’s* inhouse safetyrelated programs; and
 - a copy of the Notice of Project filed with the Ministry of Labour naming itself as “constructor” under *OHSA*.
 - 9.4.3 *Contractor* hereby represents and warrants to *Owner* that appropriate health and safety instruction and training have been provided and will be provided to *Contractor’s* employees and *Subcontractors*, *Suppliers* and any one for whom *Contractor* is responsible, before the *Work* is commenced and agrees to provide to *Owner*, if requested, proof of such instruction and training.
 - 9.4.4 *Contractor* shall tour the appropriate area to familiarize itself with the job site prior to commencement of the *Work*.

- 9.4.5 *Contractor* shall never work in a manner that may endanger anyone.
- 9.4.6 *Owner* has authority, but not the obligation, to stop the progress of the *Work* whenever in the reasonable opinion of *Owner* or *Consultant* such stoppage is necessary to ensure the safety of life, or of the *Work* or of neighbouring property.
- 9.4.7 *Contractor* shall indemnify and save harmless *Owner*, *Consultant* and their respective agents, officers, directors, employees, consultants, successors and assigns from and against any and all liability, cost, damage or loss, including legal fees and fines, related to or arising out of any and all acts or omissions of *Contractor*, its *Subcontractors*, *Suppliers*, employees, agents or representatives which contravene *Contractor*'s duties and obligations, as constructor, pursuant to the *OHSA*, including the payment of legal fees and disbursements on a solicitor and client basis.
- 9.4.8 Without limiting the generality of paragraph 9.4.7, *Contractor*,
 - .1 agrees to waive and release *Owner* and its agents, officers, directors, employees, successors and assigns from any and all claims, demands, losses, costs, damages, actions, suits, or proceedings as against; and
 - .2 shall indemnify and save harmless *Owner*, *Consultant* and their respective agents, officers, directors, employees, successors and assigns, from and against any and all claims, demands, losses, costs, damages, actions, suits, or proceedings by any *Contractor*'s employees, *Subcontractors*, *Suppliers*, and/or third parties,
- that arise out of, are caused or contributed by, or are attributable to *COVID-19*, including and without limiting the generality of the foregoing, any claims, demands, losses, costs, damages, actions, suits or proceedings arising from, caused or contributed by, or attributable to *COVID-19* outbreaks originating from or on *Owner*'s premises.
- 9.4.9 In the event that *Owner* engages *Other Contractors* at the *Place of the Work* or performs work with its own forces *Owner* undertakes to include in its contracts with *Other Contractors* and/or in its instructions to its own forces the requirement that the *Other Contractors* or own forces, as the case may be, must comply with directions and instructions from *Contractor* as "constructor" with respect to occupational health and safety and related matters."

• GC 9.5 MOULD

- Delete paragraph 9.5.3.3 in its entirety and substitute new paragraph 9.5.3.3 as follows:
 - “9.5.3.3 extend the *Contract Time* for such reasonable time as *Consultant* may recommend in consultation with *Contractor*. If, in the opinion of

Consultant, Contractor has been delayed in performing the *Work* and/or has incurred additional costs under paragraph 9.5.1.2, *Owner* shall reimburse *Contractor* for its reasonable costs incurred as a result of the delay as certified by *Consultant*, and”

• **GC 10.1 TAXES AND DUTIES**

• Add new paragraphs 10.1.3, 10.1.4 and 10.1.5:

- “10.1.3 *Owner* shall be entitled to all available refunds or rebates of all taxes and custom duties applicable to the *Contract*, and *Contractor* shall cooperate with *Owner* in ascertaining the amount of such tax and custom duties and if necessary claim on its own behalf and transfer to *Owner* or facilitate a direct claim by *Owner* for any such available refund or rebate.
- 10.1.4 *Contractor* acknowledges and agrees that, at the time of execution of this *Contract*, it has taken into consideration in the *Contract Price* all known taxes and duties, including all tariffs that are currently in force and that may reasonably come into force during the progression of this *Contract*.
- 10.1.5 Notwithstanding paragraph 10.1.2, to the extent the *Contractor* imports or attains *Products* or other materials from outside of Canada (“*International Products*”), and any tariffs are increased or placed upon such *International Products* after the execution of this *Contract* for which the *Contractor* intends to seek reimbursement from the *Owner*, including any change to the *Contract Price Work*, then:
 - .1 *Contractor* shall provide notice to *Owner* of any increased or new tariffs on *International Products*, as soon as *Contractor* becomes aware of such tariffs, including the amount of such tariffs, and the particular *International Products* to which the tariffs apply.
 - .2 *Contractor* shall take all reasonable steps to seek out and locate alternatives in Canada or elsewhere for the *International Products* that comply with the *Contract Documents*, but would reduce or eliminate the impact of any such tariffs (the “*Alternative Products*”). If no *Alternative Products* are available, *Contractor* shall advise *Owner*, including explanation for the same.
 - .3 *Contractor* shall provide the *Owner* with a summary (the “*Tariff Proposal*”) setting out information that the *Owner* reasonably requires to consider proceeding with the *International Products* or *Alternative Products*, including, without limitation, any proposed change to the *Contract Price* and/or *Contract Time* resulting from the tariffs if the *Contractor* continues with the *International Products*, as compared to the *Contractor* proceeding with the *Alternative Products*.
 - .4 *Owner* shall have ten (10) *Working Days* from the receipt of the

Tariff Proposal, or such longer period as may be agreed in writing by the parties, to (a) select whether to have the *Contractor* continue with the *International Products* or proceed with the *Alternative Products*, which selection shall be recorded in a *Change Order*, or (b) request additional information reasonably required for the *Owner* to make such decision from the *Contractor*. The *Contractor* shall provide any additional requested information to the *Owner* as soon as possible, and the *Owner* shall have ten (10) *Working Days* from the submission of such information to make its selection. Any change to the *Contract Price* and/or *Contract Time*, shall apply on a go forward basis from the date of the *Change Order*, unless otherwise agreed by the parties and expressly set out in the *Change Order*. For clarity, the *Owner* shall not be responsible for paying to the *Contractor* the cost of any increased or new tariffs on any *International Products*, nor shall the costs of any increased or new tariffs form a change to the *Contract Price*, for amounts incurred prior to the issuance of the *Change Order*, as described in this paragraph 10.1.5.

- **GC 10.2 LAWS, NOTICES, PERMITS, AND FEES**

- Add to the end of paragraph 10.2.4, the following words:

“*Contractor* shall notify the Chief Building Official or the registered code agency where applicable, of the readiness, substantial completion, and completion of the stages of construction set out in the Ontario Building Code. *Contractor* shall be present at each site inspection by an inspector or registered code agency as applicable under the Ontario Building Code.”

- Delete from the first line of paragraph 10.2.5 the word, “The” and substitute the words “Subject to paragraphs 1.1.3 and 1.1.4 of GC 1.1 - GENERAL CONDITIONS OF THE STIPULATED PRICE CONTRACT, the”.
- Amend paragraph 10.2.7 by (a) deleting “bid closing” and substituting “execution of the *Contract*”, and (b) adding the following to the end of the paragraph: “, save and except for changes related to *COVID-19* which are provided for under paragraph 6.5.6 of GC 6.5 - DELAYS.”

- **GC 12.1 READY-FOR-TAKEOVER**
 - Amend paragraph 12.1.1.1 by adding “, and all prerequisites for substantial performance under the *Construction Act*, RSO 1990, c C.30 have been satisfied.” after the word “*Work*”.
 - Amend paragraph 12.1.1.4 by (a) adding “spare parts, maintenance materials, warranties, data manuals, and specifications” after the words “maintenance documents” and (b) deleting the word “immediate”.
 - Add new paragraphs 12.1.1.9, 12.1.1.10, and 12.1.1.11:
 - “.9 Local fire authority has inspected and confirmed that life safety systems are acceptable, if required by the *Contract Documents*.”
 - “.10 Elevator inspection and approval by governing authority received by Consultant, if required by the *Contract Documents*.”
 - “.11 Any other prerequisites required by the *Contract Documents*.”
 - Amend paragraph 12.1.2 by deleting “to 12.1.1.6” and substituting “, 12.1.1.5, and 12.1.1.8”.
 - Amend paragraph 12.1.4 by deleting “10 calendar days” and substituting “fifteen (15) *Working Days*, or such longer period as may be reasonably required in the circumstances”.
 - Amend paragraph 12.1.6 by adding “RIGHT OF ENTRY AND ” after “GC 12.2 – ”.
- **GC 12.2 RIGHT OF ENTRY AND EARLY OCCUPANCY BY THE OWNER**
 - Delete GC 12.2 EARLY OCCUPANCY BY THE OWNER in its entirety and substitute the following:
 - **GC 12.2 RIGHT OF ENTRY AND EARLY OCCUPANCY BY THE OWNER**
 - “12.2.1 *Owner* shall have the right to enter or occupy the *Work* in whole or in part for the purpose of placing fittings and equipment or for other uses before *Ready-for-Takeover*, if, in the opinion of *Consultant* and *Owner*, such entry or occupation does not prevent or substantially interfere with *Contractor* in completion of the *Contract* within the *Contract Time*. Such entry or occupation shall not be considered as acceptance of the *Work* or in any way relieve *Contractor* from responsibility to complete the *Contract* or its obligations under the *Contract*.”
 - 12.2.2 The use or occupancy of the *Work* or any part thereof by *Owner* shall not be taken in any manner as an acceptance by *Owner* of any work or any other part or parts of the *Work* or *Products* not in accordance with the *Contract Documents* or to relieve *Contractor* or his surety from

liability in respect of the observance or performance of the *Contract* save to the extent that loss or damage is caused during such use or occupancy by *Owner* or by persons for whom *Owner* is responsible. In particular, without limiting the generality of the foregoing, the use or occupancy of the *Work* or any part thereof by *Owner* shall not release *Contractor* from liability, or waive or impair any rights of *Owner*.”

- **GC 12.3 WARRANTY**

- Amend paragraph 12.3.1 by adding the following sentence to the end of the paragraph: “The time period for the warranty with respect to any item corrected shall commence from the date when the defect is corrected and the remedial work is accepted by *Consultant*.”
- Delete from the first line of paragraph 12.3.2 the word, “The” and substitute the words “Subject to paragraphs 1.1.3 and 1.1.4 of GC 1.1 - GENERAL CONDITIONS OF THE STIPULATED PRICE CONTRACT, the”.
- Amend paragraph 12.3.6 by adding the words “, unless otherwise required by the *Contract Documents*” to the end of the third sentence.

- **GC 13.1 INDEMNIFICATION**

- Delete paragraph 13.1.1 in its entirety and substitute the following:
 - “13.1.1 Without restricting the parties obligations to indemnify respecting toxic and hazardous substances, patent fees, and health and safety:
 - .1 *Contractor* shall indemnify and hold harmless *Owner*, *Consultant* and their respective agents and employees from and against claims, demands, losses, costs, damages, actions, suits, or proceedings (hereinafter called “claims”), by third parties that arise out of, or are attributable to, *Contractor’s* performance of the *Work* or anyone for whose acts *Contractor* may be liable including *Subcontractor* and, *Suppliers*; and
 - .2 *Owner* shall indemnify and hold harmless *Contractor*, *Contractor’s* agents and employees from and against claims, demands, losses, costs, damages, actions, suits, or proceedings arising out of *Contractor’s* performance of the *Contract* which are attributable to a lack of or defect in title or an alleged lack of or defect in title to the *Place of the Work*.”
- Delete paragraphs 13.1.2, 13.1.4 and 13.1.5 in their entirety and substitute the following: “Intentionally deleted”.
- Amend paragraph 13.1.3 by deleting “paragraphs 13.1.1 and 13.1.2” and substituting “paragraph 13.1.1”.

- **GC 13.2 WAIVER OF CLAIMS**

- Delete paragraphs 13.2.3, 13.2.4, 13.2.5, and 13.2.7 and substitute the following: “Intentionally deleted”.
- Amend paragraph 13.2.8 by deleting “party” and substituting “*Contractor*”.
- Amend paragraph 13.2.9 by deleting “paragraphs 13.2.1 or 13.2.3” and substituting “paragraph 13.2.1”.

Add new PART 14 as follows:

“PART 14 OTHER PROVISIONS

• **OWNERSHIP OF MATERIALS**

- Unless otherwise specified, all materials existing at the *Place of the Work* at the time of execution of the *Contract* shall remain the property of *Owner*. All *Work* and *Products* delivered to the *Place of the Work* by *Contractor* shall be the property of *Owner*. *Contractor* shall remove all surplus or rejected materials as its property when notified in writing to do so by *Consultant*.

• **CONSTRUCTION LIENS**

- 14.2.1 *Contractor* shall ensure that *Owner’s* title to the *Project* site is kept free and clear of all construction liens and certificates of action claimed by any person providing services and/or materials to *Contractor* for the *Project*. For greater certainty, this GC 14.2 shall not apply to construction liens or certificates of action that arise as a direct result of the failure by *Owner* to pay *Contractor* in accordance with the terms of this *Contract*.
- 14.2.2 If a construction lien or certificate of action is registered against the title to the *Project* lands, or given with respect to the *Work*, by any person claiming to provide services and/or materials to or through *Contractor*, or *Owner* receives a written notice of lien, *Contractor* shall, within seven (7) *Working Days* of having been notified or becoming aware of the existence of the construction lien, certificate of action or written notice of lien, see to its removal by way of discharge, release or by posting security in accordance with the *Construction Act*, RSO 1990, c C.30, or in the case of a written notice of lien, its written withdrawal
- 14.2.3 In the event that *Contractor* fails to comply with GC 14.2, *Owner* may see to the removal of the construction lien or certificate of action or the withdrawal of the written notice of lien, and in that event, *Contractor* shall be liable to *Owner* for any and all costs and expenses, including legal costs on a full indemnity basis, associated therewith. *Owner* shall be at liberty to set off such costs and expenses against any amount otherwise due to *Contractor* under this *Contract*. If there is no amount owing by *Owner* to *Contractor*, then *Contractor* shall reimburse *Owner* for all of the said costs and associated expenses.

- **CONTRACTOR DISCHARGE OF LIABILITIES**

- 14.3.1 In addition to the obligations assumed by *Contractor* pursuant to GC 3.6 - SUBCONTRACTORS AND SUPPLIERS, *Contractor* agrees to discharge all liabilities incurred by it for labour, materials, services, *Subcontractors* and *Products*, used or reasonably required for use in the performance of the *Work*, except for amounts withheld by reason of legitimate dispute which have been identified to the party or parties, from whom payment has been withheld.

- **DAILY REPORTS/DAILY LOGS**

- 14.4.1 *Contractor* shall cause its supervisor, or such competent person as it may delegate, to prepare a daily log or diary reporting on weather conditions, work force of *Contractor*, *Subcontractors*, *Suppliers* and any other forces on site and also record the general nature of *Project* activities. Such log or diary shall also include any extraordinary or emergency events which may occur and also the identities of any persons who visit the site who are not part of the day-to-day work force.
- *Contractor* shall also maintain records, either at its head office or at the job site, recording manpower and material resourcing on the *Project*, including records which document the activities of *Contractor* in connection with GC 3.4 - CONSTRUCTION SCHEDULE, and comparing that resourcing to the resourcing anticipated when the most recent version of the schedule was prepared pursuant to GC 3.4 - CONSTRUCTION SCHEDULE.

- **HOSPITAL RELATED PROVISIONS**

- 14.5.1 *Contractor* recognizes and understands that *Owner* is a hospital approved under the *Public Hospitals Act*, RSO 1990, c P.40 and is therefore subject to a highly regulated legal and operational environment. Without limiting the generality of any other provision in the *Contract*, *Contractor* shall provide reasonable cooperation and assistance to *Owner* during any evaluations of the *Work* (including, without limitation, any post occupancy evaluation required by the Ministry of Health and Long Term Care) and in obtaining required regulatory approvals prior to using the *Work* (including, without limitation, approvals required by Section 4(2) of the *Public Hospitals Act*, RSO 1990, c P.40).
- 14.5.2 *Contractor* acknowledges that the security and safety of the patients, employees and other occupants of the existing hospital is paramount. If any of the employees of *Contractor* or the *Subcontractors* is determined by *Owner* to be a concern for the security or safety of such patients, employees or occupants, *Owner* may require that *Contractor* replace such employee.
- 14.5.3 *Contractor* recognizes that part of the *Work* may consists of the renovation of existing buildings and structures or the addition of a structure to an existing building and that the provision of patient care

during construction is a priority for *Owner*. *Contractor* shall comply with the reasonable instructions provided by *Owner* (including, without limitation, *Owner's* infection control practitioner) in regard to patient care and the operation and use of the hospital during the performance of the *Work*. Any costs incurred by *Contractor* in complying with the said instructions shall be part of the *Contract Price*.

- 14.5.4 Notwithstanding any other provision in the *Contract*, paramountcy of access must be given to emergency vehicles and no claim may be made by *Contractor* for any delay in the performance of the *Work* as a result of any temporary lack of access to the Place of *Work* resulting from this paramountcy of access by emergency vehicles, provided that *Owner* will use commercially reasonable efforts to avoid and to limit the duration of any temporary lack of access for this reason.
- 14.5.5 *Owner* has the authority, but without the obligation, to stop the *Work* in any circumstance affecting the safety of life or property or otherwise may cause an unsafe condition for the operation of the existing hospital. *Contractor* shall abide by *Owner's* instructions to stop the *Work* and to any related instructions pertaining to the circumstance without any increase in the *Contract Price* and extension in the *Contract Time* if such circumstance was caused by *Contractor*, *Subcontractors* or *Suppliers*.
- 14.5.6 *Contractor* shall, and shall cause the *Subcontractors* and *Suppliers* to, comply with hospital policies and procedures including, without limitation, environmental requirements, infection control measures and safety and emergency preparedness guidelines which are or come into force (including, without limitation, those forming part of the *Contract Documents*) as such documents are amended by *Owner* from time to time, provided that a material amendment to the hospital policies and procedures by *Owner* after the date of the Agreement which gives rise to a significant change in the *Work* shall be dealt with in accordance PART 6 - CHANGES IN THE WORK.”

Summary of Work

PART 1 - GENERAL

1.1 Section Includes

- .1 *Contract Documents* conventions.
- .2 *Contract Documents* for construction purposes.
- .3 Law, notices, permits and fees.
- .4 Documents at the *Place of the Work*.
- .5 Use of premises and the *Place of the Work*.
- .6 Items supplied by *Owner*.
- .7 Seismic design requirements.

1.2 Contract Documents Conventions

- .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*.
 - .1 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 The *Consultant* and *Owner* 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, nor to establish subcontract limits between Sections or Divisions of the *Work*.
 - .3 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*.
- .2 The *Specifications* are written in the imperative mood and in streamlined form. The imperative language is directed to *Contractor*, unless stated otherwise.
- .3 Wherever the words "approved", "satisfactory", "selected", "directed", "required", "submit", or similar words or phrases are used in the *Contract Documents*, it shall be understood that they mean, unless the text specifies otherwise, "approved by *Consultant*", "satisfactory to *Consultant*", "selected by *Consultant*", "directed by *Consultant*", "required by *Consultant*", "submit to *Consultant*".
- .4 Omission of words "a" and "the" throughout these *Specifications* is intentional and is done to keep instructions and directions clear and concise. Use of these words is implied and shall be read throughout as if written in full.
- .5 Complete sentences by reading "shall", "*Contractor* shall", "shall be", and similar phrases by inference. Where a colon (:) is used within sentences and phrases, read the words "shall be" by inference.
- .6 Fulfill and perform all indicated requirements whether stated imperatively or otherwise.

Summary of Work

- .7 When used in the context of a *Product*, read the word “provide” to mean “supply and install to result in a complete installation ready for its intended use”.
- .8 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*.
- .9 The use of the words “include” or “including”, or variations thereof, within the *Contract Documents* is not limiting.
- .10 The words “make good” or “making good” shall mean that, when a finish or material has been altered, the material or finish shall be repaired or replaced, and refinished to match existing quality and appearance to acceptance of *Consultant*, and that repaired or replaced and refinished *Work* shall not be discernible from existing materials or finishes when judged by the *Consultant* from a viewing distance of 1830 mm (6’), and that such work is included in the *Contract Price*.
- .11 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*.
- .12 Reference standards:
 - .1 “Reference standards” means consensus standards, trade association standards, guides, and other publications expressly referenced in *Contract Documents*.
 - .2 Where an edition or version date is not specified, referenced standards shall be deemed to be the latest edition or revision issued by the publisher at the time of bid closing, except as follows:
 - .1 If a particular edition or revision date of a specified standard is referenced in an applicable code or other regulatory requirement, the edition or version referenced in the applicable code or other regulatory requirement shall apply.
 - .3 The *Contract Documents* may specify, indicate, or schedule requirements that exceed the requirements of the building code, other applicable codes, requirements of authorities having jurisdiction, and standards cited in the *Contract Documents*. In such cases, the requirements specified, indicated, or scheduled in the *Contract Documents* shall govern.
 - .4 If compliance with two or more reference standards is specified and the standards establish different or conflicting requirements, comply with the most stringent requirement. Refer uncertainties to *Consultant* for clarification.

1.3 *Contract Documents* for Construction Purposes

- .1 *Owner* shall supply *Contractor* with a complete set of *Contract Documents* in electronic form before commencement of the *Work*.

Summary of Work

1.4 Laws, Notices, Permits, and Fees

- .1 The building code - Ontario Regulation 163/24, 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* shall apply and pay for the building permit. The *Contractor* shall 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 Arrange for inspection, testing and acceptance of the *Work* required by the authorities having jurisdiction. Be responsible for necessary preparations, provisions and pay costs.
- .5 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 – Part 1 Sentence 1.3.5.1(2) and Sentence 1.3.5.2 of the building code. The *Contractor* shall be present at each site inspection by an inspector or registered code agency as applicable under Division C – Part 1 Sentence 1.3.5.2 of the building code.
 - .1 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 – Part 1 Sentence 1.3.5.3 of the building code, 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 Documents at the *Place of the Work*

- .1 Maintain at the *Place of the Work*, documents in hard copy in accordance with GC 3.9, supplemented as follows:
 - .1 Construction and submittal schedules.
 - .2 RFI responses and RFI log.
 - .3 Field test reports and independent testing reports.
 - .4 *Consultant's* field review reports and deficiency reports.
 - .5 Manufacturer's field review reports.
 - .6 Reports by authorities having jurisdiction.
 - .7 Building and other applicable permits, and related permit documents.

Summary of Work

- .8 Daily log in accordance with GC 14.4.1 and including:
 - .1 Pertinent conditions at the *Place of the Work*.
 - .2 Working hours worked at the *Place of the Work*.
 - .3 Activities with intermittent progress.
 - .4 Time lost and explanation for such time lost.
 - .5 Difficulties (work scheduled to start but did not with the reason why, delays, labour inefficiencies, labour shortage, weather).
 - .6 *Products* and materials delivered.
 - .7 Equipment mobilized and/or demobilized.
 - .8 Demolition conditions.
 - .9 Start and finish date of each part of the *Work*.
- .9 As-built drawings recording as-built conditions, instructions, changes for structure, equipment, wiring, plumbing, and the like, as called for in Section 01 78 00 and Divisions 21, 22, and 23 and Divisions 26, 27, and 28, prior to being concealed.
- .2 Make above material available to *Consultant* upon request.

1.6 Use of Premises and the *Place of the Work*

- .1 *Consultant* will designate working areas sufficient for the work of this *Project*. Confine all operations to designated areas.
- .2 Do not unreasonably encumber the *Place of the Work* with materials or equipment.
- .3 Move stored products or equipment which interferes with operations of *Owner* and other *Contractors*.
- .4 Obtain and pay for use of additional storage or work areas required for construction operations.
- .5 *Contractor* will control the designated areas. Limited exterior storage and storage at the *Place of the Work* within designated areas, if available, or other space will be allocated by the *Consultant*. Relocate stored equipment and materials which interfere with construction operations, as directed by the *Owner*.
- .6 When *Contractor* requires access to the completed areas, permission shall be obtained from the *Owner* for such access, and work shall be performed only at times approved by the *Owner* which may require work outside of regular working hours or *Working Days*. *Contractor* shall be responsible to coordinate the work of the *Subcontractors* included and include in their *Contract Price* all costs for expenses, overhead, profit and applicable taxes related to performing such work during regular time or after hours and weekends, as instructed by the *Owner*.
- .7 *Contractor* shall document existing conditions and damage and shall ensure that measures are implemented to protect the finished areas, and leave at the end of the work period affected surfaces and equipment clear and ready for use by the *Owner*. Such protective measures shall first be approved by the *Owner* and include, but are not limited to:

Summary of Work

- .1 Tarping or covering with plywood existing flooring.
- .2 Tarping of walls, furniture and equipment finishes.
- .3 Removal and reinstallation of existing furniture and equipment.
- .8 Except as otherwise specified, *Contractor* has unrestricted use of *Place of the Work* from time of *Contract* award until *Ready-for-Takeover*.
- .9 Confine *Construction Equipment*, Temporary Work, storage of *Products*, waste products and debris, and all other construction operations to limits required by laws, ordinances, permits, and *Contract Documents*, whichever is most restrictive. Do not unreasonably encumber *Place of the Work*.

1.7 Not In Contract Items and 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*.
 - .1 *Owner* Responsibilities:
 - .1 Order and pay for items supplied by *Owner* not already in *Owner's* possession.
 - .2 Arrange and pay for delivery of items supplied by *Owner* F.O.B. the *Place of the Work*, within time frames required by *Contractor's* progress schedule. If delivered sooner than required by *Contractor's* latest progress schedule submitted to *Owner*, arrange and pay for delivery to a temporary storage location and subsequent delivery to the *Place of the Work*.
 - .3 Advise *Contractor* in writing of the value of items supplied by *Owner* for *Contractor's* insurance purposes.
 - .4 Arrange and pay for delivery to *Contractor* of reviewed *Shop Drawings*, *Product* data, samples, and manufacturer's installation instructions.
 - .5 Inspect deliveries jointly with *Contractor*.
 - .6 Submit claims for transportation damage.
 - .7 Arrange for replacement of damaged, defective or missing items identified at time of delivery.
 - .8 Arrange for manufacturer's field services.
 - .9 Arrange for delivery of manufacturer's warranties to *Contractor* for inclusion in operation and maintenance manual.
 - .2 *Contractor* Responsibilities:
 - .1 Designate in progress schedule, time frames for delivery of items supplied by *Owner* to the *Place of the Work* and for receipt of related submittals. If the *Place of the Work* is not ready to receive delivery of items supplied by *Owner* within the time frame indicated in the latest progress schedule submitted to *Owner*, arrange and pay for delivery to a temporary storage location and subsequent delivery to the *Place of the Work*.

Summary of Work

- .2 Review all required submittals and notify *Consultant* of any observed discrepancies or anticipated problems.
- .3 Ensure that course of construction insurance is adequate to cover items supplied by *Owner*.
- .4 Receive and unload items supplied by *Owner* at the *Place of the Work*.
- .5 Inspect deliveries jointly with *Owner*. Record and notify *Owner* and *Consultant* of shortages and visibly damaged or defective items.
- .6 Handle items supplied by *Owner* at the *Place of the Work*, including uncrating and storage. Dispose of waste materials and debris.
- .7 Take appropriate precautions to protect items supplied by *Owner* from loss or damage.
- .8 Repair or replace items damaged at the *Place of the Work*.
- .9 Assemble, install, connect, adjust, and finish items supplied by *Owner* as specified.
- .10 Arrange for inspections required by authorities having jurisdiction as specified.
- .11 Arrange for or perform testing as specified.
- .12 Workmanship warranty for installation.

1.8 Seismic Design and Requirements

- .1 Design building components, assemblies and systems of the *Work*, as applicable, to meet seismic requirements pertinent to the location of the *Place of the Work* in accordance with the building code, 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.

Summary of Work

PART 2 - PRODUCTS

Not applicable.

PART 3 - EXECUTION

Not applicable.

END OF SECTION

Allowances

PART 1 - GENERAL

1.1 Section Includes

- .1 Cash allowances.

1.2 Cash Allowances

- .1 Expenditure of cash allowances:
 - .1 The *Owner*, through the *Consultant*, will provide the *Contractor* with documentation required to permit pricing of a cash allowance item.
 - .2 The *Owner*, through the *Consultant*, may request the *Contractor* to disclose originals of all bids, quotations, and other price-related information received from potential *Suppliers* or *Subcontractors*.
 - .3 The *Owner*, through the *Consultant*, will determine by whom each cash allowance item will be performed and for what amount. Obtain *Owner's* prior written approval in the form of a *Change Order* before entering into a subcontract, amending an existing subcontract, or before performing by own forces, work that is covered by a cash allowance. Upon issuance of the *Change Order*, the *Contractor's* responsibilities for a cash allowance item shall be the same as for other work of the *Contract*.
- .2 Cash allowances are for supply and installation unless otherwise specified.
- .3 Amount of each cash allowance does not include *Contractor's* overhead and profit, and other related costs, which shall be included in the *Contract Price* and not in the cash allowance.
- .4 Cash allowances for supply only:
 - .1 Amount of each cash allowance includes:
 - .1 Cost of *Products* as invoiced by the *Supplier*, including delivery and applicable taxes but excluding Value Added Taxes.
 - .2 Amount of each cash allowance does not include costs of the following items, which costs shall be included in the *Contract Price* and not in the cash allowance:
 - .1 Unloading, handling and storage at the *Place of the Work*.
 - .2 Installation and all other related costs.
- .5 Cash allowances for install only:
 - .1 Amount of each cash allowance includes:
 - .1 Unloading, storing, handling of *Products* at the *Place of the Work*.
 - .2 Installation, finishing, and commissioning of *Products*.
 - .3 Applicable taxes and duties (excluding Value Added Taxes).
 - .2 Amount of each cash allowance does not include costs of the following items, which costs shall be included in the *Contract Price* and not in the cash allowance:
 - .1 Net cost of *Products*.

Allowances

- .2 Delivery to the *Place of the Work*.
- .6 Cash allowances for supply and install:
 - .1 Amount of each cash allowance includes:
 - .1 All costs to provide the specified *Products*, including supply, installation, and related costs, excluding Value Added Taxes.
 - .2 *Subcontractor's* and sub-*Subcontractor's* overheads and profits related to the cash allowance.
 - .7 Cash allowances for services:
 - .1 Amount of each cash allowance includes:
 - .1 All costs related to the services, excluding Value Added Taxes.
 - .2 *Subcontractor's* and sub-*Subcontractor's* overheads and profits related to the cash allowance.
 - .8 List of cash allowances
 - .1 The following cash allowances are included in the *Contract Price*:

.1 Hazardous materials abatement	\$50,000.00
.2 Unforeseen conditions	\$70,000.00
TOTAL ALLOWANCES (1 to 2 Incl.)	\$120,000.00

PART 2 - PRODUCTS

Not applicable.

PART 3 - EXECUTION

Not applicable.

END OF SECTION

Substitution Procedures

PART 1 – GENERAL

1.1 Section Includes

- .1 Substitution procedures.
- .2 Submission requirements for proposed substitutions.

1.2 Definition

- .1 In this Section "Substitution" means a *Product*, a manufacturer, or both, not originally specified in *Contract Documents* by proprietary name but proposed for use by *Contractor* in place of a *Product*, a manufacturer, or both, specified by proprietary name.

1.3 Substitution Procedures

- .1 Proposals for substitutions of *Products* and materials must be submitted in accordance with procedures specified in this section.
- .2 *Contractor* may propose a Substitution wherever a *Product* or manufacturer is specified by proprietary name(s), unless there is accompanying language indicating that Substitutions will not be considered.
- .3 *Contractor* may propose a Substitution wherever a *Product* or manufacturer is specified by proprietary name(s) and accompanied by language such as "or equal", "or approved equal", or other similar words. Do not construe such language as an invitation to unilaterally provide a Substitution without *Consultant's* prior acceptance in writing. Do not order or install any Substitution without a *Supplemental Instruction* or *Change Order*.
- .4 Provided a proposed Substitution submission includes all of the information specified in this Section under Submission Requirements For Proposed Substitutions, *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*.
- .5 *Consultant* may recommend to *Owner* acceptance of a Substitution proposed by *Contractor* if satisfied that:
 - .1 The proposed substitute *Product* is the same type as, is capable of performing the same functions as, interfaces with adjacent work the same as, and meets or exceeds the standard of quality, performance and, if applicable, appearance and maintenance considerations, of the specified *Product*.
 - .2 The proposed substitute manufacturer has capabilities comparable to the specified manufacturer.
 - .3 The Substitution provides a benefit to *Owner*.
- .6 If *Contractor* fails to order a specified *Product* or order a *Product* by a specified manufacturer in adequate time to meet *Contractor's* construction schedule, neither *Consultant* nor *Owner* will consider that a valid reason to accept a Substitution.
- .7 If *Owner* accepts a Substitution, the change in the *Work* will be documented in the form of either a *Supplemental Instruction* or *Change Order* as specified in Section 01 26 00.

Substitution Procedures

- .8 If a Substitution is accepted in the form of a *Supplemental Instruction* or *Change Order*, *Contractor* shall not revert to an originally specified *Product* or manufacturer without *Consultant's* prior written acceptance.

1.4 Submission Requirements for Proposed Substitutions

- .1 Include with each proposed Substitution the following information:
 - .1 Identification of the Substitution, including *Product* name and manufacturer's name, address, telephone numbers, and web site.
 - .2 Reason(s) for proposing the Substitution.
 - .3 A statement verifying that the Substitution will not affect the *Contract Price* and *Contract Time* or, if applicable, the amount and extent of a proposed increase or decrease in *Contract Price* and *Contract Time* on account of the Substitution.
 - .4 A statement verifying that the Substitution will not affect the performance or warranty of other parts of the *Work*.
 - .5 Manufacturer's *Product* literature for the Substitution, including material descriptions, compliance with applicable codes and reference standards, performance and test data, compatibility with contiguous materials and systems, and environmental considerations.
 - .6 *Product* samples as applicable.
 - .7 A detailed comparison of the physical properties and performance characteristics of the specified *Product* and the Substitution, with any significant variations clearly highlighted.
 - .8 Availability of maintenance services and sources of replacement materials and parts for the Substitution, as applicable, including associated costs and time frames.
 - .9 If applicable, estimated life cycle cost savings resulting from the Substitution.
 - .10 Details of other projects and applications where the Substitution has been used.
 - .11 Identification of any consequential changes in the *Work* to accommodate the Substitution and any consequential effects on the performance of the *Work* as a whole. A later claim for an increase to the *Contract Price* or *Contract Time* for other changes in the *Work* attributable to the Substitution will not be considered.
 - .12 Confirmation of proposed substitution delivery, in writing by *Product* manufacturer.
 - .13 Compliance with the building codes and requirements of authorities having jurisdiction.
 - .14 Copy of manufacturer's warranty for any *Product* or system for which an extended warranty has been specified, along with copy of manufacturer's warranty for specified *Product* or system with differences highlighted.
- .2 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.

Substitution Procedures

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

PART 2 - PRODUCTS

Not applicable.

PART 3 - EXECUTION

Not applicable.

END OF SECTION

Contract Modification Procedures

PART 1- GENERAL

1.1 Section Includes

- .1 Schedule of labour rates.
- .2 Schedule of equipment rates.
- .3 *Supplemental Instructions.*

1.2 Schedule of Labour Rates

- .1 Prior to the first application for payment, submit for the *Consultant's* review a schedule of labour rates for all trades and classifications of trades, such as journeymen, apprentices, and foremen that will be employed in the *Work*. Provide a breakdown of payroll burden component of labour rates.
- .2 Labour rates shall reflect the salaries, wages, and benefits paid to personnel in the direct employ of the *Contractor*, *Subcontractors*, and sub-*Subcontractors*, stated as hourly rates, that will be used when:
 - .1 Preparing price quotations for *Change Orders*.
 - .2 Determining the cost of work attributable to *Change Directives*.
- .3 Labour rates stated in the schedule of labour rates shall be consistent with rates that will actually be paid, and payroll burden costs that will actually be incurred, in the normal performance of the *Work*, during regular working hours. Labour rates shall not include any additional overhead and profit component.
- .4 Where collective agreements apply, the labour rates shall not exceed those established by collective agreement.
- .5 Obtain the *Owner's* written acceptance of the schedule of labour rates before submitting the first *Change Order* quotation.
- .6 Accepted schedule of labour rates will be used solely for evaluating *Change Order* quotations and cost of performing work attributable to *Change Directives*.
- .7 The *Contractor* may request amendments to the accepted schedule of labour rates if changes in the labour rates that will actually be paid, or payroll burden cost that will actually be incurred, in the normal performance of the *Work* can be demonstrated. Obtain the *Owner's* written acceptance of such changes.

1.3 Schedule of Equipment Rates

- .1 Prior to the first application for payment, submit for the *Consultant's* review a schedule of equipment rates for *Contractor* owned *Construction Equipment*.
- .2 Equipment rates shall reflect the rates that will be used when:
 - .1 Preparing price quotations for *Change Orders*.
 - .2 Determining the cost of work attributable to *Change Directives*.
- .3 Equipment rates stated in the schedule shall be consistent with local equipment rental market rates and shall not include any additional overhead and profit component.

Contract Modification Procedures

- .4 Provide equipment rates for hourly, daily, weekly, and monthly use.
- .5 Obtain the *Owner's* written acceptance of the schedule of equipment rates before submitting the first *Change Order* quotation.
- .6 Accepted schedule of equipment rates will be used solely for evaluating *Change Order* quotations and cost of performing work attributable to *Change Directives*.
- .7 The *Contractor* may request amendments to the accepted schedule of equipment rates if changes in local equipment rental market rates can be demonstrated. Obtain the *Owner's* written acceptance of such changes.

1.4 Supplemental Instructions

- .1 The *Consultant* may issue *Supplemental Instructions* to provide clarifications to the *Contract Documents*, provide additional information, or make minor variations in the *Work* not involving adjustment in the *Contract Price* or *Contract Time*.
- .2 If the *Contractor* considers a *Supplemental Instruction* to require an adjustment in *Contract Price* or *Contract Time*, the *Contractor* shall promptly notify the *Consultant* and the *Owner* in writing and shall not proceed with any work related to the *Supplemental Instruction* pending receipt of a *Change Order*, a *Change Directive*, or, in accordance with the dispute resolution provisions of the General Conditions of *Contract*, a Notice in Writing of a dispute and instructions to proceed.

PART 2 - PRODUCTS

Not applicable.

PART 3 - EXECUTION

Not applicable.

END OF SECTION

Payment Procedures

PART 1 - GENERAL

1.1 Section Includes

- .1 Schedule of values.
- .2 Cash flow projection.
- .3 Payment for *Products* stored off site.

1.2 Schedule of Values

- .1 At least 10 *Working Days* prior to the first application for payment, submit for *Consultant's* review an initial schedule of values. Modify the initial schedule of values if and as requested by *Consultant*. Obtain *Consultant's* written acceptance of the initial schedule of values prior to the first application for payment.
- .2 Together with the first and all subsequent applications for payment, submit updated versions of the schedule of values to indicate the values, to the date of application for payment, of work performed and *Products* delivered to *Place of the Work*.
- .3 Refer to attached sample and fill out applicable fields as instructed by the *Consultant*.
- .4 Values that are required to be carried are as stipulated below:
 - .1 For item 01 00 06, Schedule and Updating, the *Contractor* is required to carry a value of two thousand dollars (\$2,000) in accordance with the attached sample for monthly draws
 - .2 For item 01 00 20, Project Books, Warranties and As Built Drawings, the *Contractor* is required to carry a value of twenty thousand dollars (\$20,000) in accordance with the attached sample.
 - .3 For item 01 00 21, Coordination and Preparation of Interference Drawings, the *Contractor* is required to carry a value of twenty thousand dollars (\$20,000) in accordance with the attached sample.
- .5 Upon request by *Consultant*, support values given with data that will substantiate their correctness.
- .6 Submit quantities of designated materials.
- .7 Schedule of Values will be used only as basis for *Contractor's* Application for payment.

1.3 Cash Flow Projection

- .1 Prior to the first application for payment submit, for *Consultant's* review, a forecast of approximate monthly progress payments for each month of the *Contract Time*.
- .2 Submit revised cash flow forecasts monthly. Submit additional revised cash flow forecasts when there are significant changes in rate of progress of the *Work* or significant changes in the *Contract Price* as determined by the *Consultant*. Submit additional revised cash flow forecasts when requested by *Consultant*.

Payment Procedures

1.4 Payment for Products Stored Off Site

- .1 *Owner* may, due to extraordinary circumstances and at *Owner's* sole discretion, make payments for *Products* delivered to and stored at a location other than *Place of the Work*, subject to:
 - .1 A request submitted by *Contractor* in writing, with appropriate justification.
 - .2 Whatever conditions *Owner* or *Consultant* may establish for such payments, as required to protect *Owner's* interests.

PART 2 - PRODUCTS

Not applicable.

PART 3 - EXECUTION

Not applicable.

END OF SECTION

Schedule of Values Form (Sample)

No.	Description	Value	Compl.	Compl. %	Compl. This	Compl. Last	This %
	DIVISION 1						
01 00 01	Bonding						
01 00 02	Insurances						
01 00 03	Site Barricades and Temporary Enclosures						
01 00 04	Site Office and Associated Fixtures						
01 00 05	Site Progress Records (As-built drawings)						
01 00 06	Schedule and Updating						
01 00 07	Cleaning during construction (interior)						
01 00 08	Garbage Disposal						
01 00 09	Office Salaries and Overhead						
01 00 10	Project Manager (s)						
01 00 11	Site Superintendent (s)						
01 00 12	Licenses and Permits						
01 00 13	Temporary Power & Water						
01 00 14	Interior Barricades/Protection						
01 00 15	Equipment Rentals						
01 00 16	Progress Photos						
01 00 17	Final Photos						
01 00 18	Shop Drawings (may be sub-categorized by trades)						
01 00 19	Samples (may be sub-categorized by trades)						
01 00 20	Project Data Books & Warranties						
01 00 21	Coordination and Preparation of Interference Drawings						
01 00 22	Final Cleaning						
01 00 23	General Contractor Commissioning Activities						
01 00 24	Health & Safety Initiatives						
01 00 25	Communications						
01 00 26	Printing						
01 00 27	Other General Expenses (Itemize)						
01 00 28	Schedule Performance Security						
01 00 29	Cash Allowances						
	DIVISION 2						
02 41 13	Demolition						
	DIVISION 5						
05 50 00	Metal Fabrications						
	DIVISION 6						
06 10 53	Rough Carpentry						
06 40 00	Architectural Woodwork						
	DIVISION 7						
07 84 00	Firestopping and Smoke Seals						
07 92 00	Joint Sealants						
	DIVISION 8						
08 11 13	Metal Doors and Frames						
08 14 00	Wood Doors						
08 42 43	ICU Sliding Doors						

Schedule of Values Form (Sample)

08 71 00	Finish Hardware						
08 80 00	Glass and Glazing						
08 87 00	Applied Films						
	DIVISION 9						
09 22 00	Metal Support Systems (Non-Structural)						
09 29 00	Gypsum Board						
09 51 13	Suspended Acoustical Ceilings						
09 65 13	Resilient Base (RB)						
09 65 17	Vinyl Sheet Flooring						
09 67 00	Epoxy Flooring and Wall Coating						
09 91 00	Field Painting						
	DIVISION 10						
10 11 00	Visual Display Surfaces						
10 21 23	Cubicle Curtain and Track						
10 26 13	Corner Guards and Wall Guards						
10 28 00	Washroom Accessories						
	DIVISION 11						
11 70 00	Healthcare Equipment						
	DIVISION 12						
12 35 53	Laboratory Metal Casework						
	DIVISIONS 20, 21, 22, 23, 24, and 25						
20 01 01	Mechanical General Requirements						
20 01 03	Mechanical Coordination and Installation						
	DIVISIONS 26, 27 and 28						
26 05 01	Electrical General Requirements						
26 05 34	Lighting Fixture Raceways						

END OF SECTION

Project Management and Coordination

PART 1 - GENERAL

1.1 Section Includes

- .1 Project coordination and responsibility.
- .2 Building dimension, templates, built-ins, and coordination.
- .3 Coordination and interference drawings.
- .4 Project manager and superintendent.
- .5 Staff.
- .6 Discrepancies and clarifications.
- .7 Request for interpretation (RFI) procedures.

1.2 Project Coordination and Responsibility

- .1 The *Contractor* shall coordinate the progress of the *Work*, mobilization areas of the *Place of the Work*, progress schedules, submittals, access to and use of the *Place of the Work* and facilities subject to any restrictions and conditions in accordance with the *Contract Documents*, reports and records, and any other processes, events, work, approvals, inspections and testing as may be required for the complete, proper and seamless execution of the *Work*.
- .2 The *Contractor* shall be solely responsible for ensuring that the complete *Contract Documents* are distributed to, or otherwise made available for review by, all *Subcontractors* and *Suppliers* as required for the complete and proper and informed coordination and execution of the *Work*. Failure in this regard will be the sole responsibility of the *Contractor* and will not be accepted as a justification for a change in the *Work* and no change in the *Work* will be approved therefore.
 - .1 *Subcontractors* shall be responsible for reviewing the complete set of *Contract Documents*.
- .3 The *Contractor* is required to employ a competent supervisor and necessary assistants who shall be in attendance at the *Place of the Work* at all times throughout the progress of the *Work* when work is being performed. The *Contractor*, through the supervisor, shall maintain good order and discipline among the *Contractor's* employees engaged on the *Work*, and among any *Subcontractors* engaged on the *Work*.
- .4 There shall be cooperation with representatives of Inspection and Testing Companies during the performance of their duties.

1.3 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 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.

Project Management and Coordination

- .3 Supply 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.
- .4 Supply items to be built in, as and when required together with templates, measurements, shop drawings and other related information and assistance.
- .5 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.
- .6 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.
- .7 Check and verify dimensions referring to interfacing of services. Verify such dimensions with interconnected portions of the *Work*.
- .8 Do not scale directly from drawings. Obtain clarification from *Consultant* if there is ambiguity or lack of information.
- .9 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*.
- .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.

1.4 Coordination and Interference Drawings

- .1 The *Contractor* shall be responsible for preparing and submitting to the *Consultant* for review, a consolidated set of installation coordination/interference drawings for the building showing how the building systems (including, but not limited to, domestic heating and cooling piping, air distribution systems, air control boxes, reheat coils, fire protection piping, electrical distribution, fire alarm systems, lighting, communication cabling, security cabling) will fit together above ceiling areas and in exposed ceiling, to allow ceiling heights required by the *Contract Documents* and by maintenance and control access.
 - .1 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.
- .2 Prepare sleeve drawings for work of Divisions 21, 22, and 23, and Divisions 26, 27, and 28 showing size and location of penetrations through load bearing elements. Submit sleeving drawings in electronic form to *Consultant* for review not less than 10 *Working Days* prior to construction of affected work.
- .3 Prepare embedded conduit drawings, showing size and location of penetrations through load bearing elements. Submit embedded conduit drawings in electronic form to *Consultant* for review not less than 10 *Working Days* prior to construction of affected work.

Project Management and Coordination

- .4 Prepare insert setting drawings for work to be cast into concrete and/or mortared into masonry elements. Submit insert setting drawings in electronic form to *Consultant* for review not less than 10 *Working Days* prior to construction of affected work.
- .5 Coordinate placement of equipment to ensure that components will be properly accommodated within spaces provided prior to commencement of *Work*. In areas where equipment and services are exposed care shall be taken to organize and layout services in an organized and orderly manner. Where possible services are to run parallel or at right angles to one another as required. *Consultant* may request that service layout be reconfigured to suit sightline concerns during the coordination drawings review phase. These drawing changes are to be executed at no additional cost to the *Owner*.
- .6 Take complete responsibility for remedial work that results from failure to coordinate the *Work* prior to fabrication and installation.
- .7 Ensure that accesses and clearance required by jurisdictional authorities and/or for easy maintenance of equipment are provided in layout of equipment and services.
 - .1 Indicate required access points, clearances, and sizes for equipment and pieces of equipment required in the *Work*. Note areas where access is compromised by interferences with other services for review by the *Consultant*. Do not proceed with installation of equipment in such compromised areas until a proposed means of providing access has been accepted by the *Consultant*.
- .8 Prepare and circulate coordination, interference and sleeving drawings prior to placing orders for equipment and materials.
- .9 Coordination and interference drawings shall be circulated for mark-ups by *Subcontractors* responsible for work of Divisions 3, 5, 6, 9, 11, 13, Divisions 21, 22, and 23, and Divisions 26, 27, and 28, as applicable.
- .10 Coordinate preparation and submission of coordination and interference drawings with *Shop Drawings*.
- .11 Show cross sections in key areas, as required, and as defined by *Consultant*. Show re-bar, structural elements, piping, air handling and heating systems distribution, sprinkler system distribution, lighting, gypsum board wall and ceiling assemblies, acoustical isolation, *Products* and systems involving life safety, conveying systems, electrical distribution.
- .12 Show ductwork as 2 lines. Show cross sections in key areas, as required, and as directed by *Consultant*. Show re-bar, structural elements, air handling and heating systems distribution, gypsum board wall and ceiling assemblies, acoustical isolation, *Products* and systems involving life safety, conveying systems, and electrical distribution.
- .13 Coordination and interference drawings shall be produced in uniform scale on media that will allow overlays to be assembled. Upon incorporation of details, drawings shall be submitted to *Consultant* for review. Areas of conflict or interference shall be resolved in a mutually agreed manner between *Subcontractors* and resubmitted on coordination and interference drawings until accepted by *Consultant*.

Project Management and Coordination

1.5 Project Manager and Superintendent

- .1 Provide *Key Personnel* who shall be 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.
 - .1 Project Manager:
 - .1 Project Manager to be currently accredited member, in good standing, of OAA, OAAAS, AATO, PEO, OACETT or other construction-related provincial or nationally-based professional association with minimum 7 years of relevant healthcare knowledge/experience.
 - .2 Project Managers not currently accredited with a related professional association but with 15 years of relevant healthcare knowledge/experience may be taken into consideration for equivalency.
 - .3 Preference will be provided to those who are also certified in accordance with the Canadian Construction Association's Gold Seal Certification Program.
 - .2 Superintendent:
 - .1 Site Superintendent to be certified in accordance with the Canadian Construction Association's Gold Seal Certification Program.
 - .2 Site Superintendents not currently Gold Seal certified but with 15 years of supervision of relevant healthcare knowledge/experience may be taken into consideration for equivalency.
 - .3 Preference will be provided to those who are also currently accredited member, in good standing, of OAA, OAAAS, AATO, PEO, OACETT or other construction-related provincial or nationally-based professional associations.
- .2 The *Contractor* shall appoint project manager and superintendent 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 The project manager shall fulfill the role of supervisor in accordance with GC 3.5.

1.6 Staff

- .1 All *Contractors* and *Subcontractors* will be expected to maintain the staff team identified in the bid form. Any modifications to the team composition from those submitted must be approved in writing by the *Owner* prior to implementation. 2 weeks notice is required prior to any proposed change for *Owner* review prior to the start of the *Work*. 4 weeks notice is required prior to any proposed change for *Owner* review during the *Work*.

1.7 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.

Project Management and Coordination

- .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 requirements 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 requirements.

1.8 Request for Interpretation - RFI

- .1 A request for interpretation (RFI) is a formal process used during the *Work* to obtain an interpretation of the *Contract Documents* pursuant to GC 2.2.6 through GC 2.2.9 (inclusive).
 - .1 An RFI shall not constitute notice of claim for a delay.
- .2 Submittal procedures:
 - .1 RFI form:
 - .1 Submit RFI on "Request for Interpretation" in form acceptable to the *Consultant*, an example of which is appended to this section. The *Consultant* shall not respond to an RFI except as submitted on this form.
 - .2 Where RFI form does not provide sufficient space for complete information to be provided thereon, attach additional sheets as required.
 - .3 Submit with RFI form necessary supporting documentation.
 - .2 Submit RFI form as follows:
 - .1 1 copy digitally in pdf format to *Consultant* via email.
 - .2 Submit RFIs sufficiently in advance of affected parts of the *Work* so as not to cause delay in the performance of the *Work*. Costs resulting from failure to do this will not be paid by the *Owner*.
 - .3 RFIs shall be submitted only to the *Consultant*.
 - .4 RFIs shall be submitted only by *Contractor*. RFIs submitted by *Subcontractors* or *Suppliers* shall not be accepted.
 - .5 Number RFIs consecutively in one sequence in order submitted.
 - .6 Submit one distinct RFI per RFI form.
- .3 RFI log:
 - .1 Maintain log of RFIs sent to and responses received from the *Consultant*, complete with corresponding dates.
 - .2 Submit updated log of RFIs with each progress draw submittal.
- .4 *Consultant* shall review RFIs from the *Contractor* submitted in accordance with this section, with the following understandings:

Project Management and Coordination

- .1 *Consultant's* response shall not be considered as a *Change Order* or *Change Directive*, nor does it authorize changes in the *Contract Price* or *Contract Time* or changes in the *Work*.
- .2 Only the *Consultant* shall respond to RFIs. Responses to RFIs received from entities other than the *Consultant* shall not be considered.
- .5 Allow 5 *Working Days* for review of each RFI by the *Consultant*.
 - .1 Where the *Consultant* deems the nature of the RFI requires additional time for review, or where information required to accommodate review is not available or forthcoming from third parties; the *Consultant* shall advise the *Contractor* accordingly and where feasible advise of additional time required for review.
 - .2 *Consultant's* review of RFI commences on date of receipt by the *Consultant* of RFI submittal and extends to date RFI returned by *Consultant*.
 - .3 When the RFI submittal is received by *Consultant* before noon, review period commences that day; when RFI submittal is received by *Consultant* after noon, review period begins on the next *Working Day*.
 - .4 If, at any time, the *Contractor* submits a large enough number of RFIs such that the *Consultant* cannot process these RFIs within 5 *Working Days*, the *Consultant*, will confer with the *Contractor* within 1 *Working Day* of receipt of such RFIs, and the *Consultant* and the *Contractor* will jointly prepare an estimate of the time necessary for processing same as well as an order of priority between the RFIs submitted. The *Contractor* shall accommodate such necessary time at no increase in the *Contract Time* and at no additional cost to the *Owner*.
- .6 Undertake a review of the *Contract Documents* to determine that the matter in question relating to the interpretation of the *Contract Documents* cannot be resolved by direct reference to the *Contract Documents*. Describe this review in detail on the RFI form. RFI submittals that lack a detailed review description, or where the detail provided is insufficient, in the sole opinion of the *Consultant*, shall not be reviewed by the *Consultant* and shall be rejected.

PART 2 - PRODUCTS

Not applicable.

PART 3 - EXECUTION

Not applicable.

END OF SECTION

REQUEST FOR INFORMATION (RFI)

Project: _____

RFI Number: _____

Project No.: _____

To: ☐ (architect)
☐ (consultant?)
☐ (other?)

☐ Action	☐ Info	☐ Emailed	☐ Faxed	☐ Mailed	Pages _____
☐ Action	☐ Info	☐ Emailed	☐ Faxed	☐ Mailed	Pages _____
☐ Action	☐ Info	☐ Emailed	☐ Faxed	☐ Mailed	Pages _____

Regarding: _____

References: *(List specific Contract Documents researched when seeking the information being requested)*

Spec. No.: _____ Dwg. No.: _____

Request: *(Provide complete description of request with document references and sketches or photos if necessary, and present status of work)*

Requester's Recommended Solution: *(If RFI concerns a site or construction condition, provide a recommended solution, including cost & schedule considerations)*

Response Priority: ☐ Normal ☐ Rush (Work in progress)
Reason For Request: ☐ Existing Condition ☐ Non-conformance ☐ Clarification / Interpretation ☐ Agency Generated ☐ Other

Subcontractor: _____ Date: _____
CM/Contractor: _____
BY: _____ Date: _____
cc: _____

Response:

- ☐ The above is considered a change. The following document will be used for processing and approval: _____
- ☐ The above is consistent with the intent of and reasonably inferable from Contract Documents, or makes minor changes in the Work without change in Contract Sum or Contract Time. If Contractor does not agree, submit written notice substantiating claim in accordance with Contract Documents.
- ☐ This RFI is related to one of the following & may be returned without response:
- | | | |
|---|---|---|
| ☐ Incomplete or lack of detailed information | ☐ Related to "means & methods" | ☐ Response required by others |
| ☐ Lack of adequate Coordination Drawings | ☐ Is a "Substitution Request" | ☐ Information contained in documents |

From: **HDR Architecture, Inc.**

By: _____

Date: _____

cc: _____

Project Meetings

PART 1 - GENERAL

1.1 Section Includes

- .1 Project meeting requirements.

1.2 Administrative

- .1 The *Contractor* shall schedule meetings as specified herein.
 - .1 Such scheduling shall be in consultation both with the *Owner* and with the *Consultant*.
- .2 The *Contractor* shall prepare agendas for meetings specified herein.
 - .1 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, 5 *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.
 - .1 *Contractor* shall 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 attend meetings only when directed by the *Consultant*, or when specifically called for in the *Contract Documents*.
- .7 The *Contractor* shall prepare, and distribute to the *Consultant* and the *Owner* 4 days in advance of next progress meeting date, the following:
 - .1 Monthly progress reports containing updated construction schedule, submittal logs, requests for interpretation logs, and budget.

1.3 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 Attendees at *Contract* start-up meeting shall include the following:
 - .1 *Contractor*.
 - .2 *Contractor's* site superintendent(s).
 - .3 *Consultant*.
 - .4 *Owner*.
 - .5 Independent inspection and testing company.
- .3 Agenda to include the following:
 - .1 *Owner's* guidelines and policies.

Project Meetings

- .2 Appointment of official representative of participants in the *Project*.
- .3 Status of permits, fees and requirement of authorities having jurisdiction. Action required.
- .4 Establishing a schedule for progress meetings.
- .5 Review of work sequence and *Stages of the Work*.
- .6 Requirements for *Contract* modification and interpretation procedures, including, but not limited to: requests for interpretation, *Contemplated Change Notice*, *Change Orders*, *Change Directives*, *Supplemental Instructions*, procedures, approvals required, mark-up percentages permitted, time extensions, overtime, and administrative requirements.
- .7 Submittal requirements and procedures.
- .8 Schedule of submission of samples, colour chips, and items for *Owner's* and/or *Consultant's* consideration.
- .9 Construction schedule and progress scheduling.
- .10 Delivery schedule of specified equipment.
- .11 Requirements for infection prevention and control.
- .12 Appointment of independent inspection and testing agencies or firms.
- .13 Requirements for notification for reviews. Allow a minimum of 48 hours' notice to *Consultant* for review of the *Work*.
- .14 Requirements for *Temporary Work*.
- .15 Requirements for firestopping coordination and preparation of firestopping manual (refer to Section 01 33 00).
- .16 Security requirements at and for the *Place of the Work*.
- .17 *Owner* supplied *Products*.
- .18 Review of waste management and disposal procedures and requirements.
- .19 As-built documents.
- .20 Operation and maintenance manuals.
- .21 Take-over procedures, acceptance, warranties.
- .22 Publication to be used for publishing certificate of substantial performance.
- .23 Progress claims, administrative procedures, holdbacks.
- .24 Insurances, transcripts of policies.
- .25 *Contractor's* safety procedures.
- .26 Certificate of Clearance from the Workplace Safety and Insurance Board (WSIB).

1.4 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*.

Project Meetings

- .2 As far as possible, pre-installation meetings shall be scheduled to take place on the same day as regularly scheduled progress meetings.
- .3 Attendees at pre-installation meetings shall include the following:
 - .1 *Contractor*.
 - .2 *Subcontractors* affected by the work for which the pre-installation meeting is being conducted.
 - .3 *Consultant*.
 - .4 Infection control representative.
 - .5 Manufacturer's representatives, as applicable.
 - .6 Independent inspection and testing company, as applicable.
- .4 Agenda to include the following:
 - .1 *Owner's* guidelines and policies.
 - .2 Appointment of official representatives of participants in the *Project*.
 - .3 Review of existing conditions and affected work, and testing thereof as required.
 - .4 Review of installation procedures and requirements.
 - .5 Review of environmental and site condition requirements.
 - .6 Review of infection prevention and control procedures.
 - .7 Schedule of the applicable portions of the *Work*.
 - .8 Schedule of submission of submittals, samples, mock-ups, and items for *Consultant's* consideration.
 - .9 Requirements for *Temporary Work*.
 - .10 Requirements for notification for reviews. Allow a minimum of 48 hours' notice to *Consultant* for review of the *Work*.
 - .11 Requirements for inspections and tests, as applicable. Schedule and undertake inspections and tests.
 - .12 Delivery schedule of specified equipment.
 - .13 Special safety requirements and procedures.
 - .14 Publication to be used for publishing certificate of substantial performance.

1.5 Progress Meetings

- .1 During the course of the *Work* prior to *Substantial Performance of the Work*, schedule regular progress meetings to occur as directed by the *Consultant*.
- .2 Attendees at progress meetings shall include the following:
 - .1 *Contractor*.
 - .2 *Contractor's* site superintendent(s).
 - .3 *Consultant*.

Project Meetings

.4 Owner.

.3 Agenda to include the following:

- .1 Owner's guidelines and policies.
- .2 Review of site safety.
- .3 Revisions to construction schedule.
- .4 Review, approval of proceedings of previous meeting.
- .5 Review of items arising from proceedings.
- .6 Review of progress of the *Work* since previous meeting and *Contractor's* monthly progress report.
- .7 Review of RFIs log.
- .8 Field observations, problems, conflicts.
- .9 Problems that impede compliance with construction schedule.
- .10 Review of off-site fabrication delivery schedules.
- .11 Review material delivery dates/schedule.
- .12 Corrective measures and procedures to regain construction schedule.
- .13 Revisions to construction schedule.
- .14 Progress, schedule, during subsequent period of the *Work*.
- .15 Review submittal schedules.
- .16 Review status of submittals.
- .17 Review of infection prevention and control procedures.
- .18 Maintenance of quality standards.
- .19 Pending changes and substitutions.
- .20 Review of *Contract* modifications and interpretations including, but not limited to: requests for interpretation and log, *Contemplated Change Notice*, *Change Orders*, *Change Directives*, and *Supplemental Instructions* for effect on construction schedule and on *Contract Time*.
- .21 Review of status of as-built documents.
- .22 Other business.

1.6 Pre-Takeover Meeting

- .1 Prior to application for *Substantial Performance of the Work*, schedule a pre-takeover meeting.
- .2 Agenda to include the following:
 - .1 Review, approval of proceedings of previous meeting.
 - .2 Review of items arising from proceedings.

Project Meetings

- .3 Review of procedures for *Substantial Performance of the Work*, completion of the *Contract*, and handover of the *Work*.
- .4 Field observations, problems, conflicts.
- .5 Review of outstanding *Contract* modifications and interpretations including, but not limited to: requests for interpretation and log, *Contemplated Change Notice*, *Change Orders*, *Change Directives*, and *Supplemental Instructions* for effect on construction schedule and on *Contract Time*.
- .6 Problems which impede *Substantial Performance of the Work*.
- .7 Review of procedures for deficiency review. Corrective measures required.
- .8 Review of arrangements for hydro, heating, and other services.
- .9 Progress, schedule, during succeeding period of the *Work*.
- .10 Review submittal requirements for warranties, manuals, and all demonstrations and documentation required for *Substantial Performance of the Work*.
- .11 Review of keying and hardware requirements.
- .12 Review of status of as-built documents and record drawings.
- .13 Status of commissioning and training.
- .14 Review of RFIs log.
- .15 Final photographs requirements.
- .16 Review *Contractor's* deficiency list and status.
- .17 Cleaning for occupancy.
- .18 Other business.

1.7 Post-Construction Meeting

- .1 Prior to application for completion of *Contract*, schedule a post-construction meeting. 5 *Working 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:
 - .1 Review, approval of proceedings of previous meeting.
 - .2 Confirmation that no business is arising from proceedings.
 - .3 Confirmation of completion of the *Contract*, and handover of reviewed documentation from the *Consultant* to the *Owner*.
 - .4 Confirmation of completion of *Contemplated Change Notice*, *Change Orders*, *Change Directives*, and *Supplemental Instructions*.
 - .5 Problems that impede *Contract* completion.
 - .6 Identify unresolved issues or potential warranty problems.
 - .7 Confirmation of completion of deficiencies.
 - .8 Corrective measures required.

Project Meetings

- .9 Confirmation of arrangements for hydro, heating and other services.
- .10 Confirm submittal requirements for warranties, manuals, and demonstrations and documentation for *Contract* completion are in order.
- .11 Review of procedures for communication during post-construction period.
- .12 Handover of reviewed record documents by the *Contractor* to the *Owner*.
- .13 Submission of final application for payment.
- .14 Review and finalize outstanding claims, pricing, and allowance amounts.
- .15 Status of commissioning and training.
- .16 Demobilization and the *Place of the Work* restoration.
- .17 Review of requests for interpretation log.
- .18 Other business.

1.8 Special Meetings

- .1 *Owner* and/or *Consultant* reserves 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 within 3 *Working Days* to all in attendance and those affected by agreements made at such meetings.

PART 2 - PRODUCTS

Not applicable.

PART 3 - EXECUTION

Not applicable.

END OF SECTION

Construction Progress Documentation

PART 1 - GENERAL

1.1 Section includes

- .1 Schedule format.
- .2 Scheduling roles.
- .3 Construction progress schedule.
- .4 Submittals schedule.
- .5 Inspection and testing schedule.
- .6 Recording actual site conditions on as-built documents.
- .7 Schedule management.
- .8 Digital photographs.

1.2 Summary

- .1 This Section specifies *Contractor's* responsibilities for preparation and submission of schedules and other documentation related to tracking construction progress.
- .2 The schedule shall:
 - .1 Show actual progress versus planned progress.
 - .2 Demonstrate that scheduling issues are being proactively identified and addressed in a timely manner, and that planned progress is being maintained as closely as possible.

1.3 Schedule Format

- .1 Prepare schedules in the form of a Critical Path Method (CPM) Gantt chart method in accordance with GC 3.4.1.
 - .1 Prepare schedules utilizing Microsoft Project 2003 (or later version).
- .2 Include horizontal time scale identifying the first *Working Day* of each week.
- .3 Include a separate bar for each trade, work package, or operation.
- .4 Format for listings: The chronological order of the start of each item or part of the *Work*.
- .5 Identification of listings: By systems description.

1.4 Scheduling Roles

- .1 *Contractor*:
 - .1 The *Contractor* is responsible for the preparation and maintenance of construction schedule information including the construction schedule and other schedules as defined herein. The *Contractor* is responsible for obtaining planning and scheduling information from its management staff, site supervisory staff, *Subcontractors* and suppliers in a timely manner as an essential part of the preparation and maintenance of the Construction Schedule and other schedules as defined herein.

Construction Progress Documentation

- .2 The *Contractor* maintains full responsibility for the implementation and management of the construction activities contained in their schedules.
- .3 The *Contractor* is to identify to the *Owner* and *Consultant* the *Contractor's* designated individual responsible for utilizing the specified scheduling software to prepare and maintain the construction schedule and other schedules, herein defined as the *Contractor's* Scheduler. The *Contractor's* Scheduler is required to have a minimum of 5 years of experience utilizing the specified scheduling software for planning and scheduling of hospital construction projects.

1.5 Construction Progress Schedule

- .1 Format and content:
 - .1 Include the complete sequence of construction activities, including provision for climate and weather.
 - .2 At any given point in time, the construction schedule must be fully detailed with activities and milestones for the entire project duration.
 - .3 The *Contractor* shall provide further refined and expanded schedule information, as the *Work* progresses and in sufficient advance of the upcoming work. Dates for the development of this information shall be agreed with the *Owner, Consultant*.
 - .4 Submission of the Construction Schedule shall constitute the representation by the *Contractor* that:
 - .1 The *Contractor* has distributed the proposed Construction Schedule to the *Subcontractors* for their review and comment.
 - .2 Seasonal weather conditions have been considered and included in the planning and scheduling of the *Work* influenced by high and low ambient temperatures and/or precipitation to ensure completion of the *Work* in accordance with the *Contract Documents*.
 - .3 The *Contractor* has incorporated any other special conditions in planning the *Work* such as specified non-work periods, etc.
 - .4 The *Work* has been co-ordinated and scheduled to permit time for work associated with the allowances (cash allowances) included as part of this *Contract*.
 - .5 The *Work* has been co-ordinated and scheduled to permit time for work associated with the alternatives included as part of this *Contract*.
 - .5 Include activities in the construction schedule for the commencement and completion of each major element of all *Contractor* and *Subcontractor* work. Identify *Contractor* activities and events that affect the operations of the *Owner* including but not limited to:
 - .1 Erection and removal of construction barriers and other temporary works.
 - .2 Periods of *Contractor* access.
 - .3 Changes to *Owner* access and exiting.
 - .4 Changes / shutdowns to mechanical, electrical, medical, communications systems.

Construction Progress Documentation

- .5 Equipment decommissioning, installation and re-commissioning.
- .6 Other access requirements for demolition and new work in existing building.
- .7 Demolition.
- .8 Partitions.
- .9 Ceilings.
- .10 Finishes.
- .11 Equipment Relocations & Installations.
- .12 Mechanical and electrical rough in.
- .13 Mechanical and electrical finishings.
- .14 Mechanical and electrical systems and commissioning.
- .15 Inspections, deficiency correction.
- .16 Handover to *Owner*.
- .6 Provide a work breakdown structure identifying key activities, work packages, and major milestones at a sufficient level of detail to effectively manage construction progress, including:
 - .1 Long delivery *Products*.
 - .2 Dates for the commencement and completion of inspection and testing.
 - .3 Preparation and review of mock-ups.
 - .4 *Owner* decisions for cash allowances.
 - .5 Shutdown or closure activities.
 - .6 Delivery of items supplied by *Owner*.
 - .7 *Owner* performed work.
 - .8 Demonstration and training activities.
 - .9 Dates for the commencement and completion of each major element of the *Work* parallel to the sections of the specifications.
 - .10 Dates for *Ready-for-Takeover* and *Substantial Performance of the Work*.
 - .11 Dates for delivery of *Products*, equipment, finish items, factory-finished manufactured items. Show last dates for order, shipment, and delivery in order to meet construction schedule.
- .7 Show projected percentage of completion for each item as of the first *Working Day* of each week.
- .8 Show sufficient detail to identify the major activities and milestones dates for overall planning and coordination purposes. Activities (with the exception of the contingency for unforeseen delays and delays resulting from changes to the *Contract*) shall have a maximum duration of 4 weeks. Show milestones for the start and completion of each major work area, building system and phase or sub-phase of the *Work*.

Construction Progress Documentation

- .9 Ensure that work of all disciplines (i.e. mechanical, electrical and all other trades) is included and logically linked within the Construction Schedule. Show manufacturing time and delivery dates (milestones) for major equipment and materials. Show deliveries of *Owner* supplied equipment required to meet the Construction Schedule.
- .10 Activities must be in sufficient detail to include for decisions / approvals required by the *Owner* and/or *Consultant* for shop drawings, mock ups, sample submissions, deliveries, cash allowance requirement schedule, off site fabrication, erection, on site installation and any other events or sub activities which may pertain to the activities of the Construction Schedule.
- .11 Construction Schedule information should be in sufficient detail to allow for accurate assessment of percentage completion and coordination with other tasks within the Project Master Schedule.
- .12 Provide a horizontal time scale identifying the first day of each week as Monday. Show in the Construction Schedule the intended working days and holidays used as the basis for the Construction Schedule information and critical path calculations.
- .13 Activity descriptions should be as consistent and clear as possible in terminology. Start activity descriptions with verbs.
- .14 Include as part of the Construction Schedule information, "dependency logic" information indicating the major predecessor and successor links between schedule activities. When requested, identify the crewing assumptions for the Construction Schedule activities and dependency logic that is governed by or representing crewing availability.
- .2 Submission:
 - .1 Submit initial schedule to *Owner* and *Consultant* in accordance with General Conditions GC 3.4.1.
 - .2 Submit schedule in pdf format to *Consultant* using the *Consultant's* document management system.
 - .3 In addition, submit a digital copy of the construction schedule to the *Consultant*. The digital copy shall be in a native file type that permits modification of the data. In case of discrepancy between native file and PDF copy of the construction schedule, the PDF 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 00 shall govern.
 - .4 The *Contractor* shall revise and resubmit the initial construction schedule for further review and comment. Upon final review, that construction schedule will be defined as the "Baseline" version of the construction schedule.
 - .5 Baseline construction schedule
 - .1 The baseline construction schedule will form the basis for *Contractor* and *Owner* planning and progress tracking.

Construction Progress Documentation

- .2 No changes to the baseline construction schedule reflecting later completion dates of activities or target milestones will be accepted as a revision to the construction schedule, unless accepted by *Owner* in writing.
- .3 Neither the review of the baseline schedule or other date submitted by the *Contractor* pursuant to this Section, nor any other action on the part of the *Consultant* under this section shall in any way be deemed as representation by *Owner* that the *Contractor*, by following a particular schedule or sequence of operation, can or will complete the *Work* by the time(s) required by the *Contract* or by any other time(s). The review of any baseline schedule or other date does not relieve the *Contractor* of his obligation to complete the *Work* by the time(s) required in the *Contract*.
- .4 Submit electronic copy in native format from the agreed upon scheduling software. *Owner* will review schedule and return review copy.
- .6 *Consultant* will review format and content of initial schedule and request necessary changes, if any, within 10 *Working Days* after receipt.
- .7 If changes are required, resubmit finalized initial schedule within 5 *Working Days* after return of review copy.
- .8 Progress schedule:
 - .1 Submit updated progress schedule to *Owner* and *Consultant* with each application for progress payment, indicating actual and projected start and finish dates with report date line and progress. Submit more frequently if requested by *Owner* or *Consultant*.
 - .2 At each date of submission of construction schedule, indicate progress of each activity.
 - .1 Show changes occurring since previous submission of the construction schedule:
 - .1 Major changes in scope.
 - .2 *Change Orders* and *Change Directives*.
 - .3 Activities modified since previous submission.
 - .4 Revised projections of progress and completion.
 - .5 Other identifiable changes.
 - .2 Include a narrative report to define:
 - .1 Problem areas, anticipated delays, and the impact on the schedule.
 - .2 Corrective action recommended and its impact on the schedule.
 - .3 Include cash flow projection with minimum look ahead as directed by the *Consultant*.
 - .3 Indicate changes in the schedule, its impact on completion of the total *Project*, and corrective actions. Appropriate corrective action may include, but not be limited to, assignment of additional labour, trade *Subcontractors* or equipment, shift or overtime work at no additional cost to the *Owner*.

Construction Progress Documentation

- .4 Submit a separate bi-weekly “look-ahead” narrative report and construction schedule indicating major activities to be undertaken or constructed, areas of work, and any impacts upon the *Owner* over the course of the following month.
- .9 Baseline Schedule Revisions:
 - .1 Updating the Construction Schedule, as required, to reflect actual progress up to the monthly cut-off date shall not be considered a revision to the Baseline Schedule. All other changes, including, but not limited to, the following shall be considered Baseline Schedule revisions:
 - .1 Adding and/or deleting activity relationships
 - .2 Adding and/or deleting activities
 - .3 Changes to original durations
 - .4 Changes to *Contract* Milestone dates or Constraint dates
 - .5 Performance of work out of sequence
 - .6 Scope Changes through Change Orders
 - .2 If, as a result of the monthly Progress Schedule submission, it appears the Progress Schedule no longer represents the actual progress of the *Work*, the *Contractor* shall request, a revision to the Baseline Schedule.

1.6 Submittals Schedule

- .1 Format and content:
 - .1 Prepare a detailed schedule of submittals required by the *Contract Documents*, including samples required for testing, and including those for items supplied by *Owner* in accordance with GC 3.8.
 - .2 Provide a separate line for each required submittal, organized by *Specifications* section names and numbers, and further broken down by individual *Products* and systems as required.
 - .3 Indicate dates for submitting, review time, resubmission time, float time, and last date for meeting construction schedule.
 - .4 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*.
 - .5 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* subconsultants, add 5 more *Working Days* for a total 15 *Working Days* review period.
 - .6 If the *Consultant* requires resubmission of submittals, allow for an additional 10 *Working Days* review for each resubmission.

Construction Progress Documentation

- .7 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*.
- .8 Changes in the construction schedule shall maintain the minimum review periods for the *Consultant's* review specified above.
- .2 Submission:
 - .1 Submit initial schedule to *Consultant* within 10 *Working Days* after *Contract* award.
 - .2 Submit schedule in pdf format to *Consultant* using the *Consultant's* document management system.
 - .3 *Consultant* will review format and content of initial schedule and request necessary changes, if any, within 15 *Working Days* after receipt in accordance with GC 3.8.7.
 - .4 *Consultant* will review submittal schedule and advise *Contractor* if volume and timing of submittals will permit review of and response to submittals within timeframes specified under Section 01 32 00. *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.
 - .5 If changes are required, resubmit finalized schedule within 5 *Working Days* after return of review copy.
 - .6 Submit updated submittals schedule monthly to the *Consultant* or more frequently as directed by the *Consultant*.
 - .7 Schedule shall be accompanied by a checklist, correlated to each of the schedule of submittals, the construction schedule, and the schedule of inspections and tests, listing the following:
 - .1 *Shop Drawings*.
 - .2 *Samples*.
 - .3 *Mock-ups*.
 - .4 *Reviews, tests and inspections by:*
 - .1 *Manufacturers*.
 - .2 *Authorities having jurisdiction*.
 - .3 *The Owner*.
 - .4 *The Consultant*.
 - .5 *Independent inspection and testing companies*.
 - .5 *Demonstration and training*.

Construction Progress Documentation

1.7 Inspection and Testing Schedule

- .1 Prepare schedule for inspection and testing by advance discussion with the selected independent inspection and testing company to determine the time required for the independent inspection and testing company to perform its tests and to issue each of its findings, and allow for required time in the construction schedule.
- .2 Refer to Section 01 45 00 for additional requirements for inspection and testing scheduling.

1.8 Schedule Management

- .1 A schedule submitted as specified and accepted by *Consultant* shall become the baseline schedule and shall be used as the baseline for updates.
- .2 At each regular progress meeting, review and discuss current construction progress and submittals schedules with *Consultant* and *Owner*, including activities that are behind schedule and planned measures to regain schedule slippage in key areas on or near the critical path.
- .3 Activities considered behind schedule are those with start or completion dates later than the dates shown on the baseline schedule.

1.9 Recording Actual Site Conditions on As-Built Documents

- .1 *Owner* will provide digital copies of *Contract Documents* to the *Contractor* for as-built documentation purposes. Record information and maintain as-built documents in clean, dry and legible condition.
- .2 Clearly label each drawing as "AS-BUILT DRAWING" and each specification "AS-BUILT SPECIFICATION" and each schedule "AS-BUILT SCHEDULE". Record information concurrently with construction progress. Do not conceal Work until required information is recorded.
- .3 Accurately document as-built conditions and deviations from *Contract Documents* as the *Work* progresses.
- .4 Mark changes in red ink.
- .5 Document actual construction including:
 - .1 Field changes of dimensions/details.
 - .2 Changes by *Change Orders*, *Change Directives*, and *Supplemental Instructions*.
 - .3 References to *Shop Drawings*, where *Shop Drawings* show more detail.
 - .4 Locations of interior mechanical and electrical equipment and distribution.
 - .5 In specification as-builts: Document as-built *Products*, including manufacturer, manufacturer's model or system number.
- .6 Do not use as-built drawings for construction purposes.

1.10 Digital Photographs

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

Construction Progress Documentation

- .1 No other photographs of the *Place of the Work* or of any portion of the *Work* will be permitted without written approval of the *Owner*.
- .2 Equipment: Provide photographs using minimum 10 megapixel digital camera.
- .3 Submit the required photographs to the *Consultant* and to the *Owner*.
- .4 Title each photograph. Include in title: *Project* name, *Contractor's* name, direction of view, and date when taken.
- .5 Output: Supply date stamped maximum resolution colour photos to *Consultant* in JPEG format, on CD-ROM format or digital sharing program.
- .6 Number of photos required:
 - .1 Prior to construction: Provide necessary number of photographs, as required to document existing conditions and verify damage to adjacent streets and property that may have existed prior to construction or demolition work: Minimum 50 photos.
 - .2 Each Progress draw: Provide 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.
 - .3 Completion: When the *Work* is completed, arrange to take final photographs of the *Work* from a minimum of 8 points of view.

PART 2 - PRODUCTS

Not applicable.

PART 3 - EXECUTION

Not applicable.

END OF SECTION

Submittal Procedures

PART 1 - GENERAL

1.1 Section Includes

- .1 Administrative requirements.
- .2 Submission procedures.
- .3 Certificates and Certification Submittals
- .4 *Product* data sheets.
- .5 *Shop Drawings*.
- .6 Engineered Judgements.
- .7 Project firestopping manual and coordination.
- .8 Samples.

1.2 Administrative Requirements

- .1 Submit submittals as requested by the *Contract Documents*, as specified herein, and in accordance with the submittals schedule prepared in accordance with Section 01 32 00.
- .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 Where required by authorities having jurisdiction, provide submittals to such authorities for review and approval.
- .4 Make submittals with reasonable promptness and in an orderly sequence so as to cause no delay in the *Work*. Be solely responsible for delays, make up time lost, and pay added costs incurred because of not making submittals in due time to permit proper review by *Consultant*.
- .5 Once submitted, a submittal shall not be re-submitted until original submission has been reviewed by *Consultant* and returned to *Contractor*.
- .6 Submittals that contain substitutions will be rejected. Substitutions are permitted only in accordance with Section 01 25 00.
- .7 Do not proceed with work affected by a submittal, including ordering of *Products*, until relevant submittal has been reviewed by *Consultant*.
- .8 Prepare submittals using SI (metric) units.
- .9 *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.
- .10 Keep copies of reviewed submittals at the *Place of the Work* in an organized 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*.

Submittal Procedures

- .11 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*.
- .12 *Contractor's* review of submittals:
 - .1 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*. 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.
 - .2 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.
 - .3 Assume sole responsibility for any conflicts occurring in the *Work* that result from lack of comparison and coordination of submittals required for the *Work*.
 - .4 Assume sole responsibility for dimensions to be confirmed and correlated at the *Place of the Work* for information that pertains to fabrication processes or to techniques of construction and installation, and for coordination of the *Work*.
 - .5 Submittals that have not been reviewed, checked, and coordinated by *Contractor* prior to submission to *Consultant*, or that do not bear the stamp and signature of *Contractor* as described above, will be stamped "REVISE AND RESUBMIT" and returned.
 - .6 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*.
- .13 *Consultant's* review of submittals:
 - .1 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, nor of responsibility for meeting requirements of *Contract Documents*.

Submittal Procedures

- .2 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 Drawings* reviews.
 - .3 *Consultant's* review and markings on submittals do not authorize changes in the *Work* nor in the *Contract Time*, and shall 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 31 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 an increase the *Contract Time*.
 - .4 Submittals that are not required by the *Contract Documents* or not requested by the *Consultant* will not be reviewed by the *Consultant* and will be marked 'NOT REVIEWED' by the *Consultant* and returned to the *Contractor*.
- .14 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 licensed in the jurisdiction in which the *Place of the Work* is located, having in force professional liability insurance with minimum coverage limit of \$2,000,000 per claim and annual aggregate.
 - .2 Include with engineered submittal, proof of insurance identifying insurer, policy number, policy term, and limit of liability, on duly signed letterhead and / or certificates of insurance.
 - .3 Design includes post disaster building, seismic design, 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.

Submittal Procedures

- .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*.

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 containing:
 - .1 Date.
 - .2 *Project* title and number.
 - .3 *Contractor's* name and address.
 - .4 *Contractor's* review stamp.
 - .5 Identification and quantity of each submittal.
 - .6 Other pertinent data.
- .4 Each submittal shall be identified numerically by relevant *Specifications* section number with a numeric indicator for multiple submittals by that section followed by revisions number, for example 04 05 19-01-R0.
- .5 Submit original PDF documents only: scanned documents shall not be accepted.
 - .1 PDF submittals shall be bookmarked and linked to a Table of Contents or cover letter identifying the contents of the submission.
- .6 Make any changes in submittal that *Consultant* may require, consistent with *Contract Documents*, and resubmit as directed by *Consultant*.

Submittal Procedures

- .7 Notify *Consultant*, in writing, when resubmitting, of any revisions other than those requested by *Consultant*.
- .8 After *Consultant*'s review, distribute copies to affected parties.

1.4 Certificates and Certification Submittals

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

1.5 Product Data Sheets

- .1 Submit *Product* data sheets as follows:
 - .1 1 copy digitally as a bookmarked PDF to *Consultant* using the *Consultant*'s document management system.
- .2 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.
- .3 Where requirements of *Contract Documents* are more stringent than design proposed on *Product* data sheets, the requirements of the *Contract Documents* take priority.
- .4 Upon completion of review by *Consultant*, 1 marked set of *Product* data sheets will be returned to *Contractor* in digital format for reproduction and distribution.
- .5 Retain 1 complete set of reviewed *Product* data sheets for issuance as part of closeout submittals in accordance with Section 01 78 00.

1.6 Shop Drawings

- .1 Submit *Shop Drawings* as follows:
 - .1 1 copy digitally as a bookmarked PDF to *Consultant* using the *Consultant*'s document management system.
- .2 Lettering on *Shop Drawings* shall be not less than 3 mm (1/8") high.
- .3 Reproduction of construction *Drawings* to serve as background for *Shop Drawings* is not permitted.
- .4 Where requirements of *Contract Documents* are more stringent than design proposed on *Shop Drawings*, the requirements of the *Contract Documents* take priority.
- .5 *Consultant* markings and resulting action required:
 - .1 *Shop Drawings* requiring no changes will be marked 'REVIEWED', and shall be submitted for as-built drawings purposes.
 - .2 *Shop Drawings* requiring several changes will be marked 'REVIEWED as NOTED' and shall be revised and submitted for as-built drawings purposes.

Submittal Procedures

- .3 *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'.
- .6 *Shop Drawings* 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.
- .7 Upon completion of review by *Consultant*, 1 marked set of *Shop Drawings* will be returned to *Contractor* in digital format for reproduction and distribution.
- .8 Retain 1 complete set of reviewed *Shop Drawings* for issuance as part of closeout submittals in accordance with Section 01 78 00.
- .9 Submit copies of reviewed *Shop Drawings* to authorities having jurisdiction as required.
- .10 *Shop Drawings* shall include:
 - .1 Fabrication and erection dimensions.
 - .2 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*.
 - .3 Design calculations for items that require design calculations.
 - .4 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 shall be rejected without having been reviewed by the *Consultant*.
 - .5 Location and type of exposed anchors, attachments and locations and types of fasteners, including concealed reinforcements to accept mounted fasteners.
 - .6 Adhesives, joinery methods and bonding agents.
 - .7 Kinds and grades of materials, their characteristics relative to their purpose, detailed description of finishes and other fabrication information.
 - .8 Configurations, types and sizes required; identify each unit type on drawing and on *Product*.
 - .9 Descriptive names of equipment and mechanical and electrical characteristics when applicable.
 - .10 Data verifying that superimposed loads will not affect function, appearance and safety or work shown on shop drawings, as well as other interconnected work.
 - .11 Assumed design loadings, dimensions of elements and material *Specifications* for load-bearing members.
 - .12 Proposed chases, sleeves, cuts and holes in structural members.
 - .13 Wall thicknesses of metals.
 - .14 Location and types of welds. For structural welds use AWS symbols and clearly show net weld lengths and sizes.

Submittal Procedures

- .15 Materials, gauges, and sizes being supplied including connections, attachments, reinforcement, anchorage and locations of exposed fastenings.
- .16 Installation instructions and details for *Products* to be installed by separate *Subcontractors*, including function of each part.
- .17 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.
- .18 Refer to individual sections of the *Specifications* for more particular requirements for *Shop Drawings*.
- .19 Compatibility statement: Include with each *Shop Drawings* a statement that each *Product* and material indicated on the *Shop Drawings* is compatible with each *Product* and material with which it comes into contact.

1.7 Engineered Judgements

- .1 When an engineered judgement is required by authorities having jurisdiction, such engineered judgement shall be prepared as an engineered submittal in accordance with Section 01 33 00.

1.8 Project Firestopping Manual and Coordination

- .1 The *Contractor* shall assign a firestopping and smoke seal firestopping coordinator to coordinate the firestopping details and systems required in the *Work*. Applicator shall designate a single individual as *Project* foreperson who shall be present at the *Place of the Work* throughout the *Work*.
- .2 Firestopping manual:
 - .1 *Contractor* and firestopping and smoke seal coordinator shall prepare a preliminary fire stopping manual, inclusive of all firestopping systems in the *Work*, to be submitted to the *Consultant* prior to the installation of any firestopping and smoke seal work.
 - .2 Manual shall include:
 - .1 Project key plans of each level, with enlarged key plans at areas where required, which identify and tag each anticipated penetration and fire stopping location and type (i.e. multiple metallic pipes through gypsum board wall assembly; single metallic pipe through concrete floor assembly, and the like).
 - .2 *Product* data sheets: data and installation instructions for *Products* providing descriptions sufficient for identification at the *Place of the Work*.
 - .1 Materials list of *Products* proposed for use in the *Work*; complying with listed systems designs.
 - .2 Listing agency's detailed drawing showing joint assemblies and firestopping materials, identified with listing agency's name and number or designation, fire rating achieved, and date of listing.
 - .3 Manufacturers' installation instructions and recommendations.

Submittal Procedures

.3 *Shop Drawings*:

- .1 Submit drawings indicating fire resistance rated assembly number, required temperature, hose stream, and flame rating, material thicknesses, installation methods and materials of firestopping and smoke seals, primers, supports, damming materials as applicable, reinforcements, anchorages, fastenings and methods of installation for each condition to be encountered.
- .2 Designate on *Shop Drawings* static through penetrations and dynamic joint systems, relative positions, expansion and control joints in rated slabs and walls, and firestopping details.
- .3 Engineered *Shop Drawings*; for engineering judgements:
 - .1 Where *Project* conditions require modification to an accredited third party testing agency's listed system design to address a particular firestopping condition that is not covered by a listed system, submit engineered shop drawings detailing the modifications to the listed system design as an engineering judgment or equivalent fire-resistance-rated assembly, for each *Project* location and condition.
 - .2 Submit the manufacturer's engineering judgment identification number and *Shop Drawings* details prepared by a professional engineer. The engineering judgment submittal shall include both *Project* name, *Project* location, and *Subcontractor's* name who will install firestop system as described in engineering judgement *Shop Drawings*.
 - .3 Provide complete details of specific application of listed system and its modifications upon which the engineered judgement is based upon.
 - .4 For perimeter fire barrier systems:
 - .1 Submit engineered *Shop Drawings* for engineering judgements covering perimeter fire barrier systems. Identify each cladding assembly type in contact with each perimeter fire barrier system.
 - .4 Fire resistance rating test listings for firestopping and smoke seal systems.
- .3 Firestopping manual shall be submitted within 4 weeks of *Contract* award.
- .4 Prior to concealment of firestopping conditions above a ceiling or by another assembly or finish, the *Contractor* shall submit an updated firestopping manual including as-built drawings that identify firestopping conditions and penetrations.
- .3 Closeout submittals:
 - .1 Submit closeout submittals in accordance with Section 01 78 00.
 - .2 Submit the following certification documents with closeout submittals:
 - .1 Manufacturer's certification: Submit manufacturer's certification that installed firestopping and smoke seal *Products* are suitable for the use indicated and comply with specified requirements.
 - .2 Installation certification: Installer shall submit certification that all joint firestopping system installations are completed and that installations comply with listed systems designs.

Submittal Procedures

- .3 As-built copy of the firestopping manual.

1.9 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:
 - .1 *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 Where a required colour, pattern or texture has not been specified, submit full range of available *Products* meeting other specified requirements.
- .5 *Consultant* selection from samples is not intended to change the *Contract Price* or *Contract Time*. If a selection would affect the *Contract Price* or *Contract Time*, notify *Consultant* in writing prior to proceeding with the *Work*.
- .6 Resubmit samples until written acceptance is obtained from *Consultant*.
- .7 Reviewed and accepted samples will establish the standard against which installed *Work* will be reviewed.

PART 2 - PRODUCTS

Not applicable.

PART 3 - EXECUTION

Not applicable.

END OF SECTION

Special Project Procedures for Healthcare Facilities

PART 1 - GENERAL

1.1 Section Includes

- .1 General scope and responsibility.
- .2 Employee control.
- .3 Temporary ventilation.
- .4 Existing facilities.
- .5 Existing services.
- .6 Dust tight partitions and enclosures.
- .7 Protection of the existing building.
- .8 Emergency and fire protection.
- .9 Missing patient search.

1.2 General Scope and Responsibility

- .1 For the purposes of this section:
 - .1 The words “worker” or “workers” shall mean the *Contractor*, *Contractor’s* staff or employees, *Subcontractors*, *Subcontractor’s* staff or employees, *Suppliers*, *Supplier’s* staff or employees, or anyone engaged for the *Work*, directly or indirectly, by the *Contractor*, unless specifically noted otherwise.
- .2 Hospital hours of operation: 24/7.
- .3 *Contractor’s* work hours:
 - .1 Decontamination and medication room areas: After 7 a.m.
 - .2 Security area: 12 a.m. to 8 a.m.
- .4 Conform to the *Owner’s* construction procedures and safety manual. In case of conflict between the *Owner’s* construction procedures and safety manual and the remainder of the *Contract Documents*, the *Owner’s* construction procedures and safety manual shall govern.
- .5 Operational limitations:
 - .1 The existing building will remain in full use and occupancy throughout the *Work*, except for such parts of the building that have been vacated for the *Work*.
 - .2 *Contractor’s* use of the *Place of the Work* is limited to permit regular use of *Owner’s* facilities to continue with the least amount of interference possible.
 - .3 In consultation with, and to acceptance of, the *Consultant* in the presence of the *Owner*, designate an entrance and a circulation route that workers shall use and that shall not be used by *Owner’s* staff, building occupants, or the public.
 - .4 Limit noise levels in accordance with requirements of the *Owner*.

Special Project Procedures for Healthcare Facilities

- .5 Loading dock or such designated area by the *Owner* can only be used between the hours of 3:00 p.m and 7:00 p.m daily unless otherwise coordinated and approved in writing by the *Owner*.
- .6 *Work* will only be permitted to be performed under the direct full time supervision of the *Contractors* superintendent. If *Work* progresses without the superintendent the work will be stopped.
- .6 Dust tight enclosure and partition doors or flaps and entrance doors to the *Place of the Work* shall remain closed.
- .7 Areas of the existing building adjacent to the *Place of the Work* or areas affected by the *Work*, including circulation and access routes, shall be maintained in a clean state equivalent to the level of cleanliness maintained in the existing building, and as follows:
 - .1 Clean and vacuum the *Place of the Work* and areas surrounding the *Place of the Work* daily or more frequently as required.
 - .2 Provide tack mats at access doors to the *Place of the Work* so that workers can remove dust and debris from their footwear when exiting the *Place of the Work*. Replace or clean daily, or more frequently as required.
 - .3 Wet mop floor areas in vicinity of access doors to the *Place of the Work* daily, or more frequently as required.
 - .4 Vacuum carpeted areas daily or more frequently as required.
 - .5 Wet clean carpets in accordance with manufacturer's recommendations once work in such areas is complete.
 - .6 Final cleaning shall be in accordance with Section 01 74 00.
- .8 Waste protection and removal:
 - .1 Waste management and disposal shall be in accordance with Section 01 74 00 as supplemented herein.
 - .2 Transport waste in containers with tightly fitting lids or cover waste with a wet sheet.
 - .3 Remove waste as it is created. Debris shall be contained and covered if it cannot be removed immediately.
 - .4 Do not transport waste through occupied areas of existing building.
 - .5 Remove waste at the end of each *Working Day* through construction access routes.
- .9 Document condition of the existing building in areas immediately adjacent to the *Place of the Work* by means of construction photographs in accordance with Section 01 32 00.
- .10 Workers shall remove dust from body and clothing by vacuum cleaning prior to traversing patient care areas.
- .11 In areas designated by the *Owner*, workers shall be required to wear protective clothing as directed by the *Owner*. Protective clothing shall be removed upon exiting designated areas.

Special Project Procedures for Healthcare Facilities

- .12 Walkie-talkies shall not be used in the existing building without the express, written approval of the *Owner*.
- .13 Safety clearances are required before any cutting, welding, core drilling, or open flame work is done. A request in writing to the *Owner* must be made and approved a minimum of 1 *Working Day* prior to commencing such work.

1.3 Employee Control

- .1 Workers are permitted into existing buildings only where their work is affected.
- .2 All entrances to existing buildings from new additions, whether through existing doors or through doors in temporary partitions, shall be kept locked. Submit duplicate keys for locks to *Consultant*.
- .3 *Owner* will provide identification badges to *Contractor* for all *Subcontractor* employees at the *Contractors* expense, at \$25.00 charge per unit, who must wear them attached to their clothing in a conspicuous location throughout the duration of this project when at the *Place of the Work*. If damaged or lost and not returned to *Owner*, a nominal charge of \$25.00 per damaged or lost badge will be assessed against the *Contractor*. *Contractor* shall obtain the badges from the office of the Sunnybrook Coordinator for Fire & Security Services at local 5991.
- .4 *Contractor, Subcontractors, Suppliers*, and anyone employed either directly or indirectly by them, will not be permitted to use *Owner's* cafeteria and washroom facilities during work of this *Contract*. Consuming of food and beverages will be restricted to the *Place of the Work*.

1.4 Temporary Ventilation

- .1 Provide temporary ventilation in accordance with Section 01 51 00 supplemented as follows:
 - .1 Provide negative pressure air ventilation as described below.
 - .2 Ensure quality of intake air to existing building through existing intake louvers is not compromised by dust or noxious or odorous fumes.

1.5 Existing Facilities

- .1 Restrict access, parking, material deliveries, execution of work, operations and procedures to designated locations and times and do not deviate from designated procedures without prior acceptance by the *Consultant* in the presence of the *Owner*.
- .2 Periodically review proposed construction operations with the *Consultant* in the presence of the *Owner* and cooperate as required to ensure that *Owner's* interests and requirements are not unduly compromised with regard to the normal operation and function of occupied areas on the existing building.
- .3 Workers shall not be permitted to use the hospital cafeteria.

Special Project Procedures for Healthcare Facilities

- .4 While working in the existing hospital, workers shall not remain in areas in which they are working for meals and breaks. Workers shall not be permitted to have meals or take breaks in the existing hospital. Meals shall and breaks shall be taken in the site office, or away from the *Place of the Work*.
- .5 Traffic through existing occupied areas of the hospital shall be kept to a minimum. Travel within existing occupied areas of the hospital shall be via the most direct route that does not pass through patient wards or sensitive areas.
- .6 Noise, dust and debris, and odours shall be minimized to ensure hospital staff and patients in adjacent areas are disturbed as little as possible. Corrective action to cease or limit disagreeable annoyances to hospital staff and patients shall be implemented immediately upon notification by the *Consultant* or the *Owner*.
- .7 Use of existing containers and garbage bins shall not be permitted.
- .8 Existing fire protection equipment:
 - .1 Existing fire protection equipment, such as fire extinguishers and hoses, shall only be used in an emergency situation.
 - .2 Do not remove existing fire protection equipment.
 - .3 If any existing fire protection equipment is used or interfered with in any way, the *Owner's* fire equipment inspector shall be retained to inspect, test, recharge, and otherwise repair such equipment at no additional cost to the *Owner*.

1.6 Existing Services

- .1 Service interruptions:
 - .1 Connection or disconnection of services that will interfere with the operation of the *Owner's* facilities shall not be done without the prior written acceptance of the *Consultant* in the presence of the *Owner* and during the times designated by the *Owner*. Premium charges associated with such work shall be included in the *Contract Price*.
 - .2 Provide at least 10 *Working Days*' prior written notice to the *Consultant* and the *Owner* of requirement or intention to interrupt services, and obtain written permission of the *Consultant* in the presence of the *Owner* prior to commencing such interruption.
 - .3 In no instance shall interruptions affect the entire existing building.
 - .4 As far as possible, coordinate interruptions with the *Owner's* regular maintenance of building services and systems.
 - .5 Areas adversely affected by changes in air flows outside the construction areas as a result of a required shut-down of portions of the existing HVAC system within the construction areas are to be re-balanced to comfortable levels as advised by the *Consultant*.
- .2 Should existing services be interrupted in breach of the above, make good immediately and provide protection against further such disruptions. Costs resulting from such interruptions and for making good shall be the responsibility of the *Contractor* at no additional cost to the *Owner*.

Special Project Procedures for Healthcare Facilities

1.7 Dust Tight Partitions and Enclosures

- .1 Dust tight partitions and enclosures shall be in accordance with Section 01 56 00 and Section 01 57 00, as supplemented herein.
- .2 Dust tight partitions:
 - .1 Provide dust tight partitions to localize dust generating activities, and for the protection of workers, hospital staff, patients, the public, and finished areas of the *Work*.
 - .2 Dust tight partitions shall be temporary, weather tight, dust, tight, and lockable partitions between occupied areas of the existing hospital and areas where the *Work* is being performed, and shall include treatment of joints, cracks, and openings in partitions to prevent dust from entering occupied areas of the hospital.
 - .3 Dust tight partitions shall be assemblies with 1 hour fire resistance rating complete with doors and frames having 3/4 hour fire resistance ratings.
 - .4 Construct dust tight partitions as follows:
 - .1 Provide 92 mm (3-5/8") steel studs at 400 mm (16") on centre, with 2 rows of bracing between studs and additional bracing for gypsum board finish. Steel studs shall be in accordance with Section 09 22 00.
 - .2 Provide fire resistance rated tarpaulins fastened to studs on the side of the partition opposite to the occupied areas of the hospital. Lap joints 100 mm (4") minimum, and seal laps and perforations dust tight with 75 mm (3") wide plastic film tape.
 - .3 Provide 1 layer of 12.7 mm (1/2") thick square edge fire resistant gypsum board over both side of partition. Seal joints with 75 mm (3") wide plastic film tape. Gypsum board and installation shall be in accordance with Section 09 29 00.
 - .4 Provide felt gaskets around perimeter of partitions.
 - .5 Paint sides of partitions exposed to occupied areas of the existing building in accordance with Section 09 91 00, colour as to later selection by the *Consultant*.
- .3 Dust tight enclosures:
 - .1 Where minor isolated alteration work occurs in the existing building and a dust tight partition is not feasible, provide a mobile containment system, extending floor to ceiling.
 - .2 Mobile containment system shall be fabricated of an adjustable aluminum frame, vinyl enclosure with pressure porthole, wheel base platform, and disposable plastic liner, and sized as required.
 - .3 Provide HEPA filter vacuum device and manometer and connect to pressure porthole.
 - .4 Acceptable *Product*: Kontrol Kube Topsider or Kontrol Kube Topsider Jr., as manufactured by Fiberlock Technologies Inc., or approved alternate.

Special Project Procedures for Healthcare Facilities

- .4 Maintain and relocate dust tight partitions and enclosures until dust generating work is complete, or until directed otherwise in writing by the *Consultant* in consultation with the *Owner*.
- .5 Provide "Construction Zone" signage outside dust tight partitions and enclosures, manufactured by signage company, with minimum 75 mm (3") letters.

1.8 Protection of the Existing Building

- .1 Protection requirements shall be in accordance with GC 9.1, as amended by the supplementary conditions, Section 01 56 00, and as supplemented herein.
- .2 Keep *Place of the Work* safe and secure, denying access to unauthorized personnel.
- .3 Protect existing work from damage. Make good any damage caused. The onus is on the *Contractor* to substantiate that damage existed prior to commencement of the *Work*.
- .4 Do not overload the existing structure due to the *Work*.
- .5 Take special measures to protect existing work from damage when moving heavy loads or equipment. Protect areas used as passageways or through which materials are moved. Use resilient tired conveyances only when moving materials and equipment inside building. Provide coverings as required to protect existing work from damage.
- .6 Separate exterior access, work and storage areas from *Owner* occupied existing areas, with fencing and hoarding as specified in Section 01 56 00. Rearrange fencing/hoarding as *Work* progresses to suit extent and configuration of the *Work*.
- .7 Provide guards, barricades and other temporary protection to prevent injury to persons.
- .8 Protect existing building components and contents from damage by weather, when executing *Work* affecting integrity of the building envelope. provide temporary insulated and air tight weatherproof closures to protect openings made in existing building envelope. *Make Good* existing building components and contents damaged by weather resulting from inadequate temporary protection measures.
- .9 Protection of existing occupied areas:
 - .1 Existing exterior walls with windows of plain glazing, when exposed to the *Work*, shall be protected with 16 mm (5/8") gypsum board for interior surfaces and 9.5 mm (3/8") exterior grade plywood for exterior surfaces, mounted on suitable framing.
 - .1 Plywood: in accordance with Section 06 10 53.
 - .2 Metal framing: in accordance with Section 09 22 00.
 - .3 Gypsum board: in accordance with Section 09 29 00.
 - .2 Maintain such protection throughout the *Work*.
 - .3 Other openings in the existing exterior walls, such as doors and louvres, shall be similarly protected or replaced with doors of solid core wood or hollow steel construction.

Special Project Procedures for Healthcare Facilities

1.9 Emergency and Fire Protection

- .1 Provide and maintain ready access to fire protection equipment.
- .2 Immediately implement any request or instruction made by the hospital's fire marshal.
- .3 Provide temporary fire resistant closures at existing areas openings exposed to construction areas for the *Work* to maintain fire and life safety of existing building.
- .4 *Contractor* shall coordinate the work with the *Owner* in order to ensure no disruption to the existing fire detection and annunciation systems. Failure to provide such coordination shall result in the *Contractor* incurring the responsibilities and expenses associated with disruption to the existing fire detection and annunciation systems at no additional cost to the *Owner*.
 - .1 Provide fire watch when existing fire detection and annunciation systems are not operational or on bypass.
 - .2 A technical representative from the fire alarm manufacturer shall be assigned by *Owner* to the project to coordinate different phases of the extension. *Contractor* to coordinate this work with the *Owner*.
 - .3 Whenever a changeover time occurs, which is an outage time of at least a portion of the fire alarm system, the municipal fire department shall be notified of the temporary shutdown and alternative measures shall be devised.
- .5 *Contractor* shall coordinate the work with the *Consultant* in the presence of the *Owner* in order to prevent unapproved disruptions to the existing sprinkler system, standpipe system, or other fire protection systems.
 - .1 Where temporary shut-down is necessitated, such shut down shall be in accordance with the requirements of authorities having jurisdiction and the building code.
- .6 Obtain 'Hot Work Permit' from *Owner* prior to hot work operation, which may cause the building's fire alarm system to be activated or create an unwarranted fire risk condition. The prevention of fires and false fire alarms caused by hot work operations is the primary goal of this procedure. Gas hoses, backflow preventers, fire resistive tarpaulins, curtains and other cutting and welding equipment must be in good repair before the permit is issued.
 - .1 'Hot Work' is defined as work using open flames or sources of heat that could ignite materials in the work area.
- .7 The *Owner* will, with written request a minimum 2 *Working Days* in advance, arrange to put any fire alarm zone in bypass to permit construction.
 - .1 Requests shall identify the following information:
 - .1 Name of Contractor
 - .2 Where the *Contractor* will be working.
 - .3 Telephone numbers of persons responsible.
 - .4 Type of work being conducted.
 - .5 Identify if fire/smoke/dust/vibration/flood will occur.

Special Project Procedures for Healthcare Facilities

- .6 Indicate the start and stop times.
- .2 Shutdown period will only be from 0800 hours until 1430 hours each day, unless special arrangements are made through the *Owner* in advance of the notice time specified above.
- .3 To avoid unnecessary alarms during testing, disconnect only those zones being worked on. Zones shall be re-enabled by 1430 hours at the latest.
- .4 *Contractor* shall ensure that main control panel is manned at all times during shutdown period.
- .5 Any *Contractor* working in the *Owner's* plant and facilities will be assessed \$1,500.00 fine per false alarm payable to the *Owner* by certified cheque. Any *Contractor* causing false alarms and not paying such costs, will not be permitted to continue work until said cheque is received
- .8 Fire separations:
 - .1 Maintain the integrity of fire separations, fire protection systems, and fire rated assemblies.
 - .2 Make good fire separations, fire protection, and fire rated assemblies compromised as a result of the *Work*.
- .9 Maintaining existing building exit facilities:
 - .1 Maintain exit facilities serving the existing building.
 - .2 Where an exit is blocked-off or deleted as a result of the *Work*, an alternative exit shall be provided that is acceptable to the *Consultant*, the *Owner*, and authorities having jurisdiction.
 - .3 Where it is necessary for access to be gained to an exit through the *Place of the Work*, the access shall be clearly defined and protected so that it is separated from construction areas by a smoke tight fire separation equivalent to a minimum of 1 hour fire resistance rating, unless otherwise indicated.
- .10 Intersecting corridors:
 - .1 Provide temporary fire separations between existing corridors on occupied floor areas and new corridors under construction.
 - .2 Construct temporary fire separations out of steel studs and gypsum board to provide a construction equivalent to a minimum of 1 hour fire resistance rating, unless otherwise indicated.
 - .1 Firestopping and smoke sealant: in accordance with Section 07 84 00.
 - .2 Steel studs: in accordance with Section 09 22 00.
 - .3 Gypsum board: in accordance with Section 09 29 00.
 - .3 Where access is required, the doorway shall be protected by a door of solid core wood or hollow steel construction.
 - .4 Finish hardware equivalent to a minimum of 1 hour fire resistance rating, unless otherwise indicated.
- .11 Fire department access:

Special Project Procedures for Healthcare Facilities

- .1 Do not obstruct access route designated for fire department equipment.
- .2 If it is necessary that existing access routes be obstructed or deleted, alternative access routes acceptable to the fire department and in accordance with the requirements of the *Contract Documents* and authorities having jurisdiction shall be provided prior to commencement of work that will obstruct or delete existing access.
- .12 Combustible materials:
 - .1 Stockpiling of combustible materials adjacent to or inside the existing building shall not be acceptable.
- .13 Temporary protection of openings in fire separations:
 - .1 Openings in existing floor assemblies and vertical fire rated assemblies required by the *Work*, shall be temporarily protected with materials as required to maintain continuity of the required fire resistance rating for existing fire rated assembly.
- .14 Additional Life Safety Measures
 - .1 Generally, additional life safety measures should include following additional requirements:
 - .1 *Contractors* should obtain alternate fire safety plan from the *Owner*.
 - .2 Submit and obtain written approval from local Fire Department for alternate Fire Safety Plan and Training Procedure. *Contractor* to coordinate work with the *Owner*.

1.10 Missing Patient Search

- .1 In the event that the *Owner* is required to undertake a missing patient search, undertake a detailed search of the *Place of the Work*, under the direction of the *Owner*.

PART 2 - PRODUCTS

Not applicable.

PART 3 - EXECUTION

Not applicable.

END OF SECTION

Infection Control During Construction

PART 1 - GENERAL

1.1 General Requirements

- .1 Read and be governed by conditions of the *Contract* and sections of Division 1.

1.2 Policy Subject: Construction and Renovation

- .1 *Contractor* shall provide staff, *Subcontractor*, *Suppliers*, workers, own forces or anyone for whom the *Contractor* may be responsible, with training in infection prevention and control procedures. *Contractor's* training seminar shall be designed and implemented by an environmental *Consultant* with healthcare experience and whose educational program has been approved by the *Owner*. Acceptable firms but not limited to are:
 - .1 Safetech Environmental Ltd. (Romeo Milano, Tel: 905-624-2722).
 - .2 Golder Associates (Jason McGonigle, Tel 905-723-2727 Ext. 256).
- .2 *Contractor* is to directly engage and enter into a contract with the approved Environmental Consultant. *Contractor* to coordinate with the environmental Consultant and the *Contract Price* includes the required number of training sessions to adequately cover the duration of the *Project*.
- .3 Prior to commencement and during the course of the *Work*, as required, the *Contractor* shall promptly provide the *Owner* with written confirmation of such training by way of a certificate issued by the environmental Consultant.
- .4 *Owner's* Infection Prevention Control Services (IPCS) will investigate and advise on the risks of organisms that exist in the *Project* area. The goal will be to determine any infectious risks where possible and eliminate infection risks associated with construction activities in order to protect patients and staff occupying this building.
- .5 During the course of the *Work*, IPCS will assess the risks related to the *Project* utilizing the Risk Assessment and Preventive Measures Checklist (Appendix I). The determination of risk will guide the need for barriers during the *Project*. The *Owner* will communicate the assessment to the *Contractor* and advise on any additional measures to protect functional areas of the hospital.
- .6 Inspection of on-going infection control procedures shall be undertaken on a regular basis by the *Owner's* infection control representative and the *Contractor*. Procedures for such inspections shall be the same as those for inspection and testing in accordance with Section 01 45 00. The *Owner's* monitoring checklist is found in Appendix B.
- .7 IPCS may stipulate changes in protocols and barrier configurations if required to ensure the safety of the patients and the clinical environments. Barriers and hoarding are shown on the *Drawings* diagrammatically and as intent only. IPCS and *Contractor* to review on site barrier requirements and the *Contractor* will be responsible to construct barriers as per final instruction on site by the *Owner* at no additional cost to the *Owner*.
- .8 Definitions:
 - .1 Final cleaning is defined as; post construction cleaning as provided by the *Owner's* workforce or *Owner's* contracted cleaning service.

Infection Control During Construction

- .2 Construction Personnel: Protective clothing is to be removed when exiting through patient areas or vacuumed when exiting through other areas as categorized by IPCS as specified in Appendix "I". Construction personnel will not pass through clinical areas of the hospital without approval from the IPCS or *Owner*.
 - .1 Daily outer garments must be clean and maintained at all times.
 - .2 Daily footwear will be maintained clean and dust free at all times.
 - .3 Daily protective headgear will be maintained clean and dust free at all times.
 - .4 Hospital identification will be worn and displayed in a manner visible to any individual or passer by.
- .3 Transportation of Equipment/Supplies: Prior to commencement of the *Work*, IPCS and the *Project* team and the *Contractor* will establish paths and procedure for the transportation of clean/sterile supplies, equipment and construction materials, including the removal of construction debris. Additional information as indicated.
- .4 Surveillance: IPCS personnel will enhance surveillance as appropriate. Field review of the *Work* will be conducted on a regular basis with the *Contractor* as necessary.

1.3 Section Includes

- .1 Any and all infection control procedures described in this Section and all such means, materials and methods that are required to contain and prevent *Work* environments from spreading infection to the adjacent Hospital environment.
- .2 Means, materials and methods include but are not limited to temporary hoardings and barriers, enclosures, containment capsules, vessels, and other air tight assemblies constructed to contain airborne particulate generated by the *Work* from/out of Hospital areas adjacent and outside the *Work* area. The employment of mobile HEPA filtered recirculation units will be required in *Work* areas such as inpatient areas, laboratories and other risk areas identified by the *Owner* or IPCS and also to maintain negative air pressure in general *Work* area(s) relative adjacent Hospital areas. Refer to 1.5.7.9 for additional information.

1.4 Pre-Construction

- .1 At *Contract* start-up meeting, at meetings convened prior to the start of the *Work*, at pre-installation meetings, and at regular progress meetings, each convened in accordance with Section 01 31 19, review infection prevention and control procedures. The *Owner's* infection control representative shall attend such meetings. Subjects to be reviewed include, but are not limited to, the following:
 - .1 General information on infection prevention measures are articulated in accordance with Canadian Standards Association Z317.13-07, Infection Control during Construction or Renovation of Health Care Facilities.
 - .2 Project and/or phases are subjected to preventative measures assessment and categorization in accordance with CSA Z317.13-07.

Infection Control During Construction

- .3 Schedule mandatory infection control training for all construction trade staff. Only those trade staff that have successfully completed mandatory infection control training are permitted to work at Sunnybrook Health Sciences. Trade staff without documented infection control training will be disqualified from the job site. Delays attributed to non documented staff will be at the cost and responsibility of the *Contractor*.
- .4 General information on infection prevention measures is articulated.
- .5 Patient populations that may be at risk are identified.
- .6 Prevention measures for essential services (e.g. water, ventilation systems, electricity) that may be disrupted are provided.
- .7 Integrity of the facility's exterior structure, spatial separations, ventilation and water supplies for any penetrations and infection control problems are reviewed and assessed daily to ensure all services that supply clinical areas are provided.
- .8 Measures to control dust and routes to safely remove construction debris must be outlined and altered as necessary to protect all clinical areas and patients of the hospital. Traffic routes must be in accordance with cited CSA standard or requirements of the *Owner* whichever is more stringent.
- .9 Traffic patterns for construction workers and supply delivery routes for construction materials will be established to minimize risks to patients, staff and visitors per the *Owner's* requirements and as indicated.
- .10 Identify all critical areas of the ventilation system to ensure protection of the system from construction dust and debris including the need for increased filter changes during construction.
- .11 Properly seal penetrations to mitigate dust and moisture travel between clinical areas and construction site including the need to close down dampers temporarily to reduce circulation of contaminated air or fumes is assessed.
- .12 The systems can provide the correct air exchange rates and pressure relationships in critical areas near construction activity.
- .13 Properly adjust exhaust and supply air flow in the construction area to ensure "negative pressure" gradient between construction (negative) and clinical (positive) areas.
- .14 Properly protect all exterior air intakes as necessary to ensure optimal incoming "fresh air".
- .15 Criteria of inspections by *Owner's* infection control representative.
- .16 Ceiling/Wall/Floor Access permit requirements prior to opening concealed spaces.
- .2 Vacuum cleaners:
 - .1 Vacuums shall be commercial grade complete with HEPA filters.
 - .2 HEPA filter shall be changed as recommended by the manufacturer or required by use. Maintain a filter change log at the *Place of the Work*, available for review by the *Consultant*

Infection Control During Construction

1.5 Construction

- .1 Breaches in infection prevention containment measures, as outlined in Appendix I or as prescribed by CSA 317.13-07 or by the IPCS where negative outcome (s) that may place staff and/or patients of the *Owner's* facilities at risk will result in "stop" construction orders to the *Contractor* by IPCS.
- .2 Construction area and all related traffic routes will be maintained in an "acceptable" state of cleanliness as specified by the IPCS during the project without exception.
- .3 Cleaning will be provided as categorized by IPCS as specified in Appendix "I". Refer also to Section 01 74 00 Cleaning. The *Place of the Work* must also be cleaned prior to and at completion of work as follows:
 - .1 Undertaken by *Contractor* and included in the *Contract Price*:
 - .1 Construction cleaning prior to reopening a supply air duct during construction.
 - .2 Construction cleaning completed prior to the removal of any containment barriers.
 - .3 Construction cleaning completed after the removal of any barrier.
 - .4 Construction cleaning immediately after completion of minor work performed after the removal of barriers.
 - .2 Undertaken by *Owner* and not included in *Contract Price*:
 - .1 Final cleaning by Environmental Services must be completed prior to occupancy.
- .4 Construction Cleaning is defined as the complete removal of "daily" construction debris, dust containment and mitigation measures during construction activities. Measures to contain and mitigate dust during construction activities include but are not limited to, daily vacuuming of the work area with a HEPA filtered vacuum device, wet mopping, wrapping and/or bagging of debris, using vacuum equipped tools, etc. Area is to be inspected and approved as clean by IPCS.
- .5 Transportation of Equipment and Supplies: Prior to construction, IPCS, the *Consultants*, and the *Contractor* will establish delivery paths, time and procedures for the transportation of trade carts, equipment, materials, and "clean" install equipment. Movements and storage of equipment and supplies through the hospital may include but is not limited to:
 - .1 Daily maintenance of all trade carts so that they are kept in a clean and dust free condition.
 - .2 Daily wipe down of all trade carts with an approved "hospital disinfectant".
 - .3 Trade or supply carts of raw wood are NOT permitted. Exterior wood must be sealed to sustained daily cleaning and disinfection.
 - .4 Washdown of all waste carts after the disposal of any wastes and before the cart returns to the hospital.
 - .5 Removal of all packaging material from "final install" equipment prior to delivery through the hospital. *Contractor* will consult with the IPCS or designate on packaging necessary to protect devices prior to final install.

Infection Control During Construction

- .6 Packaging materials permitted onto the construction site must be removed daily or as generated, whichever is more frequent.
- .7 Transportation of equipment, materials/supplies and wastes is NOT permitted between the hours of 07:00 and 21:00 hrs. *Owner* or designate may grant limited exceptions in writing.
- .8 Incoming construction material must be handled in accordance with CSA 317.13-07. Materials must be protected from moisture and dirt.
- .9 Oversized “new install” equipment must be delivered in accordance with measures outlined by the IPCS or designate. Procedures may include but is not limited to additional cleaning of “new equipment”, cleaning of the hoarding to permit clear passage into the work area followed by immediate reinstatement of the hoarding.
- .6 Surveillance: IPCS or designate will determine frequency of site reviews of the construction area. Site review may include but is not limited to assessing the area for cleanliness and dust mitigation, worker compliance with measures as outlined, hospital approved workers/trades, etc..
 - .1 Security – site will have controlled access with appropriate signage to identify the area as a construction area and danger within.
 - .2 Security – access to site will be through a self closing door that is locked at the conclusion of each day's activity. Keys to the site will be provided to the IPCS or the *Owner*.
 - .3 *Contractor* will conduct daily site reviews and document daily findings in a log book as specified by the IPCS or designate.
 - .4 Site cleaner will document frequency of cleaning as specified by the IPCS or designate.
- .7 Ventilation System and Negative Pressure Differential:
 - .1 Areas where work is being undertaken shall be isolated from occupied areas of the hospital using dust tight partitions and enclosures as described above.
 - .2 The *Place of the Work* will be maintained under negative pressure at all times in relation to the occupied areas of the existing building to prevent dust and airborne pathogens from entering the occupied areas of the existing building.
 - .3 Negative pressure shall be achieved through the use of dedicated (window or otherwise) exhaust units or, if direct access cannot be achieved, by HEPA filtered recirculation units that transfer filtered air from the *Place of the Work* into the occupied areas. Exhaust points will be reviewed with the *Owner* and the *Consultant* to ensure that the exhaust air from the *Place of the Work* is not affecting pedestrian routes and is not re-entrained back into the existing building through fresh air intakes.
 - .4 Provide construction exhaust/HEPA units and remove at the completion of the *Work*.
 - .5 Air systems serving only the *Place of the Work* will be shut down and all supply, return and exhaust openings shall be sealed to prevent dust and construction debris from entering the air system. As a further precaution, the air system will be reviewed at the end of the *Work* to determine if cleaning is required.

Infection Control During Construction

- .6 Supply and return air ducts entering the *Place of the Work* are to be fitted with a pre-filter unit and sealed within the *Place of the Work* near point of entry or exit prior to the start of disruptive activity to prevent dust and construction debris from entering the air system. As a further precaution, the air system will be reviewed at the end of the *Work* to determine if cleaning is required.
- .7 During construction, the seal only on the supply air duct may be removed after demolition and clean-up to permit ventilation within the construction area provided no other means is available.
- .8 Areas adversely affected by changes in air flows outside the construction areas are to be re-balanced to comfortable levels as advised by the *Consultant*.
- .9 Main HVAC infrastructure shall be protected from contamination in accordance with CSA Z317.02-01 Special Requirements for HVAC in Health Care Facilities, and CSA Z317.13-07.
- .8 *Contractor* shall, when constructing the hoarding, install a magnehelic gauge that will measure negative pressure. *Contractor* shall take daily log of the readings of the gauge and record measurements in a report. Report shall be updated daily be available to the *Consultant* and *Owner* immediately upon request.
- .9 *Contractor* shall ensure that vacuuming and cleaning of *Contractors* and *Subcontractors* clothes is mandatory prior to leaving areas of the *Work* to prevent dispersion of dust.
- .10 *Contractor* to provide their own mobile negative pressure enclosures in adequate numbers to align with the project schedule to do localized ceiling work. Use of *Owner's* mobile negative pressure enclosures is not permitted.

APPENDIX I

Refer to appendix I, consisting of 10 pages following this section

APPENDIX B

Refer to appendix B, consisting of 2 pages following this section

APPENDIX C

Refer to appendix C, consisting of 10 pages following this section

APPENDIX D

Refer to appendix A, consisting of 1 page following this section

PART 2- PRODUCTS

Not applicable.

PART 3 - EXECUTION

Not applicable.

END OF SECTION

Infection Prevention and Control

Risk Assessment and Preventive Measures Checklist for Health Care Facility Construction & Renovation

Summary

The infection control risk assessment (ICRA) is a systematic process that identifies the level of risk to patients, staff and visitors from construction or renovation projects, and defines control measures to reduce risk. The purpose of the ICRA is to provide guidelines on the appropriate infection prevention and control procedures required for the type of activity depending on where the activity will occur. The Infection Prevention and Control Practitioner may add or omit requirements specific to a project. Recommended barriers/hoarding must be installed before construction or renovation begins.

Part One: Types of Construction Activity

DEFINITIONS OF CONSTRUCTION ACTIVITY	
Type A	Inspection and non-invasive activities. These include, but are not limited to, activities that involve a single controlled opening in a wall or ceiling within a single defined space for insula inspection, that is accessed by: a) Removing no more than one ceiling tile or b) Opening of an access panel on a wall or ceiling. Minor plumbing work that disrupts the water supply to a single fixture in a localized area *i.e., one room for a short duration (e.g. less than 1 h).
Type B	Small-scale, short-duration (e.g. less than 2h) activities that create minimal dust. These include but are not limited to a) Activities involving access to and use of chase spaces; b) 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; and c) Sanding or repair of a small area of a wall. Plumbing work that disrupts the water supply of up to three fixtures for a short duration (e.g. less than 1 h) or one fixture for 1 h or more.
Type C	Activities that generate a moderate to high level of dust, cause a moderate service disruption, require demolition, require removal of a fixed facility component (e.g. a sink) or assembly (e.g. a countertop or cupboard), and can be completed in a single or contiguous work shifts. These include, but are not limited to, a) activities that require sanding of a wall in preparation for painting or wall covering; b) Removal of floor coverings, ceiling tiles, and case work; c) New wall construction d) Minor ductwork e) Electrical work above ceilings and f) Major cabling activities Plumbing work that disrupts the water supply of more than three fixtures for a short duration (e.g. less than 1 H)
Type D	Activities that generate high levels of dust, activities that necessitate significant service disruption, and heavy demolition and construction activities requiring consecutive work shifts to complete. These include, but are not limited to: a) Soil excavation b) New construction that requires consecutive work shifts to complete; or c) Activities that involve heavy demolition or removal of a complete cabling system Plumbing work that disrupts the water supply of more than three fixtures for 1 h or more.

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 Risk Assessment and Preventive Measures Checklist for
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Part Two: Classification of Population Risk Group

POPULATION RISK GROUP BREAKDOWN			
GROUP 1 LOW	GROUP 2 MEDIUM	GROUP 3 MEDIUM to HIGH	GROUP 4 HIGHEST
- Private/Office areas - Areas operating outside or void of patient care	- Patient Care areas not identified in Group 3 or 4 - Laundry - Cafeteria - Dietary - Materials Management - PT/OT/Speech - Admission/Discharge - Echocardiography Laboratories not specified as Group 3 - Public Corridors through which patients, supplies, linen pass)	- Emergency Rooms - Radiology/Medical Imaging - Post-anesthesia Care units or Same Day Surgery (MG, M2) - Labour and Delivery - Newborn Nurseries - Medical laboratories (Microbiology (HB), Transfusion Science (B2), Chemistry (CG), Pathology (E4, M2), Haematology lab, Core Lab (CG), etc.) - Post-Surgical/Trauma Patient Care Units (D5, C5, D3, D6) - Oncology Units (C2, C6, K3C, Odette Cancer Centre) - General Medicine Units (D2, K3E, D4, B4, C4, C6)	- Ross Tilley Burn Centre (D7) - Critical Care Unit (M2, D4) - Cardiovascular Intensive Care Unit (M2) - B5 Intensive Care Unit - Operating rooms (M2/D7/MG) - Central Processing Department - Newborn Intensive Care Unit - Pharmacy Areas - Cardiovascular Care Unit (B3) - Cardiac Catheterization Suites (C3)

Part Three: Construction Activity and Risk Group Matrix

A copy of the Risk Assessment and Preventive Measures Checklist must be sent to the Infection Prevention and Control Department to determine the matrix and determine the preventive measures required. Adaptations to the prevention measures can only be made after approval has been provided by the infection control personnel.

	Construction/Renovation/Maintenance Activity			
Risk Group	Type A	Type B	Type C	Type D
Group 1	I	II	II	III
Group 2	II	II	III	IV
Group 3	II	III	III	IV
Group 4	II	III	IV	IV

Infection Prevention and Control
Risk Assessment and Preventive Measures Checklist for
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Part Four: Recommendations for Infection Control Preventive Measures**Matrix Class I Requirements****la) C/R Activities - Dust Control**

- 1 After visual inspection replace displaced tiles and close access panels
- 2 Work area HEPA vacuumed if dust created during activity
- 3 Ensure that patient care equipment and supplies are protected from dust exposure by removal from space by hospital staff or by covering with a drop sheet

lb) C/R Activities - Plumbing

- 4 Schedule water interruptions during periods of low user activity
- 5 Faucet aerators, gaskets and items made of materials that support the growth of Legionella are not installed or used
- 6 Water temperature meets standards set by Sunnybrook Health Sciences Centre
- 7 Any discolored water or water leaks to walls and substructures reported to maintenance and IP&C representative
- 8 Water lines flushed prior to re-use

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Matrix Class II Requirements

IIa) C/R Activities - Dust Control

1. All constructors and sub constructors must follow the assigned traffic route to and from the C/R zone
2. After visual inspection replace displaced tiles and close access panels
3. Active means provided to minimize dust generated and migrated into the atmosphere
4. Use drop sheets and water misting during cutting to control dust
5. Seal windows, unused doors, plumbing penetrations, electrical outlets and any other potential air leaks within C/R zone
6. Ensure that patient care equipment and supplies are protected from dust exposure by removal from space by hospital staff or by covering with a drop sheet
7. Debris removed from C/R zone in covered containers or covered with moistened sheet before transport
8. Work area wet mopped or HEPA vacuumed if dust created during activity and at completion of project
9. Horizontal and vertical surfaces to be cleaned with a hospital approved disinfectant at completion of project prior to turnover to user group

IIb) C/R Activities – HVAC

10. Ventilation system disabled in the C/R area until project completed (where possible)
11. Need to change and/or clean filters in C/R area monitored
12. Air intake and exhaust vents in C/R zone sealed off with polyethylene

IIc) C/R Activities - Plumbing

13. Schedule water interruptions during periods of low user activity
14. Faucet aerators, gaskets and items made of materials that support the growth of *Legionella* are not installed or used
15. Water temperature meets standards set by *Sunnybrook Health Sciences Centre*
16. Any discoloured water or water leaks to walls and substructures reported to maintenance and IP&C representative
17. Hyper-chlorinate or superheat stagnant domestic water and flush water lines in C/R zone and adjacent patient areas before re-use

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Matrix Class III Requirements

IIIa) C/R Activities – Dust Control

1. IP&C consultation completed and IP&C dust control measures approved
2. Impermeable solid dust barrier, from true ceiling to floor erected and inspected by IP&C before start of project (drywall/sheetrock/gypsum board)
3. Double layer of 6 mil fire retardant polyethylene is an alternative dust barrier, but IP&C must be consulted to determine optimal choice based on location, type and duration of project
4. Upper seals must be installed above the false ceiling to the true ceiling around all penetrations to complete the dust barrier
5. Sticky mat placed and maintained outside C/R zone to trap dust from workers shoes, equipment and debris that leaves the C/R zone
6. Constructors vacuum themselves with HEPA-filtered vacuum before leaving work site (alternatively constructors can wear cloth/paper coveralls that are removed each time they leave the work site)
7. Use drop sheets and water misting during cutting to minimize dust generated and migrated into the atmosphere
8. Seal windows, unused doors, plumbing penetrations, electrical outlets and any other potential air leaks within C/R zone
9. Ensure that patient care equipment and supplies are protected from dust exposure by removal from space by hospital staff or by covering with a drop sheet
10. Debris removed from C/R zone in covered containers or covered with moistened sheet before transport
11. Work area wet mopped or HEPA vacuumed if dust created during activity and at completion of project
12. Horizontal and vertical surfaces to be cleaned with a hospital approved disinfect at completion of project prior to turnover to user group
13. Holes in walls repaired within 8 hours or temporarily sealed
14. Dust barrier shall remain in place until project complete, area has been thoroughly cleaned and inspected by IP&C
15. Dust barriers removed carefully to minimize the spreading of dust and other debris particles associated with the C/R project

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Matrix Class III Requirements Continued

IIIb) C/R Activities – HVAC

16. High-Efficiency Particulate Filters (HEPA) shall be used to obtain a negative pressure differential. Constructor responsible for providing appropriate number of units based on square footage of C/R zone
17. Filters shall be monitored and replaced if clogged or functioning below the manufacturer's specifications
18. Negative pressure differential with respect to adjacent areas is no less than 7.5 Pa (0.03 in wc)
19. Intake and exhaust vents/grills within C/R zone to be sealed off with poly for the duration of the project
20. Where possible air is to be exhausted directly outside and way from intake vents, alternatively air is to be filtered through HEPA filter before being re-circulated
21. Ventilation systems working properly in adjacent areas
22. Ventilation system is cleaned if contaminated by soil, water or dust after C/R project completion

IIIc) C/R Activities – Plumbing

23. An alternate source of potable water must be provided for users during prolonged plumbing shutdowns and/or after major plumbing installation/repairs until potable water has been cleared for signs of *Legionella*
24. Schedule water interruptions during periods of low user activity
25. Faucet aerators, gaskets and items made of materials that support the growth of *Legionella* are not installed or used
26. Water temperature meets standards set by *Sunnybrook Health Sciences Centre*
27. Any discoloured water or water leaks to walls and substructures reported to maintenance and IP&C representative
28. Hyper-chlorinate or superheat stagnant domestic water and flush water lines in C/R zone and adjacent patient areas before re-use

IIId) C/R Activities – Risk Reduction

29. High risk patients in/adjacent to C/R areas moved
30. Cleaning frequency of areas adjacent to C/R zone by cleaning by Hospital Environmental Services to be increased while project is underway
31. Traffic pattern designated for clean or sterile supplies and equipment that avoids C/R zone
32. Hospital medical allied health staff are not permitted to enter to then C/R zone for the duration of the project

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Matrix Class IV Requirements

IVa) C/R Activities – Dust Control

1. IP&C consultation completed and IP&C dust control measures approved
2. Impermeable solid dust barrier with anteroom erected and inspected by IP&C before start of project
3. Upper seals must be installed above the false ceiling to the true ceiling around all penetrations to complete the dust barrier
4. Sticky mat placed and maintained fresh outside and inside anteroom to trap dust from workers shoes, equipment and debris that leaves the C/R zone
5. Construction workers leave C/R zone through anteroom to be vacuumed with HEPA-filtered vacuum before leaving work site (alternatively constructors can wear cloth/paper coveralls that are removed each time they leave the work site)
6. Impermeable solid dust barrier, from true ceiling to floor erected and inspected by IP&C before start of project (drywall/sheetrock/gypsum board)
7. Use drop sheets and water misting during cutting to minimize dust generated and migrated into the atmosphere
8. Seal windows, unused doors, plumbing penetrations, electrical outlets and any other potential air leaks within C/R zone
9. Ensure that patient care equipment and supplies are protected from dust exposure by removal from space by hospital staff or by covering with a drop sheet
10. Debris removed from C/R zone in covered containers or covered with moistened sheet before transport
11. Work area wet mopped or HEPA vacuumed if dust created during activity and at completion of project
12. Horizontal and vertical surfaces to be cleaned with a hospital approved disinfect at completion of project prior to turnover to user group
13. Holes in walls repaired within 8 hours or temporarily sealed
14. Dust barrier to remain in place until project complete, area has been thoroughly cleaned and inspected by IP&C
15. Dust barriers removed carefully to minimize the spreading of dust and other debris particles associated with the C/R project

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Matrix Class IV Requirements Continued

IVb) C/R Activities – HVAC

16. High-Efficiency Particulate Filters (HEPA) shall be used to obtain a negative pressure differential. Constructor responsible for providing appropriate number of units based on square footage of C/R zone
17. Filters shall be monitored and replaced if clogged or functioning below the manufacturer's specifications
18. Negative pressure differential with respect to adjacent areas is to be maintained no less than 7.5 Pa (0.03 in wc)
19. Intake and exhaust vents/grills within C/R zone to be sealed off with poly for the duration of the project
20. Where possible air is to be exhausted directly outside and away from intake vents, alternatively air is to be filtered through HEPA filter before being re-circulated
21. Ventilation systems working properly in adjacent areas
22. Ventilation system is cleaned if contaminated by soil, water or dust after C/R project completion

IVc) C/R Activities – Plumbing

23. An alternate source of potable water must be provided for users during prolonged plumbing shutdowns and/or after major plumbing installation/repairs until potable water has been cleared for signs of *Legionella*
24. Schedule water interruptions during periods of low user activity
25. Faucet aerators, gaskets and items made of materials that support the growth of *Legionella* are not installed or used
26. Water temperature meets standards set by *Sunnybrook Health Sciences Centre*
27. Any discoloured water or water leaks to walls and substructures reported to maintenance and IP&C representative
28. Hyper-chlorinate or superheat stagnant domestic water and flush water lines in C/R zone and adjacent patient areas before re-use

IVd) C/R Activities – Risk Reduction

29. High risk patients in/adjacent to C/R areas moved
30. Cleaning frequency of areas adjacent to C/R zone by cleaning by Hospital Environmental Services to be increased while project is underway
31. Traffic pattern designated for clean or sterile supplies and equipment that avoids C/R zone
32. Hospital medical and/or allied health staff are not permitted to enter to then C/R zone for the duration of the project

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Date: _____ Time: _____

Location: _____ Inspector: _____

Construction/Renovation/Repair site has been checked for:

ITEM	COMPLIANCE?		
1. Construction Barriers	Y	N	N/A
Infection Control Permit/Sign off posted outside work area			
Airtight plastic or drywall barriers extend from floor to ceiling			
All airtight penetrations sealed with heavy tape			
All remaining hospital equipment, doors, holes, conduits, unused windows, outlets in work area covered with poly and sealed			
Doors to anteroom and work site remain securely closed			
Upper seals intact			
Portable containment cube intact, labeled and completely sealed			
Portable HEPA vacuum or HEPA filtration unit attached outside cube and turned on during ceiling/wall access			
2. Negative Air	Y	N	N/A
HVAC system has been isolated to prevent contamination of the duct system. Supply vents are blocked and return vents are filtered			
Equipment to prevent airborne particulates from escaping work area are used appropriately (e.g. portable HEPA filter units/filtered vacuums, exhaust fans)			
Doors to anteroom and work site remain securely closed			
Portable HEPA filtration unit is well secured (clamped hose) and ducted properly			
Work site is at negative pressure to surrounding areas (0.03kpa)			
Contractors properly attired (coveralls/booties put on over clothing) prior to entering work zone			

4. CLEANLINESS OF AREA	Y	N	N/A
Protective clothing properly removed and disposed of, or existing clothing properly vacuumed in ante-room prior to leaving work area			
Sticky mats or adhesive strips are clean and available at doorways for shoe dust collection			
No visible dust or footprints outside of work zone			
Anteroom is intact and free of debris/dust			
Sticky mats are fresh and available at doorways for dust collection			
Construction area cleaned daily.			
Demonstrated compliance with traffic patterns, both construction worker and supply/debris removal.			

COMMENTS/NOTES
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- Any major deficiencies should be addressed immediately. Non-compliance should be brought to the attention of the Project Manager (refer to Infection Control Risk Assessment Tool)
- This monitor checklist will be completed periodically for the duration of the construction/renovation/repair project
- A corrective action log for documented non-compliance will be maintained by Infection Prevention and Control

For further information please contact:

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Patient Care Manual

Policy Section:	Infection Prevention and Control	Policy No:	II-i-200 R
Policy Subject:	SECTION R Construction and Renovation	Date Issued:	January 2001
Issued by:		Date Reviewed:	
		Date Revised:	

POLICY STATEMENT:

It is Sunnybrook & Women's Policy to ensure that each construction and/or renovation project's design and process meet current infection control standards and will be reviewed to:

1. Design state of the art infection prevention systems.
2. Determine the risks to patients, visitors, staff, volunteers, students, and contractors throughout the pre-construction, construction and post-construction phases and proactively initiate prevention strategies.
3. Support Infection Prevention & Control Service (IPCS) to investigate and advise on the risks of organisms that exist in the project area.

In keeping with Sunnybrook & Women's Mission, Vision, and Values, the goal is to eliminate any infectious risks where possible and minimize those risks that cannot be eliminated.

DEFINITION(S):

Project Manager (PM):

The lead representative of Corporate Planning & Development, Facilities Services and Others, responsible for the maintenance, construction or renovation projects.

The Project Manager has a key role to help prevent outbreaks due to Aspergillosis and Legionellosis by planning and employing appropriate infection prevention and control interventions before and during construction and renovation. Environmental Service also has an important role to keep the construction area clean when the responsibility for area cleanliness is not under the construction contract.

1. The Project Manager will advise IPCS of any scheduled construction and renovation projects.
2. IPCS is to be included in the design and construction process. The Project Manager, in conjunction with IPCS, is responsible for ensuring that the contractors carry out infection prevention activities.
3. The construction and renovation Infection Control Checklist is to be completed for all projects by IPCS and a copy forwarded to the Project Manager during the initial stages of the project. The checklist also notes areas where IPCS input is not needed (e.g. Class I-II activity). Projects needing special notification include breaching ceilings, walls, floors, and ventilation/air handling systems. The installation of wiring in patient care areas also constitutes a breach of ceiling integrity and warrants barrier precautions.

Project Team:

Includes the Project Manager, IPCS, Project Consultants, User Group and other Department representatives including Facilities Services as determined at project start-up.

Note: Major hazards, such as increased morbidity and mortality, result from designs that lack infection control input during construction or renovation. (Reference: APIC Text of Infection Control and Epidemiology. 2000: 72-1 – 72A-14)

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		Date Revised:	

PROCEDURE:

IPCS and hospital administration will liaise with the appropriate staff from the department/unit to determine the infection risks to patients, visitors and hospital staff. IPCS will sign-off the plans for each project.

1. DESIGN:

- Design Phase: Notify IPCS of impending construction/renovation plans. IPCS will provide expertise related to the design of the area to optimize infection prevention and control practices during the functional programming process.
- During the design phase IPCS will assess the risks related to the project utilizing the Risk Assessment and Preventive Measures Checklist ([Appendix I R](#)). The determination of risk will guide the need for barriers during the construction/renovation project. The Project Manager or delegate will communicate the assessment to the design team.
- Facilities Services will review preventative maintenance requirements during design to ensure that any costs are incorporated into the appropriate budgets.

2. PRE-CONSTRUCTION:

The Project Team will work with IPCS to address the following:

- general information on infection prevention measures
- patient populations that may be at risk
- prevention measures for essential services (e.g. water, ventilation systems, electricity) that may be disrupted
- the integrity of the facility's exterior structure, spatial separations, ventilation and water supplies for any infection control problems
- methods for dust containment and removal of construction debris
- traffic patterns for construction workers and supply delivery routes will be established to minimize risks to patients, staff and visitors
- the need for increased filter changes during construction
- the need to close down dampers temporarily to reduce circulation of contaminated air or fumes
- that the systems can provide the correct air exchange rates and pressure relationships in critical areas near construction activity
- IPCS/Occupational Health & Safety (OHS) may at the request of the project team attend OHS meetings for IPCS /OHS procedure overviews.

3. CONSTRUCTION:

Breaches in agreed to infection prevention measures, as outlined in [Appendix I R](#) and completed in Phase 1 that place staff and/or patients at risk will result in "stop" construction orders to the Project Manager by Infection Prevention & Control Service.

a) Patients

Immunosuppressed patients (e.g. Oncology patients, neonates, dialysis, burn patients) must be moved to an area away from the construction zone if air quality cannot be ensured during construction/renovation activity. Avoid transporting any patient through the construction zone. If this must be done the patient must wear a high efficiency mask.

b) Air/Ventilation

The Project Team will be responsible for addressing air and ventilation as categorized by IPCS within the initial stages of the project and as specified in [Appendix I R](#).

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Issued by:		Date Reviewed:	
		Date Revised:	

c) **Cleaning**

Cleaning will be provided as categorized by IPCS within the initial stages of the project and as specified in [Appendix I R](#).

d) **Construction Personnel**

Protective clothing is to be removed when exiting through patient areas or vacuumed when exiting through other areas as categorized by IPCS within the initial stages of the project and as specified in [Appendix I R](#).

e) **Transportation of Equipment/Supplies**

Prior to construction, IPCS and the Project Team will establish paths and procedures for the transportation of clean/sterile supplies, equipment and construction materials, including the removal of construction debris.

f) **Surveillance**

IPCS personnel will enhance surveillance as appropriate.

Site review of the construction/renovation project will be conducted on a regular basis with the Project Manager, construction representative and IPCS. IPCS will provide written inspection report to the Project Manager as necessary.

g) **Water and Ventilation Systems**

The Project Team will be responsible for addressing air and ventilation as categorized by IPCS within the initial stages of the project and as specified in [Appendix I R](#).

- The construction site will be maintained under negative pressure at all times in relation to the occupied areas of the Hospital to prevent dust and airborne pathogens from entering the occupied areas of the hospital. Negative pressure shall be achieved through the use of dedicated (window or otherwise) exhaust units or if direct cannot be achieved by Hepa filtered recirculation units which transfers filtered air from the construction site into the building exhaust system or occupied areas, as approved by the Hospital. Exhaust points will be reviewed to ensure that the exhaust air from the construction site is not affecting pedestrian routes and is not re-entrained back into the Hospital through fresh air intakes.
- Supply and return air ducts entering the defined construction zone are to be fitted with a pre-filter unit and sealed within the construction area near point of entry or exit prior to the start of disruptive activity to prevent dust and construction debris from entering the air system. As a further precaution, the air system will be reviewed at the end of the project to determine if cleaning is required.
- During construction the seal only on the supply air duct may be removed after demolition and construction clean-up as defined under [Appendix I R \(Class III\)](#) as required to permit ventilation within the construction area provided no other means is available.
- Areas adversely affected by changes in air flows outside the construction areas are to be re-balanced to comfortable levels as advised by the consultant.
- All areas deemed sensitive to airflow and designed with either negative or positive room pressurization (e.g. isolation rooms, OR, etc) must be equipped with an electronic monitor with local alarm.
- All Water systems must be thoroughly disinfected and flushed prior to occupancy.

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4. **POST-CONSTRUCTION:**

a) **Cleaning**

In addition to the cleaning requirements as categorized by IPCS within the initial stages of the project and as specified in **Appendix I R**, the construction areas must also be cleaned prior to and at completion of work as follows;

- Construction cleaning prior to reopening a supply air duct during construction.
- Construction cleaning prior to the removal of any barriers.
- Construction cleaning after the removal of any barrier.
- Construction cleaning immediately after completion of minor work performed after the removal of barriers.
- Final cleaning by Environmental Services prior to occupancy.
- Cleaning as required by Environmental Services during commissioning as required.
 - Construction cleaning is defined as the complete removal of all debris and vacuuming the entire area with a HEPA filter unit. Area is to be inspected and approved as clean by IPCS.
 - Final cleaning is defined as post construction cleaning as provided by the Hospital 's workforce or contracted cleaning service.

b) **Inspection**

A site inspection of the construction/renovation area must be undertaken by IPCS and/or Project Manager prior to occupancy.

IPCS will provide written deficiencies in a timely fashion to allow patients use of the area.

References:

1. **APIC Text of Infection Control and Epidemiology (2000). Chapter 72**
2. **Infection Control Tool Kit Series: Construction and Renovation. (1998-1999) APIC Education Committee**
3. **Construction-related Nosocomial Infections for Patients in Health Care Facilities: Decreasing the Risk of Aspergillus, Legionella and other Infections. July, 2001 Health Canada.**
4. **AIA Guidelines for Design and Construction of Hospital and Health Care Facilities. American Institute of Architects Press 2001. ISBN# 1-55835-151-5**

Policy Section: Infection Prevention and Control**Policy No:** II-i-200 R**Policy Subject:** **SECTION R**
Construction and Renovation**Date Issued:** January 2001**Issued by:****Date Reviewed:****Date Revised:****Appendix I-R****Risk Assessment and Preventive Measures Checklist for Health Care Facility Construction and Renovation**

Location of Construction:		Project Start Date:		Estimated Duration:	
Project Manager (PM):		Contractor(s):		Infection Control Professional (ICP):	
PM's phone number:		Contractor's phone number:		ICP's phone number:	
Yes	No	Construction Activity (See Part A)	Yes	No	Population Risk Group (See Part B)
		Type A: Inspection, non-invasive activities.			Group 1: Lowest Risk
		Type B: Small scale, short duration, minimal dust generating activities.			Group 2: Medium Risk
		Type C: Activities that generate moderate to high levels of dust, requires greater than one work shift to complete.			Group 3: Medium to High Risk
		Type D: Activities that generate high levels of dust, major demolition and construction activities requiring consecutive work shifts to complete.			Group 4: Highest Risk

Part A: Types of Construction Activity

Type A	Inspection and Non-invasive Activities: These include, but are not limited to, activities that require removal of ceiling tiles for visual inspection (limited to 1 tile per 50 square feet), painting (but not sanding), wall covering, electrical trim work, minor plumbing (disrupts water supply to a localized patient care area [e.g., 1 room] for less than 15 minutes), and other maintenance activities that do not generate dust or require cutting of walls or access to ceilings other than for visual inspection.
Type B	Small scale, short duration activities that create minimal dust. These include, but are not limited to, activities that require access to chase spaces, cutting of walls or ceilings where dust migration can be controlled for the installation/repairs of minor electrical work, ventilation components, telephone wires or computer cables, and sanding of walls for painting or wall covering to <u>only repair</u> small patches. It also includes plumbing that requires disruption to the water supply of more than one patient care area (e.g., > 2 rooms) for less than 30 minutes.
Type C	Any work that generates a moderate to high level of dust or requires demolition or removal of any fixed building components or assemblies (e.g. counter tops, cupboards, sinks). These include, but are not limited to, activities that require sanding of walls for painting or wall covering, removal of floor-coverings, ceiling tiles and casework, new wall construction, minor duct work or electrical work above ceilings, major cabling activities, and any activity that <u>cannot be completed</u> within a single work shift. It also includes plumbing that requires disruption to the water supply of more than one patient care area (e.g. > 2 rooms) for more than 30 minutes but less than 1 hour.
Type D	Major demolition, construction and renovation projects. These include, but are not limited to, activities that involve heavy demolition or removal of a complete cabling system and new construction that requires consecutive work shifts to complete. It also includes plumbing that results in disruption to the water supply of more than one patient care area (e.g. > 2 rooms) for more than 1 hour.

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Part B: Population and Geographical Risks Group

Group 1 Lowest Risk	Group 2 Medium Risk	Group 3 Medium to High Risk	Group 4 Highest Risk
• Office areas • Unoccupied wards • Public areas	• All other patient care areas (e.g. cardiac rehab, ambulatory care clinics unless stated in Group 3 or 4) • Outpatient clinics (except for oncology & surgery) • Admission/discharge units	• Emergency room • Radiology/MRI • Post anesthesia care units • Labour and delivery (non OR) • Normal newborn nurseries • Day surgery • Nuclear medicine • Physiotherapy tank areas • Echocardiography • Pump team • Laboratories (specimens) • General med/surg. wards other than those listed in Group 4 • Pediatrics • Geriatrics • Long-term care	• All ICUs • All ORs • Oncology units and outpatient clinics for patients with cancer • Transplant units and outpatient who have received bone marrow or solid organ transplants • Wards and out patient clinics for patients with AIDS or other immunodeficiency • Dialysis units • Tertiary care nurseries • Labour & delivery operating rooms • All cardiac catheterization & angiography areas • Cardiovascular/cardiology patients • Anesthesia and pump areas • All endoscopy areas • Pharmacy admixture rooms • Sterile processing rooms • Central Processing Dept.

Policy Section: Infection Prevention and Control**Policy No:** II-i-200 R**Policy Subject:** SECTION R
Construction and Renovation**Date Issued:** January 2001**Issued by:****Date Reviewed:****Date Revised:****Appendix I R** (cont'd)**Part C: Construction Activity and Risk Group Matrix**

A copy of the Risk Assessment and Preventive Measures Checklist must be sent to the Infection Prevention and Control Department when the matrix indicates that Class III and/or Class IV preventive measures are required (see shaded areas). Adaptations to the prevention measures can only be made after approval has been provided by the infection control professional. Infection control personnel should also be consulted when construction activities need to be done on hallways adjacent to Class III and Class IV areas.

Risk Group	Construction Activity			
	Type A	Type B	Type C	Type D
Group 1	I	II	II	III / IV
Group 2	I	II	III	IV
Group 3	I	III	III / IV	IV
Group 4	I - III Contact IPCS to ensure it is Class I	III / IV	III / IV	IV

Part D: Specifications for Infection Control Prevention Measures

Class I	<u>Engineer/Maintenance Staff & Contractors</u> a) Construction/Renovation Activities Dust Control* - Immediately replace tiles displaced for visual inspection - Vacuum work area b) Plumbing Activities - Schedule water interruptions during low activity (e.g., evenings if at all possible) - Flush water lines prior to reuse - Observe for discoloured water - Ensure water temperature meets the standards set by the health care facility - Ensure gaskets and items made of materials that support the growth of <i>Legionella</i> are not being used - Ensure faucet aerators are not installed or used - Maintain as dry an environment as possible and report any water leaks that occur to walls and substructures	<u>Environmental Services</u> a) Plumbing Activities - Report discoloured water and water leaks to maintenance and ICP <u>Medical/Nursing Staff</u> a) Construction/Renovation Activities Risk Reduction - Minimize patients' exposure to construction/renovation area b) Plumbing Activities - Report discoloured water and water leaks to maintenance and ICP
	Date:	
	Initials:	

***Note.** Class II specifications must be followed if dust should be created during the Type A construction activity.

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Part D: Specifications for Infection Control Prevention Measures (cont'd)

Class II	<u>Engineer/Maintenance Staff & Contractors</u> a) Construction/Renovation Activities Dust Control • Execute work by methods to minimize dust generation from construction or renovation activities • Wet mop and/or vacuum as necessary • Provide active means to minimize dust generation and migration into the atmosphere • Use drop sheets to control dust • Control dust by water misting work surfaces while cutting • Seal windows and unused doors with duct tape • Seal air vents in construction/renovation area • Place dust mat at entrance to and exit from work areas Ventilation • Disable the ventilation system in the construction/renovation area until the project is completed • Monitor need to change and/or clean filters in construction or renovation area Debris Removal & Cleanup • Contain debris in covered containers or cover with a moistened sheet before for disposal b) Plumbing Activities • Collection tanks and long pipes that allow water to stagnate should be avoided • Consider hyperchlorinating or superheating stagnant potable water (especially if <u>Legionella</u> is already present in potable water supply)	<u>Environmental Services</u> a) Construction/Renovation Activities Dust Control • Wet mop and vacuum area with a HEPA filtered vacuum as needed and when work is completed • Wipe horizontal work surfaces with a disinfectant <u>Medical/Nursing Staff</u> a) Construction/Renovation Activities Risk Reduction • Identify high risk patients who may need to be temporarily moved away from the construction zone
Date:		
Initials:		

Note. The above specifications are to be considered in addition to those listed in Class I.

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Appendix I R (cont'd)

Part D: Specifications for Infection Control Prevention Measures (cont'd)

Class III	<u>Engineer/Maintenance Staff & Contractors</u> a) Construction/Renovation Activities Risk Reduction • Ensure ICP consultation has been completed and infection control measures have been approved Dust Control • Erect an impermeable dust barrier from true ceiling (includes area above false ceilings) to the floor consisting of 2 layers of 6 ml polyethylene or Sheetrock • Ensure windows, doors, plumbing penetrations, electrical outlets and intake and exhaust vents are properly sealed with plastic and duct taped within the construction/renovation area • Air ducts and spaces above ceilings should be vacuumed if necessary • Construction workers should wear protective clothing that should be removed each time they leave the construction site before going into patient care areas • Do not remove dust barrier until the project is complete and the area has been cleaned thoroughly and inspected • Remove dust barrier carefully to minimize spreading dust and other debris particles associated with the construction project Ventilation • Maintain negative pressure within construction zone by using portable HEPA equipped air filtration units • Ensure air is exhausted directly outside and away from intake vents or filtered through a HEPA filter before being recirculated • Ensure ventilation system is functioning properly and is cleaned if contaminated by soil or dust after construction or renovation project is complete Debris Removal & Cleanup • Remove debris at the end of the work day • An external chute will need to be erected if the construction is not taking place on ground level • Vacuum work area with HEPA filtered vacuums daily or more frequently if needed b) Plumbing Activities • Flush water lines at construction or renovation site and adjacent patient care areas before patients are readmitted	<u>Environmental Services</u> a) Construction/Renovation Activities • Increase frequency of cleaning in areas adjacent to the construction zone while project is underway • In collaboration with infection control personnel ensure that construction zone is thoroughly cleaned when work is complete <u>Infection Control Personnel</u> a) Construction/Renovation Activities Risk Reduction • Move high risk patients who are in or adjacent to the construction area • In collaboration with environmental services ensure that construction zone is thoroughly cleaned when work is complete • Inspect dust barriers Traffic Control • In collaboration with the facility project manager designate a traffic pattern for construction workers that avoids patient care areas and a traffic pattern for clean or sterile supplies and equipment that avoids the construction area b) Plumbing Activities • Consider hyperchlorinating or superheating stagnant potable water (especially if Legionella is already present in potable water supply) <u>Medical/Nursing Staff</u> a) Construction/Renovation Activities Risk Reduction • Move high risk patients who are in or adjacent to the construction area • Ensure that patients do not go near the construction area • In collaboration with environmental services and IPCS ensure that construction zone is thoroughly cleaned when work is complete
Date: Initials:		

Note. The above specifications are to be considered in addition to those listed in Class I and II.

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Class IV Date: Initials:	<u>Engineer/Maintenance Staff & Contractors</u> a) Construction/Renovation Activities Dust Control • Before starting the construction project erect an impermeable dust barrier that also has an anteroom • Place a walk-off mat outside the anteroom in patient care areas and inside the anteroom to trap dust from the workers shoes, equipment and debris that leaves the construction zone • Construction workers should leave the construction zone through the anteroom so they can be vacuumed with a HEPA filtered vacuum cleaner before leaving the work site; or they could wear cloth or paper coveralls that are removed each time they leave the work site • All personnel entering the construction zone are required to wear shoe covers • The construction workers must change the shoe covers each time they leave the work site • Holes in walls should be repaired within 8 hours or be temporarily sealed Ventilation • Ensure negative pressure is maintained within the anteroom and construction zone • Ensure ventilation systems are working properly in adjacent areas • Review ventilation system requirements in the construction area with IPCS to ensure system is appropriate and is functioning properly Evaluation • Review infection control measures with other members of the planning team or delegate to evaluate their effectiveness and identify problems at the end of construction project b) Plumbing Activities • If there are concerns about <u>Legionella</u>, consider hyperchlorinating stagnant potable water or superheating and flushing all distal sites before restoring or repressurizing the water system	<u>Environmental Services</u> a) Construction/Renovation Activities Evaluation • Review infection control measures with other members of the planning team or delegate to evaluate their effectiveness and identify problems at the end of construction project <u>Infection Control Personnel</u> a) Construction/Renovation Activities Risk Reduction • Regularly visit the construction site to ensure preventive measures are being followed. Wear cover-alls and shoe covers when visiting the site. Evaluation • Review infection control measures with other members of the planning team or delegate to evaluate their effectiveness and identify problems at the end of construction project b) Plumbing Activities • If there are concerns about <u>Legionella</u>, consider hyperchlorinating stagnant potable water or superheating and flushing all distal sites before restoring or repressurizing the water system <u>Medical/Nursing Staff</u> Staff are not allowed to visit construction site. a) Construction/Renovation Activities Evaluation • Review infection control measures with other members of the planning team or delegate to evaluate their effectiveness and identify problems at the end of construction project b) Plumbing Activities • Consider using another source of potable water for patients who are at greatest risk until potable water has been cleared for signs of <u>Legionella</u> after major plumbing installation/repairs
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Note. The above specifications are to be considered in addition to those listed in Class I, II and III.**Reference:** #3 Health CanadaAdapted from *Reducing dust and danger during construction*. Hospital Infection Control 1997;24:26-29. (with verbal permission from Virginia Kennedy, original creator of the tool, formerly from St. Luke's Episcopal Hospital)

Patient Care Policy Manual

Section II: Infection Prevention and Control

Title: Mould Response Policy (IP&C and OHS)

Policy No: II-Q-1430

POLICY STATEMENT:

It is Sunnybrook & Women's Policy to establish procedures to ensure airborne mould is minimized through safe work practice. Procedures developed will assist to identify mould sites and the source, so that an appropriate plan of action can be put in place to assure the safety of our employees, patients and volunteers is maintained. Exposures will be kept to a minimal with respect to environmental pathogens such as moulds and other fungi. These environmental pathogens, such as *Aspergillus* and *Stachybotrys* can be harmful to patients with already compromised immune systems

DEFINITION(S):

Fungus:

Any of a major group (Fungi) of saprophytic and parasitic spore-producing organisms usually classified as plants that lack chlorophyll and include moulds (filamentous fungi), rusts, mildews, smuts, mushrooms, and yeasts.

Immune Compromised:

A reduced or lacking ability for the body to defend against pathogens (bacteria, virus, and fungi). Examples of immune compromised individuals include oncology patients, HIV/AIDS patients, dialysis patients, and patients in Intensive care units (ICU) (e.g. critical care unit, burn unit, neurosurgical ICU, Neonatal ICU, etc.).

Mould:

A growth of filamentous fungi, with a portion growing into damp or decaying organic matter and a visible surface growth, which usually assumes a fluffy appearance. Examples of filamentous fungi include *Aspergillus* and *Stachybotrys*.

PROCEDURE: If mould is suspected:

1. For an affected area greater than 10 ft², Facilities Services is to contact Infection Prevention & Control (IP&C) and Occupational Health & Safety (OHS) for direction and confirmation of the presence of mould.
2. If the presence of mould is confirmed, the affected area is to be hoarded off with 2 layers of 6 mil polyethylene sheeting. This is to prevent any further dissemination of fungal spores.
3. If the presence of mould is confirmed, and the **affected area is a ceiling tile or is less than 10 ft²** (Small-Scale), Facilities Services may remediate the mould following appropriate standards.
4. If the presence of mould is confirmed and the **affected area is greater than 10 ft²**, Facilities Services (or Corporate Planning) must contact an external Mould Abatement Contractor. The abatement must follow appropriate remediation standards.
5. Project Manager or Project Lead must retain an incident report in the building mould record and forward copies to IPC and OHS.

REFERENCES

1. Mould guidelines for the Canadian construction industry. Canadian Construction Association, 2004
2. Guidelines for the investigation, assessment and remediation of mould in workplaces. Workplace Safety and Health Division, Manitoba Department of Labour & Immigration, March 2001
3. Fungal contamination in public buildings: A guide to recognition and management. Federal-Provincial Committee on Environmental and Occupational Health, Health Canada, June 1995
4. Mold Remediation in Schools and Commercial Buildings. U. S. Environmental Protection Agency, June 25 2001
5. Alert, Mould in Workplace Buildings, Ontario Ministry of Labour, Alert 20: ISSN 1195-5228, December 2000

The Sunnybrook Intranet version of this document is considered the most current

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Quality Requirements

PART 1 - GENERAL

1.1 Section Includes

- .1 *Contractor's* quality assurance program.
- .2 *Contractor's* field quality control.
- .3 Subcontractor Qualification Statements
- .4 Independent inspection and testing – *Owner's* Quality Assurance.
- .5 Inspection and testing schedule.
- .6 Reports and documents.
- .7 Manufacturer's field review.
- .8 Mock-ups.

1.2 Contractor's Quality Assurance Program

- .1 Submit to the *Owner* and the *Consultant* for their information, a quality assurance program (the "Quality Assurance Program").
- .2 The Quality Assurance Program shall meet the requirements of Canadian Standards Association CSA CAN3-Z299.3 or such other requirements as set out in the *Contract Documents*.
 - .1 The Quality Assurance Program shall be designed so that quality requirements are obtained by progressive implementation of the controls and inspection functions stated in the Quality Assurance Program.
 - .2 Make any modifications to the Quality Assurance Program as reasonably requested by the *Owner* and/or the *Consultant*.
 - .3 The Quality Assurance Program shall include, but shall not be limited to, the following:
 - .1 A system by which changes to the *Contract Documents* and correspondence with *Subcontractor* and other correspondence is handled in a controlled manner.
 - .2 A system for purchased or manufactured materials to be identified, inspected to the specified standard, and covered by a material test report.
 - .3 A system by which measuring and testing equipment is properly stored, handled, and calibrated to a known standard.
 - .4 A system by which incoming materials are: inspected to the specified standard; accepted; allocated safe storage; and properly recorded.
 - .5 A system by which process inspection requirements shall be clearly stated for operations and carried out by qualified personnel.
 - .6 A system by which final inspections will be carried out and accepted by authorized personnel prior to release for shipping or major assembly.

Quality Requirements

- .7 A system by which non-conformance to requirements of the *Contract Documents* shall be recorded and solutions proposed by the *Owner* or the *Consultant* are also recorded.
 - .8 A system by which instructions for handling and storage of equipment shall be given.
 - .9 A system by which SBO items can be inspected and received in a manner which allows replacement or correction.
 - .10 A system by which a record of quality inspections, tests, and actions shall be kept, including field quality control.
 - .11 A system by which the *Owner* and the *Consultant* shall be afforded access to manufacturing areas and quality records and issued with copies of pertinent drawings and manufacturing schedules.
- .3 Provide the *Owner* and the *Consultant* with regular Quality Assurance Reports for their information according to an agreed schedule.

1.3 Contractor's Field Quality Control

- .1 Provide and be responsible for field quality control throughout the *Work*, including quality control of *Subcontractors* and major *Suppliers*.
- .2 Ensure that the only specified or approved *Products* and materials are used.
- .3 Provide and maintain an effective quality control program, in accordance with the Quality Assurance Program, and perform inspections and tests to ensure compliance with *Contract Documents*.
- .4 Furnish appropriate facilities, instruments, and testing devices required for performance of the quality control function.
- .5 Deliver inspection testing reports or approvals in accordance with the requirements of Section 01 45 00.
- .6 Develop a field quality control manual covering field installation. The form of the manual shall be acceptable to the *Owner* and the *Consultant*. This manual will document field quality control practices of the *Contractor*, *Subcontractors*, and major *Suppliers*. The manual shall include, but not be limited to:
 - .1 Concrete slab moisture and pH testing and surface preparation, including flatness and levelness.
 - .2 Surface preparation.
 - .3 Fastener and anchor installation.
 - .4 Material compatibility testing.
 - .5 On line fabrication quality control practices.
 - .6 Shipping.
 - .7 Field installation.
 - .8 Field inspection and testing by *Contractor*.
 - .9 Field inspection and testing independent.

Quality Requirements

- .7 Inspection and testing shall be performed by company qualified to perform the inspections or tests specified or required by the building code, regulations, by-laws, or authorities having jurisdiction.
- .8 Retain and pay for inspection and testing that is for *Contractor's* own quality control or is required by regulatory requirements
- .9 Maintain a logbook (copies to be provided to the *Consultant* at completion of fabrication) documenting date, time, results, and significance of in-plant testing carried out, where applicable, linked to daily production. The form of this logbook shall be acceptable to the *Owner* and the *Consultant*.

1.4 Subcontractor Qualification Statements

- .1 Submit list of *Subcontractors* and *Suppliers* as required to complete the *Work*, for review by *Consultant*, immediately after award of *Contract*.
- .2 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*.

1.5 Independent inspection and Testing – Owner's Quality Assurance

- .1 Independent inspection and testing services are used by the *Owner* to verify compliance with requirements of the *Contract Documents*.
- .2 Employment of inspection and testing agencies by *Contractor* or *Owner* does not relieve *Contractor* from responsibility to perform the *Work* in accordance with *Contract Documents*.
 - .1 Independent inspection and testing services do not relieve the *Contractor* of responsibility for normal shop and site inspection, and quality control of manufacturing and installation.
 - .2 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.
 - .3 Requirements for the *Contractor* to provide quality control services required by the *Contract Documents*, *Consultant*, *Owner*, or authorities having jurisdiction are not limited by *Owner's* independent inspection and testing services.
 - .4 Inspections and tests specified or required that are not specified as independent inspection and testing are the responsibility of the *Contractor* and are not covered under the *Owner's* quality assurance requirements.

Quality Requirements

- .3 The *Owner* will appoint independent inspection and testing companies, representing, reporting and responsible to the *Owner*. Payment will be by *Owner*, unless otherwise specified.
- .4 Additional inspection and testing required because of changes in materials proposed by *Contractor* or *Subcontractors*, by lack of proper notice for inspection and testing specified, or required as a result of failure of such materials to meet requirements of the *Contract Documents* when originally tested, shall be carried out at no additional cost to the *Owner*.
- .5 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*, is not part of the *Owner's* quality assurance requirements, and shall not be paid by *Owner*, unless otherwise specified in the *Contract Documents*.
- .6 Inspection or testing performed exclusively for *Contractor's* convenience shall be sole responsibility of *Contractor*, is not part of the *Owner's* quality assurance requirements, and shall not be paid by *Owner*.
- .7 Independent inspection and testing shall be performed by company qualified to perform the inspections or tests specified or required.
- .8 Requirements of regulatory companies:
 - .1 Testing shall be conducted in accordance with requirements of the building code.
 - .2 Obtain certification where required by the building code and standards.
- .9 Cooperation with independent inspection and testing companies:
 - .1 Provide independent inspection and testing companies with materials and installation information as required and/or requested.
 - .2 Submit test samples required for testing.
 - .3 Cooperate with independent inspection and testing companies and give adequate notification of any changes in source of supply, additional work shifts, and other proposed changes.
 - .4 Provide access to the *Work* for independent inspection and testing companies wherever the *Work* is in progress, or wherever *Products*, materials, or equipment are stored prior to shipping.
 - .5 Provide labour, *Construction Equipment*, and temporary facilities required to assist independent inspection and testing companies in sampling and making tests.
- .10 Inspection and test specimens:
 - .1 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*.
 - .2 Specimens and samples for testing, unless otherwise specified in the *Contract Documents*, shall be taken by the independent inspection and testing company; sampling equipment and personnel shall be provided by the independent inspection and testing company; and deliveries of specimens and samples to the testing company shall be performed by the testing company unless otherwise specified.

Quality Requirements

- .3 Independent inspection and testing company 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.
- .4 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).
- .11 Where evidence exists that defective workmanship may have occurred, or that the *Work* may have been carried out incorporating defective materials, or where tests demonstrate that installed conditions do not comply with the requirements of the *Contract Documents*, the *Consultant* reserves the right to have additional inspections, tests, analysis, and surveys performed 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*.
- .12 Repair work damaged as a result of independent inspection and testing work.

1.6 Inspection and Testing Schedule

- .1 Prepare schedule for inspection and testing company services in accordance with Section 01 32 00 and as follows:
 - .1 Establishing schedule:
 - .1 By advance discussion with the selected independent inspection or testing company, determine the appropriate time necessary to perform the required services and to issue related reports.
 - .2 Allow for required time within construction schedule.
 - .2 Adherence to schedule:
 - .1 *Contractor* shall advise independent inspection and testing companies in advance when inspection and testing of the *Work* is required.
 - .1 Amount of advance notice shall be as required by the independent inspection and testing company, but shall be no less than 2 *Working Days*.
 - .2 When independent inspection and testing company 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*.
 - .3 Notify independent inspection and testing company 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:

Quality Requirements

- .1 The *Contractor*, and the *Subcontractor* responsible for the work to inspected and/or tested, the inspection and testing company representatives, the product manufacturer's representative when required, and the *Consultant*.
- .4 For inspection and testing required by *Contract Documents* or by authorities having jurisdiction, provide *Consultant* and inspection and testing agencies with timely notification in advance of required inspection and testing.
- .5 Give 2 *Working Days*' prior notice to independent inspection and testing company of the commencement of each phase of the *Work* requiring inspection, and provide independent inspection and testing company with materials and installation information.

1.7 Reports and Documents

- .1 Inspection and testing company, whether for Owner's quality assurance or for *Contractor's* quality assurance, shall submit shop inspection and site inspection reports within 5 *Working Days* of each inspection.
- .2 Inspection and testing company, whether for *Owner's* quality assurance or for *Contractor's* quality assurance, shall submit shop inspection and site inspection reports within 7 days of each inspection.
- .3 Distribute reports digitally as follows:
 - .1 *Owner*.
 - .2 *Consultant*.
 - .3 *Contractor*.
 - .4 Consulting engineers, as applicable.
- .4 Inspection and testing companies, whether for *Owner's* quality assurance or for *Contractor's* quality assurance, 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 assembly fails to meet requirements of the *Contract Documents*.
- .5 Upon completion of portions of the *Work* subject to inspection and testing, whether for *Owner's* quality assurance or for *Contractor's* quality assurance, submit to the *Consultant* duplicate certificates of acceptance of the installation issued by the inspection and testing company.

Quality Requirements

1.8 Manufacturer's Field Review

- .1 Where manufacturer's field review is specified, direct the manufacturer to assign a representative to review the relevant parts of the *Work* at the *Place of the Work*, or wherever such affected work is in progress, as frequently as required to verify that the relevant parts of the *Work* are being executed in accordance with manufacturer's written requirements and verify their product is fit for the purpose intended.
- .2 Manufacturer's representative shall submit a type-written report on manufacturer's letterhead after each field review following procedures specified under Reports and Documents heading in this section. Report shall document manufacturer's representative's field observations and recommendations.

1.9 Mock-Ups

- .1 Provide field or shop erected example of work complete with specified materials and workmanship.
- .2 Provide field or shop erected mock-ups of *Work* as specified in the *Specifications*. If a mock-up location is not indicated in the *Drawings* or *Specifications*, locate where directed by *Consultant*.
- .3 Do not proceed with work for which mock-ups are required prior to *Consultant's* review of mock-ups.
- .4 Modify mock-up as required until *Consultant* written acceptance is obtained.
- .5 Protect and maintain mock-ups until directed to be removed.
- .6 Commence work demonstrated in mock-up only after review and acceptance of workmanship.
- .7 Remove mock-ups only when the *Work* they represent is complete or when otherwise directed by *Consultant*.
- .8 If possible, mock-up may become part of finished work, at sole discretion, and with prior written acceptance of *Consultant*.
- .9 Reviewed and accepted mock-ups shall be the standard of workmanship and material against which installed work will be compared.
- .10 Remove and replace materials or assemblies appearing in the finished work that do not match reviewed and accepted mock-ups.

PART 2 - PRODUCTS

Not applicable.

PART 3 - EXECUTION

Not applicable.

END OF SECTION

Temporary Utilities

PART 1 - GENERAL

1.1 Section Includes

- .1 Temporary utilities - general.
- .2 Temporary electrical services.
- .3 Temporary water supply.
- .4 Temporary heating and ventilation.

1.2 Temporary Utilities - General

- .1 Provide temporary utilities as specified and as otherwise necessary to perform the *Work* expeditiously.
- .2 Arrange and pay for required temporary services, unless otherwise specified.
- .3 Provide connection and disconnection of temporary services and facilities required in the *Work*, including connection to existing services made available by the *Owner*.
- .4 Remove temporary utilities after use.
- .5 Existing services:
 - .1 Do not use any existing services and facilities during construction unless specific written permission is provided by *Owner*.
 - .2 Where existing services are made available by the *Owner*, provide meters for measuring usage, the costs for which usage and meters shall be the responsibility of the *Contractor*.
 - .3 Protect and maintain without interruption, existing water, heating, drainage, and other services within the *Place of the Work* to existing buildings not within the scope of the *Work* of this *Contract*. Obtain written permission of the *Owner* for services required to be temporarily shut off, at least 2 full *Working Days* in advance.
 - .4 Do not use permanent mechanical, or electrical systems during the course of the *Work* unless specific written permission is provided by the *Consultant*. Use of permanent services for temporary construction service shall not prejudice warranties.

1.3 Temporary Electrical Services

- .1 Provide and maintain an adequate temporary electrical service for performance of the *Work* including, but not limited to, operation of electric pumps, motors, vibrators and other power tools, hoisting and related construction and general illumination during the *Work*.
 - .1 Use existing power, where available, subject to *Owner's* approval. Pay for usage at rates stipulated by the *Owner*.
 - .2 Do not use new building power systems during construction without prior written authorization from *Consultant* and *Owner*.
- .2 Provide and maintain any components and equipment necessary to transform supply power to necessary temporary power voltage.

Temporary Utilities

1.4 Temporary Water Supply

- .1 Provide and maintain a temporary supply of water for use in the *Work*.
 - .1 Use existing water supply. *Owner* will pay water bills.
- .2 Extend supply pipe or pipes from nearest available sources and maintain in good condition until permanent system is installed and ready for use.

1.5 Temporary Heating and Ventilation

- .1 Provide and pay for temporary heating, cooling and ventilating required for the *Work*, including attendance, maintenance and fuel.
- .2 Provide temporary heat and ventilation as required to:
 - .1 Facilitate continuous uninterrupted progress of the *Work*.
 - .2 Protect the *Work* and *Products* against damage and defacement caused by weather, harmful levels of temperature, humidity, and moisture.
 - .3 Protect the *Work* against dampness and cold.
 - .4 Prevent moisture condensation on surfaces, freezing, or other damage to finishes or stored *Products*.
 - .5 Provide ambient temperatures and humidity levels for proper storage, installation and curing of materials, in accordance with specified standards and manufacturer's requirements.
 - .6 Provide adequate ventilation to meet health regulations for safe working environment.
- .3 Furnish other temporary heating as required by various sections of the *Specifications* or by *Product* manufacturers.
- .4 Ventilate to the exterior of the building work areas as required when toxic materials are being utilized or cured.
- .5 Replace with new, any work damaged due to failure to provide adequate heat at no cost to *Owner*.

PART 2 - PRODUCTS

Not applicable.

PART 3 – EXECUTION

Not applicable.

END OF SECTION

Temporary Facilities

PART 1 - GENERAL

1.1 Section Includes

- .1 General scope and responsibility.
- .2 Parking.
- .3 Temporary sanitary facilities.
- .4 Temporary site office.
- .5 Temporary site storage.
- .6 Traffic Control.
- .7 Signs and notices.

1.2 General Scope and Responsibility

- .1 Temporary facilities specified in this section shall be supplemented as applicable in accordance with Section 01 35 13.
- .2 Arrange, obtain and pay cost for permits required for temporary facilities and controls.
- .3 Provide and maintain temporary facilities for the *Work* and remove them from the *Work* upon issuance of certificate of *Substantial Performance of the Work*.
- .4 Do not use permanent facilities, except standpipe for firefighting, during the course of the *Work* unless specific written permission is provided by the *Consultant*. Where use of permanent facilities is granted for temporary construction service, such use of permanent facilities shall not prejudice warranties.

1.3 Construction Parking

- .1 Construction parking is extremely limited.
- .2 Construction personnel may park in the designated construction parking lot and only with a valid parking permit.
- .3 Parking is on site and costs based on *Owner's* set fees and is on a first come first served basis.
- .4 Permits can be purchased at the Parking Services office. Please direct any parking related questions to 416-480-4591.
- .5 Permits are sold for a month's duration, whether used it for the complete month or not. If workers shall require longer than one month, they shall renew their permit prior to the expiry date on the current permit. Workers will also receive a ticket if they are parked with an expired permit.
- .6 Do not interfere with the operation of existing premises. Keep existing parking areas and road system remain free and clear of obstructions resulting from the *Work*.
- .7 Illegally parked vehicles that are ticketed and/or towed shall be the sole responsibility of the vehicle owner.

Temporary Facilities

1.4 Temporary Sanitary Facilities

- .1 Provide sanitary facilities for work force in accordance with governing regulations and ordinances.
- .2 Post notices and take such precautions as required by local health authorities. Keep area and premises in sanitary condition.
- .3 Use of new and existing sanitary facilities by workers is prohibited.

1.5 Temporary Site Offices

- .1 Provide site office within the *Work* area, of sufficient size to accommodate site meetings.

1.6 Temporary Site Storage

- .1 Handle and store materials so as to prevent damage or defacement to the *Work* and surrounding property.
- .2 Construct weather-tight storage sheds for storage of materials that may be damaged or defaced by weather. Provide floors raised 150 mm (6") clear of ground for storage of *Products*.
- .3 *Owner* is not responsible for securing *Products* or materials at the *Place of the Work*.

1.7 Traffic Control

- .1 Provide and maintain adequate access to *Place of the Work*.
- .2 Do not block roads or impede traffic. Keep construction traffic to designated roads only. Provide flagperson to direct traffic as required.

1.8 Signs and Notices

- .1 Provide project signs as instructed by *Owner* at a later date. Lay out sign and submit to *Consultant* for approval. Sign shall be painted by a professional sign painter. Locate sign where directed by *Consultant*.
- .2 Obtain and pay for permits required for the project signs.
- .3 No other signs or advertisements, other than safety, warning, or directional signs, are permitted without *Consultant's* prior approval.

PART 2 - PRODUCTS

Not applicable.

PART 3 – EXECUTION

Not applicable.

END OF SECTION

Temporary Barriers and Enclosures

PART 1 - GENERAL

1.1 Section Includes

- .1 General scope and responsibility.
- .2 Temporary enclosures and protection.
- .3 Protection of the public.
- .4 Protection of the *Work*.

1.2 General Scope and Responsibility

- .1 Temporary facilities and controls specified in this section shall be supplemented as applicable in accordance with Section 01 35 13.
- .2 Provide and maintain signs, 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.
- .3 Plant, Machinery and Scaffolding:
 - .1 Provide formwork, scaffolding, equipment, tools, machinery and incidental appurtenances necessary for the proper execution of the *Work*.
 - .2 Erect plant, machinery and scaffolding to permit access to building and the *Work*.
 - .3 Use scaffolds in such manner as to interfere as little as possible with other trades' operations.
 - .4 Support scaffolds from finished surfaces only after taking precautions to prevent damage. No supports, clips, brackets, or similar devices shall be welded, bolted, or otherwise affixed to any finished member or surface without prior permission.
- .4 Maintain temporary barriers and enclosures in good condition for the duration of the *Work*.
- .5 Remove temporary barriers and enclosures from *Place of the Work* when no longer required.

1.3 Temporary Enclosures and Protection

- .1 Provide temporary enclosures and protection of adequate construction to prevent dispersion of dust and dirt into other areas of existing building and to prevent dispersion of dust and dirt beyond the *Place of the Work*.
- .2 Provide temporary weather-tight enclosures and protection for exterior openings in building as soon as walls, floors and roofs are built so as to protect the *Work* from weather and vandalism. Provide doors in enclosures as necessary to maintain fire exits.
- .3 Erect, maintain, and relocate enclosures as required to facilitate construction operations and *Owner's* operational requirements.
- .4 Temporary enclosure and protection shall be of finished appearance and painted to colour approved by *Owner*.
- .5 Provide dust seal and sound resistant enclosures to protect existing building and operations as indicated. Include temporary doors, fastenings and keys.

Temporary Barriers and Enclosures

- .6 Insulate and airseal exterior enclosures to prevent condensation and drafts.
- .7 Supplement these requirements in accordance with Section 01 35 13.

1.4 Protection of the Public

- .1 Provide fencing, barricades, hoarding, notices and warning boards and maintain lights and signals for protection of workers engaged on the *Work*, for protection of adjoining property and for protection of the public.
- .2 Where any special hazard exists from which it is not possible to protect the public safety by other means, watchpersons shall be employed to preserve public safety until the area of special hazard no longer poses a risk to public safety.

1.5 Protection of the Work

- .1 Protect the *Work* from damage, discolouring, and defacement. Maintain protection until the *Work* is complete.
- .2 Provide necessary temporary barriers and enclosures to protect existing surfaces from damage during performance of the *Work*.
- .3 Have damaged or defaced work corrected by workers meeting qualification requirements of the *Contract Documents*.
- .4 Protect historically important surfaces during the course of the *Work* and remove protection only for the purposes of cleaning or restoration work. Protect such surfaces from damage caused by impacts, moisture, weather, lubricants, corrosive materials, paint, weld spatter, exhaust fumes, and chemicals that could leave stains or residues. Ensure that historically important surfaces are protected from exposure to precipitation by providing temporary flashings at tops of walls and other locations where moisture may collect and enter masonry assemblies.

PART 2 - PRODUCTS

Not applicable.

PART 3 – EXECUTION

Not applicable.

END OF SECTION

Temporary Controls

PART 1 - GENERAL

1.1 Section Includes

- .1 General scope and responsibility.
- .2 Security.
- .3 Dust, debris and noise control.
- .4 Pollution control.

1.2 General Scope and Responsibility

- .1 Temporary controls specified in this section shall be supplemented as applicable in accordance with Sections 01 35 13 and 01 35 33.
- .2 Arrange, obtain and pay cost for permits required for temporary controls.
- .3 Provide temporary controls as necessary for performance of the *Work* and in compliance with applicable regulatory requirements.
- .4 Maintain temporary controls in good condition for the duration of the *Work*.
- .5 Remove temporary controls and *Construction Equipment* used to provide temporary controls from *Place of the Work* when no longer required.

1.3 Security

- .1 The *Contractor* shall be solely responsible for securing the *Place of the Work* and the *Work*, and for securing areas used for the storage of *Products* or construction machinery and equipment. The *Owner* shall have no responsibility in this regard.
 - .1 Provide and maintain security lighting.
 - .2 Provide and maintain temporary locks. Premises to be locked after working hours.
- .2 Provide security for the *Place of the Work* by methods compatible with the security system for the existing building.
 - .1 *Contractor* shall coordinate the work carefully with the *Owner* in order to ensure no disruption to the existing building's security system.
 - .2 Where existing building's security system is breached due to *Contractor's* negligence, be responsible for any damage or theft of property, regardless if area where damage or theft occurred is under *Contractor's* control or not.

1.4 Dust, Debris and Noise Control

- .1 Cover or wet down dry materials and rubbish to prevent blowing dust and debris.
- .2 Control dust and dirt produced during the *Work* to prevent dispersion beyond the immediate work areas.
- .3 Prevent materials from contaminating air beyond application area, by providing temporary enclosures and ventilation/filtration.
- .4 Implement and maintain dust and particulate control measures in accordance with applicable regulatory requirements.

Temporary Controls

- .5 Execute *Work* by methods that minimize dust from construction operations and spreading of dust on site or to adjacent properties.
- .6 Provide temporary enclosures to prevent extraneous materials resulting from sandblasting or similar operations from contaminating air beyond immediate work area.
- .7 Cover or wet down dry materials and rubbish to prevent blowing dust and debris. Provide dust control for temporary roads.
- .8 Use appropriate covers on trucks hauling fine, dusty, or loose materials.
- .9 Limit noise levels in accordance with requirements of authorities having jurisdiction and the *Owner*.
- .10 Prevent abrasive-blasting, pressure-washing spray, and other extraneous materials from contaminating air beyond application area.
- .11 Supplement these requirements in accordance with Section 01 35 13.

1.5 Pollution Control

- .1 Prevent contamination of soil, water, and atmosphere through uncontrolled discharge of noxious or toxic substances and other pollutants, potentially causing environmental damage.
- .2 Be prepared, by maintaining appropriate materials, equipment, and trained personnel on site, to intercept, clean up, and dispose of spills or releases that may occur. Promptly report spills and releases that may occur to:
 - .1 Authority having jurisdiction.
 - .2 Person causing or having control of pollution source, if known.
 - .3 *Owner and Consultant*.
- .4 Take immediate action to contain and mitigate harmful effects of the spill or release.

PART 2- PRODUCTS

Not applicable.

PART 3 – EXECUTION

Not applicable.

END OF SECTION

Product Requirements

PART 1 - GENERAL

1.1 Section Includes

- .1 Availability of *Products*.
- .2 *Product* handling.
- .3 *Product* requirements and quality.

1.2 Availability of Products

- .1 Promptly upon *Contract* award and periodically during construction, review and confirm *Product* availability and delivery times. Order *Products* in sufficient time to meet the construction progress schedule and the *Contract Time*.
- .2 If a specified *Product* is no longer available, promptly notify the *Consultant*. The *Consultant* will take action as required.
- .3 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*.

1.3 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 weathertight 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, solid 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:
 - .1 Pay cost of transportation of *Products* required in performance of *Work*.
 - .2 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*.
 - .3 Reject *Products* damaged during transport.

Product Requirements

- .4 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 Compatibility of options: If given option of selecting between two or more *Products*, select *Product* compatible with products previously selected, even if previously selected products were also options.
 - .1 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*.
- .2 *Products* used for temporary facilities may have been previously used, providing they are sound in structural qualities.
- .3 *Products* and *Product* installation shall be in compliance with building code, regulations and requirements of authorities having jurisdiction.
- .4 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*.
 - .1 Wherever a *Product* or manufacturer is specified by a single proprietary name, provide the named *Product* only.
 - .2 Wherever more than one *Product* or manufacturer is specified by proprietary name for a single application, provide any one of the named *Product*.
 - .3 Wherever a *Product* is specified by reference to a standard only, provide any *Product* that meets or exceeds the specified standard. If requested by *Consultant*, submit information verifying that the proposed *Product* meets or exceeds the specified standard.
 - .4 Wherever a *Product* is specified by descriptive or performance requirements only, provide any *Product* that meets or exceeds the specified requirements. If requested by *Consultant*, submit information verifying that the proposed *Product* meets or exceeds the specified requirements.
 - .5 The onus is on the *Contractor* to prove compliance with governing published standards, prescriptive *Specifications* and with performance *Specifications*.
 - .6 Visual selection *Specifications*:
 - .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 colour, gloss, pattern, density, or texture from manufacturer's product line that includes both standard and premium items.
 - .7 Visual matching *Specifications*:

Product Requirements

- .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.
- .5 Provide *Products* that are not damaged or defective, and suitable for purpose intended, subject to specified requirements. If requested by *Consultant*, furnish evidence as to type, source and quality of *Products* provided.
 - .1 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 independent 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.
- .6 Basis of design:
 - .1 Where *Contract Documents* list "basis of design", this indicates the *Product* or system that was used in the preparation of the design included in the *Contract Documents*, and which may be deemed as an acceptable *Product*.
 - .2 The basis of design establishes the significant qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics for purposes of evaluating comparable products from other manufacturers.
 - .3 This does not preclude the use of other *Products* or systems in the *Work*, provided the proposed *Product* or system complies with the design and performance requirements contained in the *Contract Documents*, and *Products* or systems proposed for use in the work that are not the named basis of design follow procedures for product substitutions specified under Section 01 25 00.
- .7 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.
- .8 Should dispute arise as to quality or fitness of *Products*, the decision rests strictly with *Consultant* based upon the requirements of the *Contract Documents*.
- .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 *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 Section 01 33 00 for such selection.
- .11 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

Not applicable.

END OF SECTION

Examination and Preparation

PART 1 - GENERAL

1.1 Section Includes

- .1 Examination of the *Place of the Work*, documents, surfaces and conditions.
- .2 Public utilities and services.
- .3 Setting out the *Work*.

1.2 Examination of the *Place of the Work*, Documents, Surfaces and Conditions

- .1 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*, documents related to existing building or buildings, as applicable and when available, and other consideration which may affect performance of the *Work*.
- .2 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*, shall include a thorough examination of the condition of the previous work to verify that work is complete and in a condition suitable to receive the subsequent 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 Verify that ambient conditions are suitable before commencing the work of any Section and will remain suitable for as long as required for proper setting, curing, or drying of *Products* used.
- .6 Ensure that substrate surfaces are clean, dimensionally stable, cured and free of contaminants.
- .7 Do not commence work until unsatisfactory conditions are corrected. Commencement of work shall mean acceptance of surfaces, tolerances, and conditions, and existing conditions will not be accepted as a contributing factor to subsequent failure or unacceptability of the *Work*.
- .8 Work adjacent to public property:
 - .1 Verify before commencing portions of the *Work* adjacent to public and private properties, that no plans for altering clearances, set-backs, easements, grades, or otherwise have been established by authorities having jurisdiction, subsequent to issuance of the building permit.
 - .2 Notify *Consultant* of any such plans that will affect the *Work* and proceed as directed by *Consultant*.

Examination and Preparation

1.3 Public Utilities and Services

- .1 Prior to commencement of the *Work* at the *Place of the Work*, verify limitations imposed on the *Work* by presence of utilities and services, and cause no damage to them as a result of the *Work*.
- .2 Promptly notify *Consultant* if underground utilities, structures, or their locations differ from those indicated in *Contract Documents* or in available project information. *Consultant* will provide appropriate direction.
- .3 Notify service authorities concerned so that they may protect, remove, relocate, or discontinue existing utilities and services, as they may require.
- .4 Record locations of maintained, re-routed, and abandoned utility lines.

1.4 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 Contractor* shall chair and prepare minutes of the meeting, and prepare and submit sketches recording understanding of key setting out principles.
 - .1 Do not change or relocate reference points without prior written notice to *Consultant*.
 - .2 Report to *Consultant* when a reference point is lost or destroyed, or requires relocation because of necessary changes in grades or locations.
 - .3 Replace, at no additional cost to the *Owner*, any iron pins and survey bars, monuments, geodetic datum and similar reference markers, which are disturbed, moved, or lost in course of construction. Require registered land surveyor to replace reference points in accordance with original survey.
- .3 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.
- .4 Establish sufficient permanent benchmarks on site, referenced to established benchmarks by survey control points.
- .5 Establish existing bench marks, grades, lines, levels, and temporary, widely separated bench marks. Employ the services of a firm of registered land surveyors licensed in the *Place of the Work*.
 - .1 Submit name and address of registered land surveyor performing survey work.
- .6 Surveyor shall verify grades, lines, levels at the *Place of the Work*, critical setting out points specified herein, and dimensions shown, and report discrepancies in levels or dimensions before commencing *Work*. Where discrepancies between intended layout and existing conditions are found to exist, prepare and submit a detailed report to *Consultant*, including schematic digital layout of conflicting conditions, in format compatible with AutoCAD software for *Consultant's* use in reconciling these issues. Surveyor shall lay out building areas, and floor elevations.

Examination and Preparation

- .7 Surveyor shall verify location and datum reference elevation of finished foundations, relative to reference markers, showing actual finished grades in relation to noted grades in the *Contract Documents*. Prepare and submit a reproducible plan of survey certified As-Built by above firm and in format compatible with AutoCAD software, prior to date of *Substantial Performance of the Work*.
- .8 Preserve bench marks, reference points and stakes.
- .9 Upon completion of foundation work, prepare and submit an accurate survey showing the location of the foundations at the *Place of the Work*, foundation wall dimensions, and the gross floor area of the foundation plan. The survey is to be prepared by a Registered Ontario Land Surveyor acceptable to the *Owner* and to the *Consultant*. Submit a digital copy of this survey to the *Consultant* at time of completion of foundation work. Submit additional copies as part of the closeout submittals in accordance with Section 01 78 00.
- .10 Maintain a complete, accurate log of control and survey work as it progresses. Record locations with horizontal and vertical data in project record documents in accordance with Section 01 78 00.
- .11 Prepare and submit record survey documents and survey logs for incorporation into project record documents in accordance with Section 01 78 00.

PART 2 - PRODUCTS

Not applicable.

PART 3 – EXECUTION

Not applicable.

END OF SECTION

Execution

PART 1 - GENERAL

1.1 Section Includes

- .1 Work on public property.
- .2 Inserts, anchors, and fasteners.
- .3 Penetrations.
- .4 Concealed services.
- .5 Trademarks and labels.
- .6 Interferences.
- .7 Publicity releases and photographs.
- .8 Coordination with *Owner's* Commissioning Activities
- .9 Manufacturer's instructions.
- .10 Galvanic/dissimilar metal corrosion.
- .11 Workmanship.
- .12 General construction tolerances.

1.2 Work on Public Property

- .1 Include curb cuts and making good of existing property to *Provide* fully paved and finished approaches to requirements of authorities having jurisdiction.
- .2 Include making good of existing curbs, walks, paving and soft landscaping on adjacent property.

1.3 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 Prevent electrolytic action and corrosion between dissimilar metals and materials by using suitable non-metallic strips, washers, sleeves, or other permanent separators to prevent direct contact.
- .6 Use non-corrosive fasteners and anchors for securing exterior work and in spaces where high humidity levels are anticipated.

Execution

- .7 Space anchors within individual load limit or shear capacity and install such that they provide positive permanent anchorage.
- .8 Keep exposed fastenings to a minimum, space evenly and install neatly.
- .9 Fastenings for prefinished materials shall be of concealed type unless otherwise indicated, and when exposed finish is required, of matching prefinishing materials.
- .10 Do not use fastenings or fastening methods that may cause spalling or cracking of material to which anchorage is made.
- .11 Use fastenings of standard commercial sizes and patterns with material and finish suitable for service.
- .12 Bolts shall not project more than one diameter beyond nuts.
- .13 Provide metal fastenings and accessories in same texture, colour and finish as adjacent materials being fastened.
- .14 Power actuated fasteners:
 - .1 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 E1190-11 conducted by a qualified independent testing agency.
 - .2 Do not use power actuated fasteners which are stressed in withdrawal in finished work.
 - .3 Do not use power actuated fasteners within 100 mm (4") of the edge of concrete or masonry, unless otherwise accepted in writing by *Consultant*.
 - .4 Do not use power actuated fasteners in post-tensioned concrete.
- .15 The use of explosive powder tools will not be permitted under any circumstances unless equipped with a device which positively prevents free flight of the stud.
- .16 Expansion Bolt and All-In-One Anchors
 - .1 Whenever expansion type fastening devices of any kind which rely upon friction forces created by expansion of the device or all-in-one screw anchors in drilled holes of the Tapcon type are to be used in concrete and masonry, submit following data to *Consultant* for review prior to use:
 - .1 Load carrying capacity of device and design factor of safety.
 - .2 Effect of building movement and vibration on device.
 - .3 Identification marking applied on device.
 - .4 Nature and magnitude of force to be applied to device with supporting data.
 - .5 Materials to which device is fastened.

Execution

- .6 Whether device is self drilling or, if not, the size of bit to be used to drill holes to receive the device.
- .7 Installation procedure to ensure that fastener is secure and reliable and that metal reinforcing is not damaged.
- .2 The *Consultant* may request that all such data bear the seal of a professional structural engineer licensed to practice at the *Place of the Work*, and in accordance with Section 01 33 00.
- .3 If requested by the *Consultant*, conduct tests of installed fasteners at the *Place of the Work* using an approved independent testing company with properly designed and calibrated force measuring apparatus.

1.4 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 When penetrating fire rated walls, ceiling, or floor assemblies, completely seal voids with firestopping materials, smoke seals, or both, in full thickness of the construction element as required to maintain the integrity of the fire rated assembly.

1.5 Renovations, Alterations and Repairs to Existing Building

- .1 Refer also to Sections 01 35 13, 01 35 33, 01 51 00, 01 52 00, 01 56 00, and 01 57 00.
- .2 Well in advance of commencement of the *Work*; notify *Consultant* and *Owner* in writing of any part of the *Work* that is to be started within existing building. At no time interfere with operation of any department without written approval of *Owner*. Existing building to remain functional. *Contractor* shall, when required on occasion, expedite work outside of *Contractor's* normal working hours. *Owner* will cooperate to keep such overtime hours to a minimum.
- .3 Where new work connects with existing building and where existing work is altered, do all necessary cutting and fitting required to make satisfactory connections with existing work so as to leave entire *Work* in a finished and acceptable condition.
- .4 Execute work with least possible interference and disturbance to occupants, public and normal use of premises. Arrange with *Consultant* to facilitate execution of work.
- .5 Where security has been reduced by work of the *Contract*, provide temporary means to maintain security. Hoarding, security personnel, for duration required by work, to approval of *Owner* and/or *Consultant*.
- .6 Make good all existing materials and finishes, which are not to be removed nor altered, but which are damaged or disturbed during the progress of the *Work* under this *Contract*.

Execution

- .7 Where existing work is to be made good, match the new work exactly to the old work in material, form, construction and finish, unless otherwise specified or approved.
- .8 Drill existing work carefully, leaving a clean hole no larger than required.
- .9 Prior to removing any existing acoustical lay-in ceiling panels or tiles, notify *Owner's* Plant Operations Department at Local 4568.
- .10 Tag and mark electrical switches and valves used to isolate utility services as follows:
 - .1 Name of *Contractor* or *Subcontractor*
 - .2 Tradesman's name
 - .3 Date shut off
 - .4 Date and time to be turned back on
- .11 Where elevators exist in existing building, use only those assigned for *Contractor's* use may be used for moving workers and material within building, and only if permitted in writing by the *Owner*. Protect walls of elevators, to approval of *Consultant*, before use. Accept liability for damage, safety of equipment and overloading of existing equipment.
- .12 In all existing rooms which are affected by work of this *Contract*, *Owner* will remove existing furniture, equipment and other items which will be retained by *Owner*. *Contractor* shall notify *Owner* minimum 20 Working Days prior to commencing work in rooms affected.
- .13 Where Scanning/Radar and/or core drilling may be required, provide written notice to *Consultant* and *Owner* minimum five (5) business days prior to doing such work. Submit core drilling drawings showing locations for *Consultant's* approval. Indicate locations of openings in relation to column grid lines and permanent walls. Scanning/Radar and/or core drilling shall be at *Contractor's* expense.
- .14 Work within restricted and confined spaces shall be undertaken in strict compliance with Provincial regulations. Refer to the Regulations for Health Care and Residential Facilities.
- .15 Patients, visitors and employees of *Owner* shall not be exposed to environmental, health or safety risks caused by the actions of *Contractors* engaged to work at *Owner*.
- .16 Employees of *Contractors* engaged to do work at *Place of the Work* shall not be exposed unnecessarily to environmental, health or safety risks due to their employers' failure to comply with Federal or Provincial Acts and Regulations which specify environmental, health and safety requirements.
- .17 Ensure that the workers work safely, and wear or use the appropriate protective clothing, equipment and devices.

1.6 Concealed Services

- .1 Unless otherwise indicated, conceal pipes, ducts, and wiring in floors, walls, and ceilings in finished areas. Do not conceal until after:
 - .1 Review by *Consultant* and authority having jurisdiction.

Execution

- .2 Recording actual locations on as-built drawings where locations differ from those shown on *Drawings*.
- .2 Provide incidental furring or other enclosures as required.
- .3 Notify *Consultant* in writing of interferences before installation.

1.7 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*, and except for trademarks and labels:
 - .1 That are essential to identify materials, systems, assemblies, and equipment for maintenance and replacement purposes.
 - .2 That are essential for life safety, fire resistance, and temperature rise ratings.

1.8 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 Maintain accesses and clearance required by jurisdictional authorities and/or for easy maintenance of equipment in layout of equipment and services, Notify *Consultant* if indicated clearances are in conflict.
- .4 Prepare coordination and interference drawings in accordance with Section 01 31 00.

1.9 Publicity Releases and Photographs

- .1 No press or publicity releases, including photographs of the *Place of the Work*, will be permitted without prior written approval of the *Owner*.

1.10 Coordination with Owner's Commissioning Activities

- .1 The *Owner* has engaged a commissioning agent, referred to as the Building Commissioning Consultant.
- .2 *Contractor* and *Subcontractors* are to designate individuals who will be assigned to commissioning activities and will attend commissioning meetings.
- .3 Refer to Section 01 91 10, Divisions 21, 22, and 23, and Divisions 26, 27, and 28 for specific requirements related to commissioning activities.

PART 2 - PRODUCTS

Not applicable.

Execution

PART 3 - EXECUTION

3.1 Manufacturer's Instructions

- .1 Install, erect, or apply *Products* in accordance with manufacturer's written requirements. Do not rely on labels or enclosures supplied with *Products*. Obtain written requirements directly from manufacturers.
- .2 Notify *Consultant*, in writing, of conflicts between *Contract Documents* and manufacturer's instructions where, in *Contractor's* opinion, conformance with *Contract Documents* instead of the manufacturer's instructions may be detrimental to the *Work* or may jeopardize the manufacturer's warranty.
- .3 Improper installation or erection of *Products*, due to failure in complying with these requirements, shall result in removal and re-installation of such *Products* as part of the *Work* at no additional cost to the *Owner*.
- .4 Provide manufacturer's representatives with access to the *Work* at all times. Render assistance and facilities for such access so that manufacturer's representatives may properly perform their responsibilities.

3.2 Galvanic/Dissimilar Metal Corrosion

- .1 Insulate dissimilar metals from each other and from cementitious materials by suitable plastic strips, washers or sleeves, or other method in accordance with manufacturer's written requirements to prevent galvanic corrosion where conductive liquid or electrolyte exists or may reasonably be expected to exist.

3.3 Workmanship

- .1 General:
 - .1 Workmanship shall be of highest quality in accordance with best standard practice for type of work specified, except where specified more precisely.
 - .2 Execute the *Work* using workers experienced and skilled in the respective duties for which they are employed.
 - .3 Do not employ an unfit person or anyone unskilled in their required duties.
 - .4 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:
 - .1 Ensure cooperation of workers in layout of the *Work*. Maintain efficient and continuous supervision.

Execution

- .2 Be responsible for coordination and placement of openings, sleeves and accessories.
- .3 Backer plates:
 - .1 Provide backer plates to support and provide anchorage base to carry loads from surface or recessed applied materials.
- .4 Cutting and remedial work:
 - .1 Perform cutting and remedial work required to make parts of the *Work* come together. Coordinate the *Work* to ensure this requirement is maintained. Comply with requirements of Section 01 73 29.
 - .2 Notify *Consultant* of, and perform remedial work required to, repair or replace defective or unacceptable work. Ensure that properly qualified workers perform remedial work. Coordinate adjacent affected work as required.
- .5 Location of fixtures:
 - .1 Locations of fixtures, access panels, outlets, and mechanical and electrical items indicated on *Drawings* are approximate only.
 - .2 Locate fixtures, outlets, and devices to provide minimum interference, maximum usable space, and as required to meet safety, access, maintenance, acoustic, and regulatory, including barrier free, requirements. Architectural drawings will relate these items to known dimensions, such as ceiling tile grid or wall locations and the like.
 - .3 Obtain *Consultant's* acceptance for precise locations of fixtures, access panels, outlets, mechanical, and electrical items.
 - .4 *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.
 - .5 Promptly notify *Consultant* in writing of conflicting installation requirements for fixtures, outlets, and devices. If requested, indicate proposed locations and obtain approval for actual locations.
- .6 Protection of work in progress:
 - .1 Provide protection required by authorities having jurisdiction.
 - .2 Protect parts of the *Work* completed or in progress from soiling, abrasion, punctures, damage, and defacement, and maintain protection until the surrounding or overhead work is complete.
 - .3 Remove and replace materials damaged or defaced as a result of failure to provide adequate protection.

Execution

- .4 Do not cut, drill, or sleeve any load bearing structural member without written permission of *Consultant*. Comply with requirements of Section 01 73 29.
- .5 Do not load or permit to be loaded any part of the *Work* with a weight or force that will endanger the safety or integrity of the *Work*.
- .6 Protect finished flooring from damage. Take special measures when moving heavy loads or equipment on them.
- .7 Keep surfaces free of oils, grease or other materials that may damage or deface them or affect bond of applied *Products*.
- .8 Protect existing buildings, curbs, roads and lanes. If, during the *Work*, any buildings, curbs, roads or lanes are damaged, bear costs for repairs.
- .7 Protection of mechanical and electrical *Products* or materials:
 - .1 Wrap in protective plastic and seal mechanical and electrical items and equipment prior to and during shipment, storage at the *Place of the Work* and after installation.
 - .2 Remove protective coverings only to the extent required for installation of the items. Re-install protection immediately following installation.
 - .3 Remove protective coverings in stages, as work areas are completed, or when directed by *Consultant*.
- .8 Operational requirements:
 - .1 Operable *Products* shall be provided fully operational and ready for intended use.
 - .2 Adjust operating hardware and accessories for a tight fit at contact points and weather stripping for smooth operation and weathertight closure. Lubricate hardware and moving parts for smooth squeak-free function, in accordance with manufacturer's requirements.
- .9 Alterations:
 - .1 Restore new or existing work which is altered as a result of the *Work* and *Make Good*.
 - .2 Materials and workmanship shall 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 viewing distance of 1830 mm (6').

3.4 General Construction Tolerances

- .1 Match existing tolerances in every respect unless otherwise specified.
- .2 Where tolerances are not defined elsewhere in the *Contract Documents* or building code, construct the *Work* to the following tolerances:

Execution

- .1 Maximum variation from plumb in vertical lines, surfaces of columns, walls, and arrises:
 - .1 6.4 mm (1/4") in 3 m (10 ft)
 - .2 9.6 mm (3/8") in a storey height not to exceed 6 m (20 ft)
 - .3 12.7 mm (1/2") in 12 m (40 ft) or more
- .2 Maximum variation from plumb for external corners, expansion joints, and other conspicuous lines:
 - .1 6.4 mm (1/4") in any storey or 6 m (20 ft)
 - .2 12.7 mm (1/2") in 12 m (40 ft) or more
- .3 Maximum variation from level of grades for exposed lintels, sills, parapets, horizontal grooves, and other conspicuous lines:
 - .1 6.4 mm (1/4") in any bay or 6 m (20 ft)
 - .2 12.7 mm (1/2") in 12 m (40 ft) or more
- .4 Maximum variation from drawing location of columns, walls, and partitions:
 - .1 12.7 mm (1/2") in any storey or 6 m (20 ft)
 - .2 19 mm (3/4") in 12 m (40 ft) or more.
- .5 Maximum variation in cross-sectional dimension of columns and thicknesses of wall from dimensions indicated:
 - .1 Minus 6 mm (1/4")
 - .2 Plus 12.7 mm (1/2")
- .6 Maximum variation from plane or from straight:
 - .1 3.2 mm (1/8") in 3 m (10 ft) under a 3 m (10 ft) straight edge.
- .7 Maximum variation from angle indicated:
 - .1 10 seconds.
- .8 Tolerances shall be non-cumulative.

END OF SECTION

Cutting and Patching

PART 1 - GENERAL

1.1 Request for Cutting, Patching and Remedial Work

- .1 Submittal Items:
 - .1 Comply with administrative requirements of Section 01 33 00.
 - .2 Submit written request in advance of cutting, coring, and alteration that affects or is likely to affect:
 - .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.
 - .6 Warranty of *Products* affected.
 - .3 Include in request:
 - .1 Identification of *Project*.
 - .2 Location and description of affected work, including drawings or sketches as required.
 - .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.
 - .4 Do not commence cutting, patching, or remedial work until request has been reviewed by *Consultant*.

PART 2 - PRODUCTS

2.1 Materials

- .1 Unless otherwise specified, when replacing existing or previously installed *Products* in the course of cutting and patching work, use replacement *Products* of the same character and quality as those being replaced.
- .2 If an existing or previously installed *Product* must be replaced with a different *Product*, submit request for substitution in accordance with Section 01 25 00.

Cutting and Patching

PART 3 - EXECUTION

3.1 Preparation

- .1 Inspect existing conditions in accordance with Section 01 71 00, including elements subject to damage or movement during cutting and patching.
- .2 After uncovering, inspect conditions affecting performance of the *Work*.
- .3 Beginning of cutting or patching means acceptance of existing conditions.
- .4 Provide supports to maintain structural integrity of surroundings. Provide devices and methods to protect other portions of the *Work* from damage.
- .5 Provide protection from elements for areas which may be exposed by uncovering work.
- .6 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 and leave conditions exposed until receipt of *Consultant's* written instructions. If area is exposed to the exterior, provide temporary protection from inclement weather.

3.2 Existing Services and Utilities

- .1 Protect, relocate, or maintain existing active services or utilities except where breaking into or connecting to them. When inactive services are encountered, cap off in a manner approved by authority having jurisdiction and stake or otherwise record location of capped service. Record location of services, including depth, on as-built drawings.
- .2 When breaking into or connecting to existing active 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. Give notice to authorities having jurisdiction as required by such authorities.
- .3 Keep duration of interruptions to a minimum.
- .4 Carry out interruptions outside regular working hours of occupants unless *Owner's* prior written approval is obtained.
- .5 Construct or erect barriers in accordance with Section 01 56 00 as required to protect pedestrian and vehicular traffic.

3.3 Cutting and Patching

- .1 Coordinate and perform the *Work* so that cutting and patching work is kept to a minimum.
- .2 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.
- .3 Remove and replace defective and non-conforming work.
- .4 Remove samples of installed work for testing if directed by *Consultant*.
- .5 Provide openings in non-structural elements of the *Work* for penetrations of mechanical and electrical work.

Cutting and Patching

- .6 Perform work by methods to avoid damage to other work, and which will provide proper surfaces to receive patching and finishing.
- .7 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.
- .8 Perform cutting, patching, and remedial work using competent and qualified specialists familiar with the *Products* affected, in a manner that neither damages nor endangers the *Work*.
- .9 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*.
- .10 Restore work with new *Products* in accordance with requirements of *Contract Documents*.
- .11 Fit work to pipes, sleeves, ducts, conduit, and other penetrations through surfaces and with suitable allowance for deflection, expansion, contraction, and firestopping.
- .12 Enclose pipes, ducts, conduit and wires passing through floors at areas where faucets occur in a 100 mm (4") high metal sleeve and make air and watertight with water resistant firestopping.
- .13 Completely seal voids of penetrations of fire rated wall, ceiling, and floor constructions with firestopping and smoke seals.
- .14 Execute cutting, patching, and remedial work in manner that does not jeopardize manufacturers' warranties.
- .15 Refinish surfaces to match adjacent finishes. Refinish continuous surfaces to nearest intersection. Refinish entire assembly units.

END OF SECTION

Cleaning and Waste Management

PART 1 - GENERAL

1.1 Section Includes

- .1 Waste management.
- .2 Storage, handling, and protection.
- .3 Coordination.
- .4 Cleaning.
- .5 Disposal of waste.

1.2 Waste Management

- .1 Comply with requirements of authorities having jurisdiction.
- .2 Remove waste material from the *Place of the Work* daily. If waste is collected in bins, bins to be removed from site once full.
- .3 Arrange and pay for removal of debris and waste from the *Place of the Work*.
- .4 Make arrangements with and obtain permits from authorities having jurisdiction for disposal of waste and debris. Pay fees.

1.3 Storage, Handling and Protection

- .1 Store materials to be reused, recycled and salvaged in locations to prevent contamination of materials being diverted from landfill.
- .2 Prevent contamination of materials to be salvaged and recycled, and handle such materials, in accordance with requirements for acceptance by designated facilities.

1.4 Coordination

- .1 Coordinate waste management and disposal procedures and requirements with other activities at the *Place of the Work* so that there is no delay in the *Work*, and at no increase in either the *Contract Time* or the *Contract Price*.

PART 2 - PRODUCTS

Not applicable.

PART 3 - EXECUTION

3.1 Cleaning

- .1 General cleaning requirements:
 - .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.

Cleaning and Waste Management

- .4 Provide adequate ventilation during use of volatile or noxious substances. Do not rely on building ventilation systems for this purpose.
- .5 Prevent cross-contamination during the cleaning process.
- .6 Notify the *Consultant* of the need for cleaning caused by *Owner* or other contractors.
- .7 Cleaning is applicable to both the whole *Project* and for the work carried as cash allowance amounts as listed in Section 01 21 00.
- .2 Materials:
 - .1 Use only cleaning materials in accordance with written requirements of manufacturer of surface to be cleaned and in accordance with written requirements of cleaning material manufacturer.
- .3 Cleaning during construction/progressive cleaning:
 - .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 appropriate, clearly marked 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 Clean interior building areas prior to start of finish work and maintain free of dust and other contaminants during finishing operations.
 - .5 Vacuum and clean interior building areas when ready to receive finish painting, and continue vacuum cleaning on an as-needed basis until *Substantial Performance of the Work*.
 - .6 Schedule cleaning operations so that dust and other contaminants resulting from cleaning process will not fall on wet, newly painted surfaces nor contaminate building systems.
 - .7 Promptly as the *Work* proceeds, on a daily basis and upon completion, clean up and remove rubbish, surplus materials and equipment.
 - .8 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.
 - .9 Wash exposed surfaces with a cleaning solution approved by *Product* manufacturers.
 - .10 Debris and waste not permitted within cavities of *Work*.
- .4 Cleaning Prior to *Ready-for-Takeover*

Cleaning and Waste Management

- .1 Immediately prior to *Consultant's* review to determine if *Ready-for-Takeover* has been achieved, remove surplus *Products* and construction machinery and equipment not required for the performance of the remaining *Work* and clean in accordance with Final Cleaning paragraphs in Section 01 74 00 to the greatest extent practicable given work remaining to be completed. Cleaning shall be to a sufficient extent to permit the *Consultant's* review to be performed properly and reasonably.
- .5 Final cleaning:
 - .1 Before final cleaning, arrange a meeting at *Place of the Work* to determine the acceptable standard of cleaning. Ensure that *Owner, Consultant, and Contractor* are in attendance.
 - .2 Remove from *Place of the Work* surplus *Products*, waste materials, recyclables, *Temporary Work*, and *Construction Equipment* not required to perform any remaining work and other than that caused by the *Owner*, and leave the *Work* clean and suitable for occupancy by *Owner*.
 - .3 Remove waste material and debris from crawlspaces and other accessible concealed spaces.
 - .4 Clean and polish prefinished and finished surfaces including: glass, mirrors, hardware, wall tile, stainless steel, chrome, porcelain enamel, baked enamel, plastic laminate, and mechanical and electrical fixtures. Replace broken, scratched or otherwise damaged glass.
 - .5 Clean exterior and interior window glass and frames.
 - .6 Remove stains, spots, marks and dirt from decorative parts of the *Work*, electrical and mechanical fixtures, furniture fittings, walls, and floors.
 - .7 Vacuum clean and remove dust from building interiors, exposed wall, floor, and ceiling surfaces, behind grilles, louvres, and screens, and above suspended ceiling tiles and panels. Vacuum clean interior of electrical equipment.
 - .8 Clean floor finishes in accordance with manufacturer's written requirements.
 - .9 Remove non-permanent labels.
 - .10 Remove dirt and residue from surfaces.
 - .11 Inspect finishes, fittings and equipment and ensure specified workmanship and operation.
 - .12 Remove protective coatings, clean surfaces and remove excess compounds and sealant materials. Make good defective, scratched or damaged work.
 - .13 Clean equipment and fixtures to a sanitary condition,
 - .14 Remove seal wrap and protective coverings from mechanical and electrical *Products* and materials and clean as required.
 - .15 Clean mechanical, electrical, and other equipment. Replace filters for mechanical equipment.
 - .16 Clean and/or replace lighting reflectors, lamps, light fixtures, lenses, bulbs, and other lighting surfaces, and grilles.

Cleaning and Waste Management

- .17 Lock or otherwise restrict access to each room or area after completing final cleaning in that area.
- .18 Re-clean as necessary areas that have been accessed by *Contractor's* workers prior to *Owner* occupancy.

3.2 Disposal of Waste

- .1 Remove waste materials and recyclables from work areas, separate, and deposit in designated containers at end of each *Working Day*. Collect packaging materials for recycling or reuse.
- .2 Handle waste materials not reused, salvaged or recycled in accordance with appropriate regulations and codes.
- .3 Do not bury rubbish and waste materials at the *Place of the Work*.
- .4 Do not dispose of waste or volatile materials into waterways or storm or sanitary sewers.
- .5 Do not burn waste materials at the *Place of the Work*.
- .6 Comply with waste disposal requirements of authorities having jurisdiction.
- .7 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*.
- .8 Make arrangements with and obtain permits from authorities having jurisdiction for disposal of waste and debris. Pay fees.

END OF SECTION

Closeout Procedures

PART 1 - GENERAL

1.1 Section Includes

- .1 General *Contract* closeout procedures.
- .2 *Substantial Performance of the Work*.
- .3 *Ready-for-Takeover*.
- .4 Inspection and review before *Ready-for-Takeover*
- .5 Partial user occupancy.
- .6 Final inspection for completion of the *Contract*.
- .7 Warranty period.

1.2 General Contract Closeout Procedures

- .1 The procedures for completing *Contract* and acceptance by the *Owner* shall be in accordance with the methods described in current edition of OAA/OGCA Document 100 and any additional requirements described below.
- .2 Stages will be reviewed at the *Contract* start-up meeting to ensure that parties understand their responsibilities. Refer to Section 01 31 19 for procedures and requirements for *Contract* start-up meeting.
- .3 Within 4 weeks of commencement of the *Work*, submit to the *Consultant* a list of closeout submittals required by the *Contract Documents*.

1.3 Substantial Performance of the Work

- .1 The prerequisites to, and the procedures for, attaining *Substantial Performance of the Work*, or similar such milestone as provided for in the lien legislation applicable to the *Place of the Work*, shall be independent of those for attaining *Ready-for-Takeover* of the *Work*.
- .2 Deficiency review:
 - .1 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 (the deficiency list) and apply for a review of the *Work* by the *Consultant* to determine if *Substantial Performance of the Work* has been achieved.
 - .2 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.

Closeout Procedures

- .3 The *Contractor's* request described above shall include a statement by *Contractor* that the *Work* to be reviewed by *Consultant* 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.
- .4 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 Section 01 78 00, the *Consultant* and the *Contractor* 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 *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.
- .5 Provide a schedule of planned deficiency review having regard to the foregoing.
- .3 Certification of *Substantial Performance of the Work*:
 - .1 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*.
 - .2 The certificate of *Substantial Performance of the Work* shall be prepared and issued in accordance with the Construction Act.
 - .1 Inform *Owner*, *Consultant*, *Subcontractors*, and *Suppliers* which publication is to be used for publishing certificate of substantial performance in accordance with Section 01 31 19.

1.4 **Ready-for-Takeover**

- .1 The prerequisites to attaining *Ready-for-Takeover* of the *Work* are described in the General Conditions of the *Contract*, and as amended.

1.5 **Inspection and Review Before Ready-for-Takeover**

- .1 *Contractor's* Inspection: Before applying for the *Consultant's* review to establish *Ready-for-Takeover* of the *Work*:
 - .1 Ensure that the specified prerequisites to *Ready-for-Takeover* of the *Work* are completed.
 - .2 Conduct an inspection of the *Work* to identify defective, deficient, or incomplete work.
 - .3 Prepare a comprehensive and detailed list of items to be completed or corrected.
 - .4 Provide an anticipated schedule and costs for items to be completed or corrected.

Closeout Procedures

- .2 *Consultant's Review*: Upon receipt of the *Contractor's* application for review, together with the *Contractor's* list of items to be completed or corrected, the *Consultant* and the *Contractor* shall arrange a mutually satisfactory agreed date and time to jointly review the *Work*. The *Consultant* will advise the *Contractor* whether or not the *Work* is *Ready-for-Takeover*. Add additional items, if any, to the *Contractor's* list of items to be completed or corrected. Provide the *Consultant* with a copy of the revised list.
- .3 Maintain the list of items to be completed or corrected and promptly correct or complete defective, deficient and incomplete work. The *Contractor's* inspection and *Consultant's* review procedures specified above shall be repeated until the *Work* is *Ready-for-Takeover* and no items remain on the *Contractor's* list of items to be completed or corrected.
- .4 When the *Consultant* determines that the *Work* is *Ready-for-Takeover*, the *Consultant* will notify the *Contractor* and the *Owner* in writing to that effect.

1.6 Partial User Occupancy

- .1 If partial *Owner* occupancy of a part of the *Work* is required before the date of *Ready-for-Takeover* of the entire *Work* of the *Contract*, the provisions of this Section shall apply, to the extent applicable, to that part of the *Work* that the *Owner* intends to occupy.

1.7 Final Inspection for Completion of the Contract

- .1 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.
- .2 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*.
- .3 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*.
- .4 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.
- .5 *Contractor* shall thereafter submit invoice for final payment.
- .6 Money withheld for deficiency work shall be released only when all deficiencies have been completed. No partial payment to be recognized until all work is completed.

1.8 Warranty Period

- .1 Provide on-going review and attendance to building call-back, maintenance and repair problems during the warranty periods.

Closeout Procedures

- .2 Within 30 calendar days prior to the expiry of the warranty period, 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*.

PART 2 - PRODUCTS

Not applicable.

PART 3 - EXECUTION

Not applicable.

END OF SECTION

Closeout Submittals

PART 1 - GENERAL

1.1 Section Includes

- .1 As-built documents.
- .2 Record drawings.
- .3 Operation and maintenance manuals.
- .4 Operation and maintenance book.
- .5 *Project* data book.
- .6 Shop drawing book.
- .7 Warranty book.
- .8 Posted operating instructions.
- .9 Spare parts, maintenance materials, and special tools.

1.2 Administrative Requirements

- .1 Collect reviewed submittals, and assemble required closeout submittals executed by *Subcontractors*, *Suppliers*, and manufacturers. Prior to submitting closeout submittals to the *Consultant*:
 - .1 Review maintenance manual contents (operating, maintenance instructions, as-built drawings, materials) for completeness.
 - .2 Review supply and completeness of spare parts required by *Contract Documents* and manufacturers.
 - .3 Review in relation to *Contract Price*, *Change Orders*, *Change Directives*, holdbacks and other adjustments to the *Contract Price*.
 - .4 Review inspection and testing reports to verify conformance to intent of *Contract Documents* and that changes, repairs or replacements have been completed.
 - .5 Execute transition of performance bond and labour and materials payment bond to warranty period requirements.
 - .6 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 and elsewhere in the *Contract Documents*.
- .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.

Closeout Submittals

- .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*.

1.3 As-Built Documents

- .1 Prepare as-built documents in accordance with Section 01 32 00.
- .2 Submit 2 hard copies of as-built documents in accordance with Section 01 32 00.
- .3 In addition, submit digital scanned copy ("PDF" files) and native CAD files of as-built documents. Submit using digital storage medium or transfer process acceptable to the *Consultant* and the *Owner*.

1.4 Record Drawings

- .1 Once hard copy of as-built drawings have been accepted by *Consultant*, *Contractor* shall receive digital media in format compatible with currently licensed edition of AutoCAD software from the *Consultant*, to update drawings to reflect "As-Built" conditions as referenced above. Refer also to requirements of Divisions 21, 22, and 23 and Divisions 26, 27, and 28.
- .2 Transcribe hard copy changes to the drawings into the electronic media.
- .3 Mark revised *Drawings* as "RECORD DRAWINGS".
- .4 After final acceptance by *Consultant*, submit electronic copies of record drawings to *Owner*.
 - .1 Any submitted DWG files shall be accompanied by the CTB files required to print them as indented. DWG files should be generally self-contained and have all CDA Xrefs bound using the "Bind" (not "insert") options. XREFTS should not be exploded.

1.5 Operation and Maintenance Manuals

- .1 Prepare a comprehensive operation and maintenance manual, in the language of the *Contract*, using personnel qualified and experienced for this task.
- .2 Submit an initial draft of the operation and maintenance manual for *Consultant's* review. If required by *Consultant's* review comments, revise manual contents and resubmit for *Consultant's* review. If required, repeat this process until *Consultant* accepts the draft manual in writing.
- .3 Submit operation and maintenance manuals as follows:
 - .1 Submit 2 copies of operation and maintenance manuals in hard copy.
 - .2 In addition, submit digital copies ("PDF" files) of operation and maintenance manuals. Submit using digital storage medium or transfer process acceptable to the *Consultant* and the *Owner*.

1.6 Operation and Maintenance Manual Format

- .1 Organize operation and maintenance manuals into the following general components:

Closeout Submittals

- .1 Operation and maintenance book.
- .2 *Project* data book.
- .3 Shop drawing book.
- .4 Warranty book.
- .2 Organize data in the form of an instructional manual.
- .3 Bind each general component of the operation and maintenance books in separate vinyl hard covered, 3 ring loose leaf binders.
- .4 Enclose title sheet, labelled as applicable, with project name, date and list of contents.
- .5 Organize contents into applicable sections of work to parallel project *Specifications* breakdown. Mark each section by labelled tabs protected with celluloid covers fastened to hard paper dividing sheets.
- .6 When multiple binders are used, correlate data into related consistent groupings. Identify contents of each binder on spine.
- .7 Cover: Identify each binder with typed or printed title "Operation and Maintenance Manual", name of *Project* or facility, and subject matter of contents.
- .8 Text: Manufacturer's printed data, or typewritten data.

1.7 Operation and Maintenance Book

- .1 Operation and maintenance books shall contain operating and maintenance data and information specified below for supplied *Products*.
- .2 Neatly type lists and notes. Use clear drawings, diagrams of manufacturers' literature.
- .3 Each Item of Equipment and Each System: include description of unit or system and component parts. Give function, normal operation characteristics, and limiting conditions. Include performance curves, with engineering data and tests, and complete nomenclature and commercial number of replaceable parts.
- .4 Panel Board Circuit Directories: provide electrical service characteristics, controls, and communications.
- .5 Include installed colour coded wiring diagrams.
- .6 Description, operation and maintenance instructions for equipment and parts list. Indicate nameplate information such as make, size, capacity, serial number.
- .7 Operating Procedures: include start up, break in, and routine normal operating instructions and sequences. Include regulation, control, stopping, shut down, and emergency instructions. Include summer, winter, and any special operating instructions.
- .8 Maintenance Requirements: include routine procedures and guide for trouble shooting; disassembly, repair, and reassembly instructions; and alignment, adjusting, balancing, and checking instructions.
- .9 Provide servicing and lubrication schedule, and list of lubricants required.
- .10 Include manufacturer's printed operation and maintenance instructions.
- .11 Include sequence of operation by controls manufacturer.

Closeout Submittals

- .12 Provide original manufacturer's parts list, illustrations, assembly drawings, and diagrams required for maintenance.
- .13 Provide installed control diagrams by controls manufacturer.
- .14 Provide *Contractor's* coordination drawings, with installed colour coded piping diagrams.
- .15 Provide charts of valve tag numbers, with location and function of each valve, keyed to flow and control diagrams.
- .16 Provide list of original manufacturer's spare parts, current prices, and recommended quantities to be maintained in storage.
- .17 Include testing and balancing reports.
- .18 Include additional content as specified in technical *Specifications* sections.

1.8 **Project Data Book**

- .1 *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 in Section 01 79 00.
 - .6 Key construction photos.
 - .7 Permits and forms:
 - .1 Certificate of Clearance from the Workplace Safety and Insurance Board (WSIB).
 - .2 Electrical authority certificate of inspection.
 - .8 Waste management and disposal reports, prepared in accordance with Section 01 74 00.

1.9 **Shop Drawing Book**

- .1 Submit one copy of each final accepted *Shop Drawings* 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 Drawings* in the shop drawing manual.

Closeout Submittals

1.10 Warranty Book

- .1 Submit copies of bonds, guarantees, warranties and extended warranties together, complete with an indexed summary list of warranties and expiration dates. Warranties to be in accordance with Section 01 78 36.
- .2 Separate each warranty with index tab sheets keyed to Table of Contents listing.
- .3 List each warrantor with complete contact information.
- .4 Verify that documents are in proper form and contain full information. Warranties shall be for the correct duration and shall be in *Owner's* name.
- .5 Include maintenance bond(s).

1.11 Posted Operating Instructions

- .1 Prepare operating instructions in English for posting near equipment and systems. Posted instructions to be glass covered, framed and mounted.
- .2 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.
- .3 Posted instructions shall include control diagrams with added specific operating instructions, controls, interlocks, and the like.
- .4 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.

1.12 Spare Parts, Maintenance Materials, and Special Tools

- .1 Provide overage, extra stock, and maintenance materials, including keys, in quantities specified in the *Contract Documents*.
- .2 Submit to *Consultant* a typed inventory list of maintenance materials prior to application for *Substantial Performance of the Work*. List all items, complete with quantities, and storage locations. Include *Consultant* reviewed inventory listing in final submission to *Owner*.
- .3 Prepare and submit 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*.
- .4 Provide tags for special tools identifying their function and associated *Product*.
- .5 Supply spare parts, maintenance materials, and special tools in quantities specified in technical *Specifications* sections.

Closeout Submittals

- .6 Ensure spare parts and maintenance materials are new, not damaged nor defective, and of same quality, manufacturer, and batch or production run as installed *Products*.
 - .1 Replace incorrect or damaged maintenance materials.
- .7 Deliver to and store items at location and time directed by *Owner*. Store in original packaging with manufacturer's labels intact and in a manner to prevent damage or deterioration.
 - .1 Clearly mark cartons or packaging as to contents, project name, and *Supplier*.
 - .2 If applicable give colour and finish, room number or area where material is used.
 - .3 Include necessary information for re-ordering of materials as part of packaging of materials.
- .8 Catalogue all items and submit to *Consultant* an inventory listing organized by *Specifications* section. Include *Consultant* reviewed inventory listing in operation and maintenance manual.

PART 2 - PRODUCTS

Not applicable.

PART 3 - EXECUTION

Not applicable.

END OF SECTION

Warranties

PART 1 - GENERAL

1.1 Warranties

- .1 Warranties shall be in accordance with GC 12.3, as amended.

1.2 Extended Warranties

- .1 Extended warranties shall be in accordance with GC 12.3, as amended, and as follows:
 - .1 Where specifically identified in the *Contract Documents*, extended warranties shall be furnished by individual manufacturer for particular product/system/assembly.
 - .2 Extended warranties shall include for proper performance of the portion of the *Work* as defined by the scope of the applicable *Specifications* section to the extent that the design and *Contract Documents* permit such performance.
 - .3 The *Owner* shall promptly give the warrantor notice in writing of observed defects and deficiencies which occur during the warranty period.
 - .4 Extended warranties shall commence at date of *Ready-for-Takeover*.
 - .5 Extended warranties 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*.
 - .6 Submit extended warranty on warrantor's standard form specifically endorsed by the warrantor to the *Owner* and shall include the following information:
 - .1 Name and address of *Project*.
 - .2 Warranty commencement date.
 - .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.

PART 2 - PRODUCTS

Not applicable.

PART 3 - EXECUTION

Not applicable.

END OF SECTION

Demonstration and Training

PART 1 - GENERAL

1.1 Section Includes

- .1 Systems demonstration and training.

1.2 Preparation

- .1 Prior to scheduling demonstration and training:
 - .1 Review condition of equipment or systems for which demonstration and training is required and that have 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.
 - .2 When partial occupancy of uncompleted project is required by *Owner*, coordinate *Owner's* uses, requirements, access, and the like, with requirements to complete the *Work*.

1.3 Submittals

- .1 Submit proposed dates, times, durations, and locations for demonstration and training of each item of equipment and each system for which demonstration and training is required. Allow sufficient time for training and demonstration for each item of equipment or system, or time as may be specified in technical *Specifications*.
 - .1 Correlate with construction schedule in accordance with Section 01 32 00.
- .2 *Consultant* and *Owner* will review submittal and advise *Contractor* of any necessary revisions.
- .3 Submit report(s) within 5 *Working Days* after completion of demonstration and training:
 - .1 Identifying time and date of each demonstration and training session.
 - .2 Summarizing the demonstration and training performed.
 - .3 Including a list of attendees.

1.4 Demonstration and Training

- .1 Perform system demonstration work no later than 15 *Working Days* prior to submitting request for *Consultant's* review to determine if *Substantial Performance of the Work* has been achieved.
 - .1 Provide *Owner* with 5 *Working Days* prior written notice of dates scheduled for demonstration and training.
- .2 Submit required certificates of approval or acceptance from authorities having jurisdiction.
- .3 Prerequisites to demonstration and training:
 - .1 Testing, adjusting, and balancing has been performed in accordance with *Contract Documents*.
 - .2 Equipment and systems are fully operational.

Demonstration and Training

- .3 Copy of completed operation and maintenance manual is available for use in demonstration and training.
- .4 Conditions for demonstration and training comply with requirements specified in technical *Specifications*.
- .4 Demonstration and training:
 - .1 Demonstrate and provide training to *Owner's* personnel.
 - .2 Instruct *Owner's* personnel in operation 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
 - .3 *Contractor*, manufacturer's representatives, and responsible personnel from *Subcontractors* whose work is being demonstrated shall be present at these demonstrations, as well as *Owner's* personnel.
 - .4 *Owner* shall provide list of personnel to receive training and shall coordinate their attendance at agreed upon times.
 - .5 Demonstration shall include start up, operation, control, adjustment, troubleshooting, servicing, and maintenance of each item of equipment and system.
 - .6 Review operation and maintenance manual in detail to explain all aspects of operation and maintenance.
 - .7 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*.
 - .8 Prepare and insert additional data in the operation and maintenance data manuals when the need for additional data becomes apparent during demonstration or instruction.
- .5 Correct deficiencies and defects identified during demonstration, instruction, or commissioning.
- .6 Attend 'end-of-work' testing and break-in or start-up demonstration.

PART 2 - PRODUCTS

Not applicable.

PART 3 - EXECUTION

Not applicable.

END OF SECTION

Commissioning

PART 1 - GENERAL

1.1 General Requirements

- .1 A commissioning team shall be established as required by the *Owner* for the Project that shall include representatives for the *Owner*, *Consultant*, *Commissioning Agent* (which may be designated *Owner's* forces), *Contractor* and *Subcontractors* involved with the systems to be commissioned.
- .2 A qualified *Commissioning Agent* (authority) shall be appointed by the *Owner* to oversee all *Commissioning* testing of systems. All prescribed forms shall be submitted by the *Contractors* to the *Commissioning Agent* and *Consultant* for approval prior to final submission to the *Owner*.
- .3 The *Contractor* shall be responsible for providing all necessary labour, equipment, representatives and testing apparatus required for the *Commissioning* process and shall coordinate with the commissioning team through the *Commissioning Agent* to ensure all designated systems are fully commissioned and operating to design requirements.
- .4 *Commissioning* as referred to in this section does not negate the *Contractor* from doing his specified start-up requirements. Both the *Consultant* and *Commissioning Agent* shall witness all start-up procedures. Written confirmation shall be provided by the *Contractor* to the *Consultant* and *Commissioning Agent* for the start-up of each piece of equipment for all designated systems.
- .5 *Commissioning* for includes the systems listed below or as applicable to this project and as instructed by the *Consultant*.
 - .1 Designated Mechanical Systems
 - .1 New Air Handling System & Components
 - .2 Motor Starters, Variable Frequency Drives for Mechanical Equipment
 - .2 Designated Electrical Systems
 - .1 600V & 208V Distribution Systems
 - .2 Snowmelting System
 - .3 Infrared Heating System

1.2 Procedures and Formats

- .1 *Commissioning* shall consist of 'Start-Up', 'Verification' and 'Performance Testing'.
- .2 Start-Up procedures, as defined for this *Project*, entail confirmation that the *Contractor* has started-up all equipment and systems in accordance with the manufacturer's recommendations, operated the systems continuously for 48 hours under control, and started and stopped each piece of equipment at least (5) five times consecutively trouble free.
- .3 Verification forms shall be completed after start-up by the appropriate *Subcontractor* for the various systems to be commissioned. These shall be submitted to the *Commissioning Agent* and *Consultant* for approval prior to submission to the *Owner*. Forms shall be made available to the *Contractor* by the *Commissioning Agent* as required.

Commissioning

- .1 The *Contractor* shall fill out and submit the matrix as part of the verification procedure.
- .2 The forms shall be submitted complete with the related documentation in binder format.
- .3 E.g. - The item "Keys" would be submitted with a copy of the transmittal form given to the 'Owner' with the data on the turnover (i.e. No. of Keys, Name of Equipment or Item concerned, Manufacturer of Equipment, Type of Lock, etc.)
- .4 The *Contractor* will assign an individual from each of their required *Subcontractors* to act as their respective representatives on the commissioning team. Other *Subcontractor* representation (e.g. Air and Water Balancer) shall be made available to the team as and if required by the *Commissioning Agent*.
- .5 Performance tests shall not be conducted until all associated systems and equipment are started-up and verified and the scenarios are developed and scheduled by the commissioning team.
- .6 The *Commissioning Agent* with the commissioning team will develop and coordinate the individual implementation of scenarios on the various components of a system or a whole system to confirm proper operation. The *Commissioning Agent* will submit to the *Contractor* in advance of the tests the scenarios to allow the *Contractor*, if needed, to arrange the required representatives and/ or personnel that will be needed for the test and also to allow the *Contractor* the time to confirm and arrange the required test equipment.
 - .1 The *Commissioning Agent* with *Consultant's* input will develop and provide the test sheets for the various systems and/or component testing.
 - .1 Depending on the requirements of the project, the *Commissioning Agent* will have to allow for commissioning equipment and services during winter and summer months as required depending on the required use of the equipment.
 - .2 Refer to the CSA Standards indicated in article 1.2.14 for additional information on documentation.
- .7 The automation *Subcontractor* is to provide all required equipment and labour needed to confirm that the equipment and their sensors and/or monitors are reading correctly. The test equipment must be acceptable to the *Commissioning Agent* and the type of equipment to be used in the test must be reviewed at least one week in advance of the test with the *Commissioning Agent*. The *Subcontractor* must verify that the test equipment has been certified for calibration in the last three months. If there is disagreement about the accuracy of the test equipment the *Contractor* is to provide reliable proof that the test equipment is working and accurate. The BAC's must be calibrated prior to test use.
- .8 *Contractor* is to cooperate with *Subcontractors* and ensure all required personnel and manufacturer's personnel needed to participate in the testing of the systems are provided.
- .9 Re-adjustment, re-testing and re-balancing of system is to be done by the *Contractor(s)* should the test results be unacceptable to the *Commissioning Agent*, *Consultant*, or *Owner*.
- .10 The *Contractor* will be responsible for informing the *Commissioning Agent* of all changes that have occurred in the *Work* so the *Commissioning Agent* is aware of what the final review is to include.

Commissioning

- .11 The *Commissioning Agent* shall convene through the *Contractor* commissioning team meetings.
- .12 The *Commissioning Agent* will submit periodic reports to the *Owner* on the progress of the testing and indicate to the *Owner* any unusual observations as a result of the testing.
- .13 The *Contractor* shall set-up and schedule equipment and system demonstrations for the *Owner*. Confirm in writing that the *Owner's* representatives have a useable working knowledge of the systems and equipment after demonstrations are complete.
- .14 The following guidelines and standards shall be edited and incorporated into the *Commissioning* process as decided by the *Commissioning Agent* (Authority) at the time of 'Final Test Form Production'.
 - .1 ASHRAE Guideline I –1989“ Guideline for commissioning of HVAC Systems”
 - .2 C.S.A. Z318.0 Commissioning of Health Care Facilities”
 - .3 C.S.A. Z318.1 “Commissioning of HVAC Systems in Health Care Facilities”
 - .4 C.S.A. Z318.3 “Commissioning of Plumbing Systems in Health Care Facilities”
 - .5 C.S.A. Z318.4 “Commissioning of Fire Protection Systems in Health Care Facilities”
 - .6 C.S.A. Z318.5 “Commissioning of Electrical Equipment and Systems in Health Care Facilities”
 - .7 C.S.A. Z318.6 “Commissioning of Medical Gas Systems in Health Care Facilities”
 - .8 C.S.A. Z318.7 “Commissioning of Communication Systems in Health Care Facilities”

PART 2 - PRODUCTS

Not applicable.

PART 3 - EXECUTION

Not applicable.

Commissioning

APPENDIX A

The following forms are examples of the types of forms that will be provided to *Subcontractors* to be filled out as part of the *Commissioning* process. The final forms will be specifically tailored to the equipment and/or systems that are to be commissioned for this project. The forms provided are only a sample and do not in any way confirm that this will be the limit of the forms.

Mechanical Matrix

Electrical Matrix

Air Systems	Air Distribution	--	Ductwork	Verification Check Sheet
		--	Access Doors	Verification Check Sheet
		--	Fire Dampers	Verification Check Sheet
		--	Fire Damper Schedule	Verification Check Sheet
		--	Prefilters	Performance Test Sheet
		--	Supply Fan	Verification Check Sheet
			(two pages)	
		--	Supply Fan	Performance Test Sheet
			(two pages)	
		--	Automatic Dampers	Verification Check Sheet
		--	Cooling Coils	Verification Check Sheet
		--	Cooling Coils	Performance Test Sheet
		--	Heating Coils	Verification Check Sheet
		--	Heating Coils	Performance Test Sheet
		--	Mixing Plenums	Verification Check Sheet
		--	Mixing Plenums	Performance Test Sheet
			(two sheets)	
Hot Water Heating System	H.W. Distribution	--	Piping c/w Auxiliaries	Verification Check Sheet
			(two sheets)	
	Pumps	--	Reheat Coils	Verification Check Sheet
		--	Reheat Coils	Performance Test Sheet
		--	Secondary Pumps	Verification Check Sheet
Control Systems	Input Devices	--	Secondary Pumps	Performance Test Sheet
			(two sheets)	
		--	Elect. Temp. Sensor	Startup Check Sheet
		--	Elect. Temp. Sensor	Verification Check Sheet
		--	Elect. Temp. Sensor	Performance Test Sheet
		--	Pressure Switch	Startup Check Sheet
Electrical	Power and Lighting Panelboards	--	Pressure Switch	Verification Check Sheet
		--	Pressure Switch	Performance Test Sheet
	Starters	--	Panelboards	Startup Check Sheet
		--	Panelboards	Verification Check Sheet
		--	Var. Speed Controller	Performance Test Sheet
			(two sheets)	

Commissioning

Communications	--	Security System	Startup Check Sheet
	--	Nurse Call (three sheets)	Verification Check Sheet

END OF SECTION

Integrated Fire Protection and Life Safety Systems Testing

PART 1 - GENERAL

1.1 Section Includes

- .1 Procedures for verifying and documenting that interconnections between systems provided for *integrated fire protection and life safety systems* functions are installed and operating in conformance with their *design criteria* and in accordance with CAN/ULC S1001-11.
- .2 This specification is limited to testing of the interconnections between life safety and fire protection systems. Refer to separate technical specification sections for the individual testing and commissioning requirements for those systems.

1.2 Administrative Requirements

- .1 Definitions:
 - .1 Terms presented here in italic font are defined either in the Definitions of CCDC – 2 - 2020, or in CAN/ULC S1001-11.
 - .2 The *Consultant* shall be considered the *design professional* for the purposes of the *Contract*.
- .2 Coordination:
 - .1 Coordinate the applicable *Subcontractors* whose equipment or systems are part of the *integrated fire protection and life safety systems test*.
- .3 Conduct a pre-installation meeting in accordance with Section 01 31 19 and as follows:
 - .1 Attendees at pre-installation meeting shall include *Subcontractors* whose equipment or systems are part of the *integrated fire protection and life safety systems test*.
 - .2 Review requirements of authorities having jurisdiction, as well as requirements of, and roles and responsibilities for, each participant in the development of the *integrated test plan* and the execution of the *integrated fire protection and life safety systems test*.

1.3 Submittals

- .1 Submit required submittals in accordance with Section 01 33 00.
- .2 *Integrated test plan*:
 - .1 The *integrated testing coordinator* shall develop the *integrated test plan* in accordance with Section 5 of CAN/ULC S1001-11.
 - .2 Submit the *integrated test plan* for review by the *Consultant* at least 30 days prior to commencement of the first *integrated fire protection and life safety systems test*. The *integrated testing plan* shall comply with the requirements of CAN/ULC S1001-11 and as specified herein.
 - .3 Distribute final copy of plan digitally as follows:
 - .1 Authorities having jurisdiction.
 - .2 One copy to be maintained at the *Place of the Work*.

Integrated Fire Protection and Life Safety Systems Testing

- .3 *Owner.*
 - .4 *Consultant.*
 - .5 *Contractor.*
 - .6 Consulting engineers, as applicable.
- .3 Final test report:
- .1 Upon successful completion of the *integrated fire protection and life safety systems tests*, the *integrated testing coordinator* shall prepare and submit a final test report in accordance with Section 7 of CAN/ULC S1001-11.
 - .2 Distribute reports digitally as follows:
 - .1 Authorities having jurisdiction.
 - .2 One copy to be maintained at the *Place of the Work*.
 - .3 *Owner.*
 - .4 *Consultant.*
 - .5 *Contractor.*
 - .6 Consulting engineers, as applicable.

1.4 Quality Assurance

- .1 *Integrated testing coordinator* qualifications:
 - .1 The *integrated testing coordinator* services shall be provided by a firm or individual certified under the CAN/ULC-S1001 Certification of Integrated Testing Service Providers program.
 - .2 The *Contractor* shall retain and pay for the *integrated testing coordinator*.

PART 2 - PRODUCTS

Not applicable.

PART 3 - EXECUTION

3.1 Integrated Systems Testing Requirements

- .1 Conduct *integrated fire protection and life safety systems* testing in accordance with Section 6 of CAN/ULC S1001-11 and the accepted *integrated testing plan*.

3.2 Demonstration and Training

- .1 Conduct demonstration and training in accordance with Section 01 79 00.
 - .1 Demonstrate the operation of, and providing training on, the integration of *fire protection and life safety systems*.
 - .2 Demonstration and training to include:
 - .1 The function of the integration.
 - .2 The method of integration: hardwired, network communication, operating protocols.

Integrated Fire Protection and Life Safety Systems Testing

- .3 The type of information: data, commands, monitoring.
- .4 Any temporary measures to be taken to retest in the future.

END OF SECTION

Demolition

PART 1- GENERAL

1.1 Summary

- .1 Section includes:
 - .1 Demolition and removal of selected non-structural portions of building.
 - .2 Salvage of designated items.
 - .3 Removal of surplus materials from the *Place of the Work*.
 - .4 Related mechanical and electrical work and demolition requirements are covered under Divisions 21, 22, and 23 and Divisions 26, 27, and 28 respectively.
- .2 Section excludes:
 - .1 Demolition, removal, remediation, or abatement of designated substances or materials and toxic and hazardous substances.

1.2 Administrative Requirements

- .1 Pre-demolition meeting:
 - .1 Schedule a pre-demolition meeting following the procedures specified for pre-installation meetings in accordance with Section 01 31 19.
 - .2 Review existing conditions at the *Place of the Work* thoroughly to establish full extent of items to be removed and items to remain. Commencement of demolition work will be considered to be acceptance of existing conditions at the *Place of the Work* and removal of such items.
 - .3 Examine adjacent areas to determine extent of protection required.

1.3 Submittals

- .1 Submit required submittals in accordance with Section 01 33 00.
- .2 Special procedures submittals:
 - .1 Existing conditions documentation:
 - .1 Document existing conditions of adjoining construction, including pre-existing damage to finish surfaces that might be misconstrued as damage caused by demolition operations.
 - .2 Comply with Section 01 32 00.
 - .3 Submit existing conditions documentation before demolition work begins.
 - .2 Inventory of items to be salvaged:
 - .1 Prepare typed inventory of items to be salvaged and cross-reference to drawing showing existing locations.
 - .2 Submit inventory following procedures for submittal of shop drawings in accordance with Section 01 33 00.

Demolition

1.4 Quality Assurance

.1 Qualifications:

- .1 Execute the work of this section using workers skilled in the respective duties for which they are employed, and with minimum 3 years' experience in application of *Products*, systems, and assemblies specified.

PART 2 - PRODUCTS

Not applicable.

PART 3 - EXECUTION

3.1 Examination

- .1 Verify that utilities have been disconnected and capped.
- .2 Observe existing conditions and correlate with requirements indicated to determine extent of selective demolition required.
- .3 Inventory and record the condition of items to be removed and reinstalled and items to be removed and salvaged.
- .4 When unanticipated mechanical, electrical, or structural elements that conflict with intended function or design are encountered, investigate and measure the nature and extent of conflict. Promptly submit a written report to *Consultant*.
- .5 Survey of existing conditions: Record existing conditions by use of photographs in accordance with Section 01 32 00.

3.2 Utility Services and Mechanical / Electrical Systems

- .1 Refer to Divisions 21, 22, and 23 and Divisions 26, 27, and 28 respectively.

3.3 Selective Demolition, General

- .1 Demolish and remove existing construction only to the extent required by new construction, and as otherwise indicated. Use methods required to complete the work within limitations of governing regulations and as follows:
 - .1 Proceed with selective demolition systematically, from higher to lower level. Complete selective demolition operations above each floor or tier before disturbing supporting members on the next lower level.
 - .2 Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping, to minimize disturbance of adjacent surfaces. Temporarily cover openings to remain.
 - .3 Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.

Demolition

- .4 Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain fire watch and portable fire-suppression devices during flame-cutting operations.
- .5 Maintain adequate ventilation when using cutting torches.
- .6 Remove decayed, infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.
- .7 Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
- .8 Dispose of demolished items and materials promptly.
- .2 Dispose of demolished materials from *Project* site except where noted otherwise and in accordance with authorities having jurisdiction. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
- .3 Do not sell demolished material at the *Place of the Project*.
- .4 Clean existing surfaces specified to receive new applied finishes to assure proper adherence.

3.4 Selective Demolition Procedures for Specific Materials

- .1 Masonry: Demolish in small sections. Cut masonry at junctures with construction to remain, using power-driven saw, then remove masonry between saw cuts.
- .2 Concrete Slabs-on-Grade: Saw-cut perimeter of area to be demolished, then break up and remove.

3.5 Salvage

- .1 Remove and store items indicated or directed for salvage. Remove, handle and transport such items to storage area designated in the *Contract Documents*, to an area within the *Place of the Work* designated by *Consultant*, or to an area away from the *Place of the Work* as directed by the *Consultant*. Perform such work to prevent damage to the items during removal and in storage.
- .2 Remove and store indicated items for future use by *Owner*. Remove, handle and transport such items to storage area indicated in the *Contract Documents* or to an area within the *Place of the Work* designated by *Consultant*. Perform such work carefully and with diligence to prevent any damage to the items during removal and in storage.

3.6 Protection

- .1 Prevent movement, settlement or damage of adjacent structures, services, walks, paving, trees, landscaping, adjacent grades and parts of existing building to remain. Make good damage caused by demolition.
- .2 Take precautions to support affected structures and, if safety of building being demolished or adjacent structures or services appears to be endangered, cease operations and notify demolition engineer, *Contractor* and *Consultant*.
- .3 *Provide* temporary weather enclosures in accordance with Section 01 35 13 and Section 01 56 00.

Demolition

- .4 Prevent debris from obstructing active services and drainage systems.
- .5 Protect work to remain against damage. Repair or replace damaged work at no additional cost to the *Owner*.
- .6 Slopes of excavated areas after removal of footings shall be left in a stable condition and as required by authorities having jurisdiction.

END OF SECTION

Metal Fabrications

PART 1- GENERAL

1.1 Summary

- .1 Section includes:
 - .1 Work of this section includes metal fabrications as indicated.

1.2 Administrative Requirements

- .1 Conduct a pre-installation meeting in accordance with Section 01 31 19.

1.3 Submittals

- .1 Submit required submittals in accordance with Section 01 33 00.
- .2 Submit list of fabrications to be *Provided* as part of the work of this section.
- .3 *Product* data sheets:
 - .1 Submit manufacturer's *Product* data sheets for *Products* proposed for use in the work of this section.
- .4 Shop drawings:
 - .1 Submit engineered shop drawings.
 - .2 Include plans, sections and large scale details, and indicate components and methods of assembly, materials and their characteristics, fastenings, metal finishes, welds, and their structural characteristics relative to their purpose, and other fabrication information required.
 - .3 Indicate seismic design, connections and restraint.
 - .4 Indicate proposed *Place of the Work* connections and methods.
 - .5 Submit coordination drawings indicating locations of concealed grounds, cutouts, plates, and other required fabrications.
 - .6 Show relation to adjoining construction, details of outside and inside corners and door openings.

1.4 Quality Assurance

- .1 Qualifications:
 - .1 Execute the work of this section using workers skilled in the respective duties for which they are employed, and with minimum 3 years' experience in application of *Products*, systems, and assemblies specified.

1.5 Product Handling

- .1 Product handling shall be in accordance with Section 01 60 00 as supplemented by the requirements of this section.

1.6 Warranty

- .1 Warrant work of this section in accordance with Section 01 78 36.

Metal Fabrications

PART 2 - PRODUCTS

2.1 Performance/Design Requirements

- .1 Design, fabricate, and install work of this section in accordance with the building code and requirements of authorities having jurisdiction.
- .2 Welding:
 - .1 Steel: Weld components to conform to requirements of CSA W59-24, and by a fabricator fully certified by the Canadian Welding Bureau to conditions of CSA W47.1-25 and CSA W55.3-08 (R2023) as applicable.
- .3 Design assemblies and connections to withstand own dead load, live loads, super-imposed dead loads, and fabrication forces, without permanent distortions or deformation, to maximum allowable deflection of $L/360$, within the following construction tolerances:
 - .1 Maximum variation from plumb in vertical lines: 3.2 mm (1/8") in 3 m (10'-0").
 - .2 Maximum variation from level: 3.2 mm (1/8") in 9 m (30'-0").
 - .3 Maximum variation from straight: 3.2 mm (1/8") in 3 m (10'-0") under a 3 m (10'-0") straight edge.
 - .4 Maximum variation from angle indicated: 10 seconds.
 - .5 Tolerances shall be non-cumulative.

2.2 Materials

- .1 General:
 - .1 Unless detailed or specified otherwise, standard *Products* will be acceptable if construction details and installation meet requirements of the *Contract Documents*.
 - .2 Include materials, *Products*, accessories, and supplementary parts necessary to complete assembly and installation of work of Section 05 50 00.
 - .3 Incorporate only metals that are free from defects that are visible, or that impair strength or durability. Install only new metals that are of best quality, free from rust or waves and buckles, clean, straight, with sharply defined profiles.
- .2 Steel:
 - .1 Structural shapes, plate, bars: hot-rolled or cold-rolled to suit design requirements, in accordance with CSA G40.21-13, Grade 300W.
 - .2 Hollow structural sections: hot-formed or cold-formed to suit design requirements, seamless, in accordance with CSA G40.21-13, Grade 350W, Class H or Class C.
 - .3 Mild sheet and strip: hot rolled, in accordance with ASTM A1011/A1011M-18a.
 - .4 Cold rolled sheet: stretcher levelled, fully pickled, in accordance with ASTM A1008/A1008M-18, Grade CS Type A exposed, matte finish, dry, unless otherwise indicated.
 - .5 Steel pipe: in accordance with ASTM A53/A53M-18, Type E or S, Grade A or B, standard weight, Schedule 40 seamless black or AISI MT 1010/1015.

Metal Fabrications

2.3 Accessories

.1 Fasteners:

- .1 Exposed fasteners to match the appearance of the surface on which they occur.
- .2 For fastening steel: Zinc plated screws and bolts, and in accordance with ASTM A307-21, Type 304 stainless steel where exposed to exterior.
- .3 For fastening stainless steel: Stainless steel 300 Series or stainless steel 400 Series.
- .4 For fastening aluminum: Stainless steel 300 Series, stainless steel 400 Series, cadmium plated or aluminum.
- .5 High strength bolts: in accordance with ASTM A325-14.
- .6 Concrete anchors; exterior exposed to weather: embedded epoxy set anchors, unless otherwise indicated.
 - .1 Size: in accordance with manufacturer's written requirements and reviewed shop drawings. Embedment depth shall not be greater than 80% of concrete thickness.
- .7 Other types of fasteners as appropriate to meet design requirements.
- .8 Fasteners shall be tamperproof where exposed.

.2 Welding materials:

- .1 Steel: in accordance with CSA W59-24.

.3 Grout:

- .1 Epoxy grout; non-shrink, non-expanding.
 - .1 Acceptable *Products*:
 - .1 Hilti 'HY-200'.
 - .2 Sika 'Sika AnchorFix 3001'.
 - .3 W.R. Meadows 'REZI-WELD 3/2 EPOXY GROUT/PATCH'.
 - .4 Substitutions: in accordance with Section 01 25 00.
 - .2 Cementitious grout: non-shrink, non-expanding in accordance with ASTM C1107/C1107M-20:
 - .1 Acceptable *Products*:
 - .1 Sika 'Sika Grout 212' or 'Sika M-Bed Standard'.
 - .2 W.R. Meadows 'Sealtight CG-86 Construction Grout'.
 - .3 Substitutions: in accordance with Section 01 25 00.
- .4 Galvanic/dissimilar metal corrosion inhibitor (isolation coating): in accordance with Section 01 73 00 and written requirements of manufacturers of metals affected.

2.4 Finishes

- .1 Shop primer; steel:

Metal Fabrications

- .1 In accordance with CISC/CPMA 2-75 or SSPC-Paint 20, Paint Specification No. 20: Zinc-Rich Primers (Type I "Inorganic" and Type II "Organic").

2.5 Fabrication

.1 General:

- .1 Fabricate metal fabrications with machinery and tools specifically designed for the intended manufacturing processes and by skilled tradesmen.
- .2 Fit and assemble metal fabrications in shop. When this is not possible, make a trial shop assembly.
- .3 Incorporate means for fastenings of other work secured to work of this section.

.2 Construction:

- .1 Fabricate with materials, component sizes, metal 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.
- .2 Metal fabrications shall remain free of warping, buckling, opening of joints and seams, distortion, and permanent deformation.
- .3 Stairs:
 - .1 NAAMM Stair Standard: Comply with NAAMM-AMP 510-92, "Metal Stairs Manual," for Industrial Class, unless more stringent requirements are indicated.
- .4 Construct items that are part of floor construction, such as gratings and trench covers, to support the same live loads for which surrounding construction is designed.

.3 Assembly:

- .1 Accurately cut, machine and fit joints, corners, copes and mitres so that junctions between components fit together tightly and in true planes.
- .2 Provide smooth welds with splatter removed where exposed to view.
 - .1 Finish welds shall comply with NOMMA's "Voluntary Joint Finish Standards" for Finish #4 - Good quality, uniform undressed weld with minimal splatter as shown in NAAMM-AMP 521-01(R2012).
- .3 Allow for differential movements within assemblies and at junctions of assemblies with surrounding *Work*.
- .4 Field welding of hot dipped galvanized members permitted only when other fastening methods are not possible. Locations of field welds to be clearly identified on reviewed shop drawings.
- .5 Incorporate holes and connections for work installed under other sections.
- .6 Cleanly and smoothly finish exposed edges of materials including holes.
- .7 Cap open ends of sections exposed to view, such as pipes, channels, angles, and other similar work.

.4 Shop prime painting:

Metal Fabrications

- .1 Clean loose mill scale, rust, dirt, weld flux and spatter from the work after fabrication.
- .2 Prepare and prime paint in accordance with manufacturer's installation requirements. Prepare steel by methods specified in CISC/CPMA 2-75 or SSPC-SP3-18.
- .5 Galvanizing:
 - .1 Galvanize metal fabrications following fabrication.
 - .2 Paint damage galvanized surfaces with zinc rich paint, immediately following damage to galvanized protection. Prepare substrate to remove oil and grease to SSPC-SP1-16, rust scale to SSPC-SP3-18, mill scale to SSPC-SP6/NACE No. 3-07.

PART 3 - EXECUTION

3.1 Examination

- .1 Take measurements at the *Place of the Work* to verify that metal fabrications 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.
- .3 Countersink holes at wood screw locations where wood is attached to metal fabrications.
- .4 Attach metal fabrications to interior concrete and masonry with corrosion resistant expansion bolts to support load with a safety factor of 3.
- .5 Attach metal fabrications to exterior concrete and masonry with non-shrink epoxy cement to support load with a safety factor of 3.
- .6 *Provide* galvanic/dissimilar metal corrosion inhibitor (isolation coating) in accordance with Section 01 73 00 and written requirements of manufacturers of metals affected.
- .7 Hand items over for casting into concrete or building into masonry to appropriate trades together with setting templates.

3.3 Field Quality Control

- .1 Conduct quality control in accordance with Section 01 45 00.

3.4 Adjusting and Cleaning

- .1 After erection, touch up primed surfaces that are burned, scratched or otherwise damaged with prime paint to match shop paint.

Metal Fabrications

- .2 Clean and repair areas of bare metal and welds on galvanized surfaces with zinc rich paint. Mask welded areas of members to minimize overpainting of adjacent undamaged surfaces. Prepare substrate to remove oil and grease in accordance with SSPC-SP1-16, rust scale in accordance with SSPC-SP3-18, mill scale in accordance with SSPC-SP6/NACE No. 3-07.
- .3 Remove damaged, dented, defaced, defectively finished, or tool marked components and replace with new.

END OF SECTION

Rough Carpentry

PART 1- GENERAL

1.1 Summary

- .1 Section includes:
 - .1 The work of this section includes, but is not necessarily limited to, the following:
 - .1 Plywood backing panels.
 - .2 Wood furring, blocking, nailing strips, grounds.

1.2 Submittals

- .1 Submit required submittals in accordance with Section 01 33 00.

1.3 Product Handling

- .1 Product handling shall be in accordance with Section 01 60 00 as supplemented by the requirements of this section.
- .2 Where stability of wood dimensions and tolerances is required to ensure accurate installation of later work, store and install only in dry areas where no installation of moist or wet materials will be undertaken.

PART 2 - PRODUCTS

2.1 Wood Materials

- .1 General requirements:
 - .1 Except as indicated or specified otherwise lumber shall be softwood, S4S, moisture content not greater than 19% at time of installation, in accordance with following standards:
 - .1 CSA O141-05.
 - .2 NLGA-2017 Standard Grading Rules for Canadian Lumber.
- .2 Furring, blocking, nailing strips, grounds:
 - .1 Use S2S material.
 - .2 Dimension lumber sizes: in compliance with Section 12 of the NLGA-2017.
 - .3 Dimension lumber species and grades:
 - .1 Spruce-Pine-Fir.
 - .2 Light framing in accordance with NLGA-2017 Construction grade, S-Dry.
 - .3 Planks in accordance with NLGA-2017 No. 2 grade, S-Dry.
 - .4 Boards in accordance with NLGA-2017 No. 4 Common grade, S-Dry.

2.2 Panel Materials

- .1 Softwood plywood (CSP): in accordance with CSA O151-17.
- .2 Douglas Fir plywood (DFP): in accordance with CSA O121-17.

Rough Carpentry

2.3 Fastenings and Hardware

.1 General:

- .1 *Provide* fasteners of size and type indicated, acceptable to authorities having jurisdiction, and that comply with requirements specified in this article for material and manufacture. Provide nails or screws, in sufficient length, to penetrate not less than 38 mm (1-1/2") into wood substrate.
- .2 Anchors to concrete and unit masonry: Capability to sustain, without failure, a load equal to 6 times the load imposed when installed in unit masonry assemblies and equal to 4 times the load imposed when installed in concrete as determined by testing according to ASTM E488/E488M-22.
- .3 Use surface fastenings of following types, except where specific type is indicated.
 - .1 To hollow masonry, plaster and panel surfaces use 9 mm (11/32") expansion bolts or other acceptable anchor.
 - .2 To solid masonry and concrete use expansion bolts.
 - .3 To structural steel use bolts through drilled hole, or welded stud-bolts or power driven self-drilling screws, or welded stud-bolts.
- .4 Fastener materials:
 - .1 Hot-dip galvanized fasteners: in accordance with ASTM A153/A153M-16a Class A or B1 G185 and connectors meeting ASTM A653/A653M-18 Class G-185 sheet or better.
- .5 Hardware materials:
 - .1 Hot-dipped galvanized in accordance with ASTM A153/A153M-16a, Class A or B1, and connectors in accordance with ASTM A653/A653M-18, Class G185.

2.4 Construction Adhesive

- .1 Construction adhesive: to requirements of American Plywood Association AFG-01, ASTM C557-03(2017), ASTM D3498-19a, and FHA UM60.

2.5 Source Quality Control

- .1 Identify lumber by grade stamp of an agency certified by Canadian Lumber Standards Accreditation Board.

PART 3 - EXECUTION

3.1 General

- .1 Layout work to accommodate work of others. Cut and fit accurately. Erect in position indicated. Align, level, square, plumb, and secure work permanently in place.
- .2 Bore holes true to line and to same size as bolts. Drive bolts into place for snug fit, and use plates or washers for bolt head and nut bearings. Turn up bolts and lag screws tightly when installed, and again just before concealed by other work or at completion of work.

Rough Carpentry

- .3 Include in work of this section rough hardware such as nails, bolts, nuts, washers, screws, clips, and connectors required for complete and proper installations; and operating hardware required on work of this section for temporary use.
- .4 Do not attach work by wood plugs or blocking in concrete or masonry.
- .5 Do not regard nailers, blocking, and such other fastening provision indicated as exact or complete. Install required provisions for fastening, located and secured to suit *Place of the Work* conditions, and adequate for intended support.
- .6 Verify that grounds required for fastening of components and equipment are located correctly, and sized for adequate support.

3.2 Equipment Backboard

- .1 *Provide* backboards for mounting equipment as required. Use 19 mm (3/4") Softwood Plywood.
- .2 Refer to Divisions 21, 22, and 23 and Divisions 26, 27, and 28 for requirements for electrical backboards.

END OF SECTION

Architectural Woodwork

PART 1 - GENERAL

1.1 Summary

- .1 Section includes:
 - .1 Work of this section includes architectural including, but not limited to, the following:
 - .1 Cabinetry and hardware.
 - .2 Plastic laminate fabrications.
 - .3 Solid surfacing fabrications.
 - .4 Ballistic protection.
 - .5 Factory and site finishing of architectural woodwork.

1.2 Administrative Requirements

- .1 Coordination:
 - .1 Coordinate with other work for satisfactory and expeditious completion of the work of this section. Coordinate with partition accessories, electrical, communications, and finish components to ensure that proper provisions are made for the installation of the work of this section and for work by others.
 - .2 Where woodwork is to be fitted to other construction, check actual dimension of other construction by accurate field measurements before manufacturing woodwork; show recorded measurements on final shop drawings. Coordinate manufacturing schedule with construction progress to avoid delays in the *Work*.
 - .3 *Provide* forms, templates, anchors, sleeves, inserts and accessories required to be fixed to or inserted in the work of this section and set in place. Instruct applicable *Subcontractors* as to their locations.
 - .4 *Provide* cut-outs for raceways, sleeves, grommets and other manufactured accessories which are required for the work of this section and for work by others.
- .2 Conduct a pre-installation meeting in accordance with Section 01 31 19.

1.3 Submittals

- .1 Submit required submittals in accordance with Section 01 33 00.
- .2 *Product* data sheets:
 - .1 Submit manufacturer's *Product* data for each type of *Product* and process proposed for use in the work of this section and incorporated into items of architectural woodwork.
 - .2 For fire retardant pressure treated lumber or panel materials: include manufacturer's written requirements for finishing treated material.
- .3 Shop drawings:
 - .1 Submit shop drawings for the work of this section complying with the North American Architectural Woodwork Standards 4.0 requirements.

Architectural Woodwork

- .2 Shop drawings for the following shall be engineered shop drawings:
 - .1 Seismic design, connections, and restraint.
 - .2 Wall hung or suspended millwork.
- .3 Indicate quality standards and grades.
- .4 Include full scale drawings of exposed-to-view edge conditions.
- .5 Include plans, sections and large scale details, and indicate components and methods of assembly, fastenings, and other fabrication information required for the work of this section. Indicate assembly joint lines.
- .6 Include materials and their characteristics and finishes as applicable including the following:
 - .1 Panel core and material types, thicknesses, compliance with specified standards, special treatments.
 - .2 Adhesive types to be used and locations.
 - .3 Finishing requirements including North American Architectural Woodwork Standards 4.0 finish system number, sheen, and required application steps.
- .7 Submit coordination drawings indicating locations of concealed grounds, cut-outs, plates, and other required fabrications.
- .8 Show relation to adjoining construction, details of outside and inside corners and door openings.
- .4 Verification samples:
 - .1 Submit samples for purpose of verification of compliance with specified requirements.
 - .2 Submit 3 sets of 200 mm x 200 mm (8" x 8") samples, or 200 mm (8") long as applicable, of each specified *Product*, material and finish, including but not limited to the following:
 - .1 Shop finished materials, showing each type of finish and colour.
 - .2 Samples of each specified *Product*, in each specified colour and finish.
 - .3 Solid surfacing in each specified colour and finish.
 - .4 Plastic laminates, in each specified colour and finish.

1.4 Closeout Submittals

- .1 Submit closeout submittals in accordance with Section 01 78 00.
- .2 Operation and maintenance data:
 - .1 Submit maintenance and cleaning instructions for finishes requiring specific care, noting particularly those procedures or materials which will cause damage to finished surfaces to be included in maintenance manuals.
- .3 Maintenance materials:
 - .1 Deliver extra sets of hardware items for maintenance as follows:

Architectural Woodwork

- .1 Drawer Slides: 2 percent of each type actually installed, but not less than 2 sets.
- .2 Door/drawer pulls: 2 percent of each type actually installed, but not less than 2 sets.
- .3 Hinges: 2 percent of each type actually installed, but not less than 2 sets.

1.5 Quality Assurance

- .1 Qualifications:
 - .1 Execute the work of this section using workers skilled in the respective duties for which they are employed, and with minimum 3 years' experience in application of *Products*, systems, and assemblies specified. In addition:
 - .1 Fabricators, finishers, and installers shall each be a member in good standing of the Architectural Woodwork Institute or the Architectural Woodwork Manufacturers Association of Canada or the Woodwork Institute.
 - .2 Solid surfacing fabricator shall be a solid surface manufacturer's approved fabricator.
- .2 Quality standard:
 - .1 Work shall be in accordance with the North American Architectural Woodwork Standards 4.0, Premium Grade, or the highest grade available for performance and appearance characteristics of materials in Sections 3 – 5 used that apply to *Product* fabrication and installation requirements governed by Sections 6 – 12.
- .3 Requirements of regulatory agencies: the work of this section that functions to resist forces imposed by dead and live loads shall conform to requirements of jurisdictional authorities.

1.6 Product Handling

- .1 Product handling shall be in accordance with Section 01 60 00 as supplemented by the requirements of this section.
- .2 Protect architectural woodwork during transit, delivery, storage and handling to prevent damage, spoilage, and deterioration.
- .3 Do not deliver woodwork until painting, wet work, grinding, and similar operations that could damage, soil, or deteriorate architectural woodwork have been completed in installation areas. If woodwork must be stored in other than installation areas, store only in areas whose environmental conditions meet requirements specified under paragraph Site Conditions paragraphs of Section 06 40 00.
- .4 The architectural woodwork manufacturer and the *Contractor* shall be jointly responsible to make certain that architectural woodwork is not delivered until the building and storage areas are sufficiently dry so that the architectural woodwork will not be damaged by changes in moisture content.

Architectural Woodwork

1.7 Site Conditions

- .1 During storage and installation: Obtain and comply with North American Architectural Woodwork Standards 4.0 for optimum temperature and relative humidity conditions for woodwork during its storage and installation. Do not install woodwork until these conditions have been attained. Woodwork shall be acclimatized for a minimum of 72 hours prior to commencing woodwork installation.
- .2 During finishing: Comply with Architectural Woodwork Standard's temperature and humidity requirements before, during, and after application of finishes.
- .3 During service life of woodwork: Obtain and comply with woodwork manufacturer's advice for optimum temperature and humidity conditions.

1.8 Warranty

- .1 Warrant work of this section in accordance with Section 01 78 36.

PART 2 - PRODUCTS

2.1 Performance/Design Requirements

- .1 Casework integrity shall meet the minimum acceptance levels in accordance with SEFA 8-1999 as outlined in the North American Architectural Woodwork Standards 4.0 and additional or greater loading capacities as specified throughout the North American Architectural Woodwork Standards 4.0.
- .2 Maximum allowable adjustable shelf lengths shall comply with shelves assembly rules per the North American Architectural Woodwork Standards 4.0 based on shelf thickness indicated or scheduled.

2.2 Wood Materials

- .1 Lumber:
 - .1 Hardwood for concealed blocking and framing: Custom grade, any species that, when painted, will not show any defects.
 - .2 Hardwood for exposed blocking: species and grade to match panel veneer.
 - .3 Moisture content: *Provide* kiln-dried (KD) lumber with moisture content range between 6% to 12% for interior architectural woodwork. Maintain temperature and relative humidity during fabrication, storage and finishing operations so that moisture content values for woodwork at time of installation do not exceed 5% to 10%.

2.3 Panel Materials

- .1 Panel material schedule; except where indicated otherwise:
 - .1 Thickness: 19 mm (3/4") minimum.
 - .2 Core panels:
 - .1 At plastic laminate and melamine work: Particle board.
 - .2 Plywood backing; countertops, backsplashes, and where indicated: Exterior grade plywood with no added urea-formaldehyde used in composition.

Architectural Woodwork

- .3 Maximum moisture content at time of installation: 10% to 12%.
- .2 Plywood:
 - .1 Veneer core plywood non telegraphing grain: Sanded good one side or good two sides (when both sides exposed or to receive applied finish materials) plywood:
 - .1 Hardwood plywood: in accordance with ANSI/HPVA HP-1-2009.
 - .2 Softwood plywood: to US Plywood Standard APA PS-1-19 Structural Plywood (with Typical APA Trademarks).
 - .2 Fire rated plywood shall be pressure impregnated with fire-retardant chemicals in accordance with CAN/CSA O80 and have Flame Spread Value (FSV) of not more than 25 to CAN/ULC-S102-10.
- .3 Particleboard:
 - .1 In accordance with ANSI A208.1-2009, and as follows:
 - .1 Industrial grade:
 - .1 Fire retardant: M-S Medium density; between 640 - 800 kg/m³ (40 - 50 lb/ft³).
 - .2 Non fire retardant: M-3i Medium density; between 640 - 800 kg/m³ (40 - 50 lb/ft³).
 - .2 Formaldehyde emission: Maximum levels in accordance with ANSI A208.1-2009. No added urea-formaldehyde used in composition.

2.4 Plastic and Composite Materials

- .1 High pressure decorative laminate:
 - .1 General purpose grade: in accordance with ANSI/NEMA LD 3-2005, Horizontal General Purpose Grade (HGS).
 - .2 Colours, finishes, and patterns: In accordance with Finish Schedule.
- .2 Solid surfacing sheet:
 - .1 Homogenous (not coated, laminated or composite construction), filled material containing methyl methacrylate.
 - .1 Acceptable *Product*: Dupont 'Corian'.
 - .2 Nominal sheet thickness: 13 mm (1/2") minimum, unless otherwise indicated.
 - .3 Colour/pattern: In accordance with Finish Schedule.
 - .4 Substitutions: in accordance with Section 01 25 00.

2.5 Glass Materials

- .1 Glass: in accordance with Section 08 80 00.

2.6 Ballistic Panels

- .1 Acceptable *Product*:
 - .1 Amulet Ballistic Barriers 'Amulet 1 Ballistic Barrier'.

Architectural Woodwork

- .1 Non directional, panels installed horizontally or vertically.
- .2 Fasteners and adhesives: as recommended by panel manufacturer.
- .2 Substitutions in accordance with Section 01 25 00.

2.7 Fasteners and Adhesives

- .1 Fasteners shall comply with North American Architectural Woodwork Standards 4.0.
- .2 Adhesives: Shall be used for intended purpose and manufacturer materials applications and installation, applied in accordance with manufacturer's written requirements and shall comply with the "adhesive usage guidelines" recommendations of North American Architectural Woodwork Standards 4.0.

2.8 Hardware

- .1 Casework hardware; to be furnished and installed by the architectural woodwork manufacturer.
 - .1 Where casework hardware is not specified or indicated on drawings or scheduled, casework hardware shall comply with ANSI/BHMA Standards, latest edition, minimum grades, loading and other basic rules per the North American Architectural Woodwork Standards 4.0.
 - .2 General: Where finish hardware manufacturer is not designated, submit descriptive literature to Consultant of item and proposed manufacturer for acceptance, prior to placing order for supply.
- .2 Hardware:
 - .1 Hinges: Blum Modul 90 or approved alternative by Hettiche.
 - .2 Pulls: Hafele Cat. No. 116.09.617, Nickel matt with concealed fastening, 'D' style.
 - .3 Pilaster strips and recessed wall standards: recessed, slotted, nickel plated, complete with brackets/clips.
 - .4 Drawer Slides:
 - .1 Acceptable manufacturers:
 - .1 Knape & Vogt.
 - .2 Accuride
 - .2 Type 1: Regular duty; typical drawer slide: 100 lb, telescoping, full extension, on precision steel ball bearings, length to suit, unless otherwise indicated on drawings.
 - .5 Pilaster Strips: recessed, slotted, nickel plated typical, and stainless steel on open shelving and where noted on Drawings complete with brackets/clips.
 - .6 Heavy duty hinges: stainless steel five knuckle hinge, to CB179 (ANSI A8112), 89 mm x 89 mm.
 - .7 Aluminum bar grille: Price Industries 'Mandrel LBMH'.
 - .8 Grommets: Brushed nickel.
 - .9 Cable management system:

Architectural Woodwork

.10 Richelieu 'Wire Management Molding 512490'.

2.9 Finishes - Interior Architectural Woodwork

- .1 General: The entire finish of interior architectural woodwork is specified in this section, regardless of whether factory applied or applied after installation.
- .2 Preparations for finishing:
 - .1 Prior to finishing, exposed portions of woodwork shall have handling marks or effects of exposure to moisture removed with a thorough final sanding over surfaces of the exposed portions, using appropriate grit sandpaper, and shall be cleaned prior to applying sealer or finish. Sanding shall be completed just prior to stain or finishing application.
 - .2 Concealed surfaces of woodwork that might be exposed to moisture, such as those adjacent to exterior concrete or masonry walls, shall be back-primed.
 - .3 Comply with referenced quality standard in Part 1 for sanding, filling countersunk fasteners, sealing concealed surfaces and similar preparations for finishing of architectural woodwork, as applicable to each unit of work.

2.10 Fabrication

- .1 Fabricate woodwork to dimensions, profiles, and details indicated with openings and mortises pre-cut, where possible, to receive hardware and other items of work.
- .2 Complete fabrication, assembly, finishing, hardware application, and other work before shipment to maximum extent possible. Trial fit in shop and disassemble components only as necessary for shipment and installation. Where necessary, provide ample allowance for scribing, trimming, and fitting. Reassemble with concealed fasteners.
- .3 *Provide* woodwork, solid tops and other indicated materials with pre-cut openings, where possible, for hardware, appliances, plumbing fixtures, electrical work, telephone cut-outs and similar items. Locate openings accurately and *Provide* proper size and shape. Smooth edges of cut-outs and, where located in countertops, seal edges of cut-outs with a water-resistant coating.
- .4 *Provide* framing for architectural woodwork, complete with bracing and fastening devices as required for a rigid installation, and as required to sustain the imposed loads.
- .5 Reinforcing shown is minimum. *Provide* additional reinforcing as required to ensure a rigid assembly. Take responsibility for the stability of furniture and fitments.
- .6 *Provide* balancing sheets as required, and specified, complying with the North American Architectural Woodwork Standards 4.0.
- .7 *Provide* surface mount blocking and strapping necessary to support the work of this section. Such blocking shall not be exposed upon completion of work.
- .8 Prefinish work at the factory, except where specified or indicated otherwise.
- .9 Ballistic panels:
 - .1 Install ballistic panels in accordance with manufacturer's recommendations.
 - .2 Conceal ballistic panels within woodwork construction. For mechanical attachment, drill pilot holes prior to attaching.

Architectural Woodwork

- .3 At all horizontal or vertical seams or butt joints, install a 100 mm (4") wide batten strip of ballistic panel, attached directly to the substrate, providing minimum 50 mm (2") overlap from one panel to the next or on each side of the seam or butt joint.

2.11 Fabrication - Solid Surfacing

- .1 Fabricate components in shop to greatest extent practical to size and shape indicated, in accordance with reviewed shop drawings and manufacturer's written requirements.
- .2 Form joints between components using manufacturer's standard joint adhesive. Joints shall be inconspicuous in appearance and without voids. Attach 100 mm (4") wide solid surfacing material reinforcing strip under joints.
- .3 *Provide* holes and cut-outs as indicated or as required.
- .4 Rout and finish component edges to a smooth, uniform finish. Rout cut-outs then sand edges smooth. Repair or reject defective or inaccurate work.
- .5 Surfaces shall have a uniform finish.

PART 3- EXECUTION

3.1 Preparation

- .1 Condition woodwork to field conditions in installation areas before installing. Ensure that field conditions have been provided as requested and specified.
- .2 Before installing architectural woodwork, examine shop-fabricated work for completion and complete work as required, including back priming and removal of packing.
- .3 *Provide* grounds, nailers and other required fabrications which are to be built into other work when required.
- .4 Ensure that wall and ceiling variations are not in excess of 6.4 mm (1/4") in 3658 mm (144") and that floors are not in excess of 12.7 mm (1/2") in 3658 mm (144") of being plumb, level, flat, straight, square, of the correct size. Variations shall be corrected prior to installation of work of this section.
- .5 Report conditions contrary to requirements preventing proper installation. Do not proceed with the installation until unsatisfactory conditions have been corrected.

3.2 Installation

- .1 Install woodwork to comply with North American Architectural Woodwork Standards 4.0 for same grade specified in Part 1 of this section for type of woodwork involved.
- .2 Install woodwork plumb, level, true, and straight with no distortions.
- .3 Scribe and cut woodwork to fit adjoining work and refinish cut surfaces or repair damaged finish at cuts.
- .4 Anchor woodwork to anchors or blocking built in or directly attached to substrates. Secure to grounds, stripping and blocking with countersunk, concealed fasteners and blind nailing as required for a complete installation. Except where prefinished matching fastener heads are required, use fine finishing nails for exposed nailing, countersunk and filled flush with woodwork and matching final finish where transparent finish is indicated.

Architectural Woodwork

- .5 Complete the finishing work specified in this section to whatever extent not completed at shop or before installation of woodwork.

3.3 Installation - Tolerances

- .1 Install to a tolerance of 3 mm in 2400 mm (1/8" in 8'-0") for plumb and level (including tops) and with no variations in flushness of adjoining surfaces unless otherwise acceptable in accordance with the North American Architectural Woodwork Standards 4.0.

3.4 Adjusting and Cleaning

- .1 Repair damaged and defective woodwork where possible to eliminate defects functionally and visually; where not possible to repair, replace woodwork.
- .2 Clean, lubricate, and adjust hardware.
- .3 Clean woodwork on exposed and semi-exposed surfaces. Touch up factory-applied finishes to restore damaged or soiled areas.

3.5 Protection

- .1 Protect architectural woodwork during remainder of construction period to ensure that work will be without damage or deterioration at time of acceptance.
- .2 *Provide* final protection and maintain conditions, in a manner acceptable to manufacturer and installer, that ensure that woodwork is without damage or deterioration at time of *Substantial Performance of the Work*.

END OF SECTION

Joint Firestopping and Smoke Seals

PART 1- GENERAL

1.1 Summary

- .1 Section includes:
 - .1 Materials installed in joints to restrict the spread of fire and smoke.
 - .1 Joints in or between fire-resistance-rated constructions.
 - .2 Perimeter fire barrier systems between fire-rated floor/roof and non-rated exterior wall assembly.
 - .1 Coordinate perimeter fire barrier system installation requirements with work of curtain wall assemblies.
- .2 Section excludes:
 - .1 Firestopping and smoke seals, for mechanical, electrical and communications penetrations of fire resistant assemblies, and firestopping and smoke seals within their respective assemblies. Refer to Divisions 21, 22, and 23 and Divisions 26, 27, and 28.

1.2 Administrative Requirements

- .1 Coordination:
 - .1 Coordinate joint firestopping and smoke seal work with requirements specified under "Project Firestopping Manual and Coordination" heading in Section 01 33 00.
 - .2 Coordinate with other sections to assure that pipes, conduit, cable, and other items that penetrate fire rated construction, have been permanently installed prior to installation of firestop assemblies.
 - .3 Schedule the *Work* to assure that penetrations and other construction that conceals penetrations are not erected prior to the installation of firestop and smoke seals.
- .2 Conduct a pre-installation meeting in accordance with Section 01 31 19.
 - .1 Representatives for mechanical and electrical work shall attend pre-installation meeting.

1.3 Submittals

- .1 Submit required submittals in accordance with Section 01 33 00.
- .2 *Product* data sheets:
 - .1 Submit manufacturer's *Product* data sheets for *Products* proposed for use in the work of this section.
 - .2 *Product* data sheets shall include the following information:
 - .1 Data and installation instructions for *Products* providing descriptions sufficient for identification at the *Place of the Work*.

Joint Firestopping and Smoke Seals

- .2 Materials list of *Products* proposed for use in the work of this section; complying with listed systems designs.
 - .3 Listing agency's detailed drawing showing joint assemblies and firestopping materials, identified with listing agency's name and number or designation, fire rating achieved, and date of listing.
 - .4 Submit fire resistance rating test listings for firestopping and smoke seal systems.
- .3 Shop drawings:
- .1 Submit drawings indicating fire resistance rated assembly number, required temperature, hose stream, and flame rating, material thicknesses, installation methods and materials of firestopping and smoke seals, primers, supports, damming materials as applicable, reinforcements, anchorages, fastenings and methods of installation for each condition to be encountered.
 - .2 Designate on shop drawings static and dynamic joint systems, relative positions, expansion and control joints in rated slabs and walls, and firestopping details.
 - .3 Engineered shop drawings; for engineering judgements:
 - .1 Where *Project* conditions require modification to an accredited third party testing agency's listed system design to address a particular firestopping condition that is not covered by a listed system, submit engineered shop drawings detailing the modifications to the listed system design as an engineering judgment or equivalent fire-resistance-rated assembly, for each Project location and condition.
 - .2 Submit the manufacturer's engineering judgment identification number and shop drawing details prepared by a professional engineer. The engineering judgment submittal shall include *Project* name, *Project* location, and *Subcontractor's* name who will install firestop system as described in engineering judgement shop drawings.
 - .3 Provide complete details of specific application of listed system and its modifications upon which the engineered judgement is based upon.
- .4 Manufacturers' instructions:
- .1 Manufacturer of *Products* proposed for use in work of this section shall prepare firestopping manual scheduling products to be used for each assembly and installation required in the *Work*.
 - .1 Coordinate with project firestopping manual specified under Section 01 33 00.
 - .2 Manual shall include manufacturer's *Product* data sheets as specified under "*Product* data sheets" heading in Section 07 84 00.

1.4 Closeout Submittals

- .1 Submit closeout submittals in accordance with Section 01 78 00.
- .2 Submit the following for inclusion in the operation and maintenance manual:

Joint Firestopping and Smoke Seals

- .1 Letter signed by firestopping and smoke seal manufacturer on manufacturer's letterhead verifying that installed firestopping and smoke seal *Products* are suitable for the use indicated and comply with requirements of the *Contract Documents*.
- .2 Letter signed by firestopping and smoke seal installer on installer's letterhead verifying that joint firestopping system installations are completed and that installations comply with listed systems designs and requirements of the *Contract Documents*.

1.5 Quality Assurance

- .1 Qualifications:
 - .1 Execute the work of this section using workers skilled in the respective duties for which they are employed, and with minimum 3 years' experience in application of *Products*, systems, and assemblies specified. In addition:
 - .1 Installer shall be approved in writing by the firestopping manufacturer.
 - .2 Applicator shall designate a single individual as *Project* foreperson who shall be present at the *Place of the Work* at all times throughout the work of this section when the work of this section is being performed.

1.6 Warranty

- .1 Warrant work of this section in accordance with Section 01 78 36.
- .2 Extended warranty:
 - .1 Labour, materials, and workmanship for work of this section.
 - .2 Duration: 5 years from date of Substantial Performance.

PART 2 - PRODUCTS

2.1 Manufacturers

- .1 General: Manufacturers of firestopping and smoke seal system *Products* and installation specialists for the work of this section are limited to applicable assemblies as required for the *Work* and having listing mark on packaging.
- .2 Subject to compliance with requirements, provide products by one of the following:
 - .1 3M Canada Inc.
 - .2 Hilti Canada Corp.
 - .3 NUCO Inc.
 - .4 STI Firestop.
 - .5 Tremco Commercial Sealants & Waterproofing.

2.2 Performance/Design Requirements

- .1 Single source responsibility:

Joint Firestopping and Smoke Seals

- .1 Provide *Products* from one manufacturer for the work of this section, including accessory *Products* and materials.
 - .1 Where manufacturer does not manufacture or supply required accessory *Products* and materials, any such accessory *Products* or materials supplied for use in the Work shall have approval from manufacturer for use as part of the final warranted installation.
- .2 Firestop and smoke sealant systems shall consist of material, or combination of materials installed to retain integrity of fire-rated construction by effectively impeding spread of flame, smoke, and/or hot gasses through perimeter joint or gaps, construction joints, or at perimeter fire containment in or adjacent to fire-rated barriers.
- .3 Smoke sealants applied over firestopping materials or combination smoke seal/firestop seal material shall form air tight barriers to prevent passage of gas and smoke.
- .4 Fire-resistance rating of firestopping system shall be equivalent to rating of adjacent floor, wall or other fire separation assembly.
- .5 Firestopping system at fire rated assemblies with assembly STC rating requirements shall provide STC rating equal to STC rating of fire rated assembly.
- .6 Confirm locations of exposed/non-exposed firestopping/smoke seal surfaces with *Consultant* prior to application.
- .7 *Provide* movement capability at movement joints in accordance with design requirements for movement joint.
- .8 Head-of-wall joints; with dynamic designation:
 - .1 Joint assemblies shall permit vertical movement allowing wall to move independent of structure due to forces including, but not limited to, live loads, dead loads, thermal expansion/contraction, seismic movements, and wind sway. Such movement shall not damage the wall assembly or its fire protection components.
 - .1 Provide head-of-wall joints with dynamic designation.
 - .2 Seismic dynamic joints: Provide head-of-wall joints with dynamic designation to accommodate seismic movement. Seismic requirements in accordance with building code.
- .9 Regulatory requirements:
 - .1 Joint firestop systems shall be listed in accordance with CAN/ULC-S115-11 and shall achieve required fire resistance rating in accordance with building code.
 - .2 Joint firestop systems located between a horizontal floor and exterior wall shall be tested in accordance with ASTM E2307-15b and have a fire resistance rating no less than the fire-resistance rating of the horizontal fire separation.
 - .3 Proposed firestopping and smoke seal materials and methods shall conform to applicable governing codes having local jurisdiction.

2.3 Materials

- .1 Firestopping and smoke seal systems shall conform to the following:
 - .1 Have a VOC limit of 250 g/L maximum, unless otherwise specified.

Joint Firestopping and Smoke Seals

- .2 Asbestos-free materials and systems capable of maintaining an effective barrier against flame, smoke and gasses in compliance with requirements of CAN/ULC-S115-11 and not to exceed opening sizes for which they are intended.
- .3 *Provide* firestopping materials and systems with FT fire-resistance rating not less than the fire-resistance rating of applicable adjacent assembly.
- .4 Listed in accordance with CAN/ULC-S115-11.
- .5 Use only joint firestop systems that have been tested by an accredited third party testing agency for specific fire-rated construction conditions conforming to construction assembly type, joint type and fire-rating requirements for each separate instance.
 - .1 Where there is no specific third party tested and classified firestop system for a particular firestop configuration, submit engineered shop drawings.
- .6 For joints in fire-separations, provide listed systems designs for the joint firestop and smoke seal systems as required by building code to maintain the integrity of the fire separations.
- .7 *Products* shall be compatible with abutting dissimilar membranes, architectural coatings, finishes at floors, walls and ceilings. Check with requirements of *Contract Documents* and manufacturer of selected materials being installed.
- .2 Smoke sealants for overhead and vertical joints shall be non-sagging; sealants for floors shall be self-levelling.

PART 3- EXECUTION

3.1 Preparation

- .1 Examine sizes, anticipated movement and conditions to establish correct thickness and installation of back-up materials.
- .2 Prepare surfaces in accordance with manufacturer's written specifications and to requirements of listed system designs.

3.2 Installation

- .1 Install joint firestopping and smoke seal systems in accordance with manufacturer's written requirements and in compliance with listed system designs. Products and installation requirements must comply with listed system designs.
- .2 For materials that will remain exposed after completing the *Work*, finish to achieve smooth, uniform surfaces. Tool or trowel exposed surfaces.
- .3 Notify *Consultant* when random completed installations are ready for review, as directed by *Consultant*, prior to concealing or enclosing firestopping and as applicable, smoke seals.
- .4 Protect materials from damage on surfaces subjected to traffic.

3.3 Identification and Documentation

- .1 Provide documentation for each joint firestop system application addressed. This documentation is to identify each joint location on the entire Project.

Joint Firestopping and Smoke Seals

- .2 Provide labels of suitable material for permanent field identification of through-penetration firestops.
 - .1 Labels shall identify the following:
 - .1 'WARNING, FIRESTOP MATERIAL, DO NOT TAMPER OR REMOVE'.
 - .2 Sequential location number identified in documentation for installed firestop system.
 - .3 Installer's name and contact information in case of modification or new penetration of fire stop system.
 - .4 Date of installation.
 - .5 Through-penetration firestop system manufacturer's name.
 - .6 Firestop system hourly rating including applicable F and FT rating.
 - .7 Listed firestop system design number or engineered judgment number.
 - .2 Field fabricated labels are not acceptable.
- .3 Documentation for installed joint firestop systems is to include:
 - .1 Sequential location number.
 - .2 Project name.
 - .3 Date of installation.
 - .4 Detailed description of joint firestop system location.
 - .5 Listed firestop system design number or engineered judgment number.
 - .6 Type of joint.
 - .7 Width of joint.
 - .8 Overall length of joint.
 - .9 Number of sides addressed.
 - .10 Hourly rating of firestop joint system to be achieved.
 - .11 Installers name.

3.4 Field Quality Control

- .1 Conduct quality control to be in accordance with Section 01 45 00.
 - .1 Field tests and inspections:
 - .1 Examine completed firestop joint installations to ensure proper installation before concealing or enclosing areas. Keep areas of work accessible until inspections are completed.
 - .2 Inspection consultant to review installation of the work of this section and to perform random tests to verify its completion in accordance with the requirements of the *Contract Documents*.

Joint Firestopping and Smoke Seals

- .3 Give at least 48 hours notice before operations commence, and arrange for a pre-job conference with *Contractor*, installer, independent inspection and testing company, manufacturer, and *Consultant* present.
 - .4 Independent inspection and testing company shall examine installed firestopping in accordance with ASTM E2174-24 and ASTM E2393-24. Independent inspection and testing company shall examine firestopping and shall determine, in general, that firestopping has been installed in accordance with requirements of the *Contract Documents* and in compliance with each listed firestop system design.
 - .5 Representatives of the manufacturer(s) shall have access to the *Work*. *Contractor* shall provide assistance and facilities for such access in order that the manufacturer(s) representative(s) may properly perform its function.
- .2 Manufacturer's field review to be in accordance with Section 01 45 00.

END OF SECTION

Joint Sealants

PART 1- GENERAL

1.1 Summary

- .1 Section includes:
 - .1 Joint sealants – interior locations.
- .2 Section excludes:
 - .1 Glazing system assembly sealants.
 - .2 Fluid-applied flooring sealants.
 - .3 Mechanical and electrical sealants.
 - .4 Acoustic sealants.

1.2 Administrative Requirements

- .1 Conduct a pre-installation meeting in accordance with Section 01 31 19.
 - .1 The following items shall be addressed at the pre-installation meeting:
 - .1 Analysis of the work and weather conditions.
 - .2 Shape factor of the joint.
 - .3 Recommendations for priming joints.
 - .4 Inspection of surfaces and joints.
 - .5 Compatibility of materials.
 - .6 Backing materials.

1.3 Submittals

- .1 Submit required submittals in accordance with Section 01 33 00.
- .2 *Product* data sheets:
 - .1 Submit manufacturer's *Product* data sheets for *Products* proposed for use in the work of this section.
 - .2 Submit manufacturer's and *Product* name for each sealant which will be used in the *Work* prior to commencing the *Work*.
- .3 Samples:
 - .1 Submit sealant colour samples for each sealant *Product* and colour.
 - .2 Samples shall be custom fabricated for the *Work*, using substrates reflecting materials to be joined with sealants being sampled. Manufacturer's standard, prefabricated samples shall not be accepted.
- .4 Test and evaluation reports:
 - .1 Test sealant in contact with samples of materials to be sealed to verify adhesion will be achieved and no staining of the material will result. Prepare sample joints at the *Place of the Work* of each type of sealant for each joint condition.

Joint Sealants

- .1 Submit test results to *Consultant* prior to application of sealants.
- .2 Test sealant in contact with samples of porous materials to be sealed to ensure that no staining of the material will result in accordance with ASTM C1248-22.
- .1 Submit test results to *Consultant* prior to application of sealants.

1.4 Closeout Submittals

- .1 Submit closeout submittals in accordance with Section 01 78 00.
 - .1 Include manufacturer's warranties.
- .2 Maintenance instructions:
 - .1 Submit maintenance instructions for all items for incorporation into the operation and maintenance manuals.

1.5 Quality Assurance

- .1 Qualifications:
 - .1 Execute the work of this section using workers skilled in the respective duties for which they are employed, and with minimum 3 years' experience in application of *Products*, systems, and assemblies specified.

1.6 Warranty

- .1 Warrant work of this section in accordance with Section 01 78 36.

PART 2- PRODUCTS

2.1 Performance/Design Requirements

- .1 Interior sealants shall have a VOC limit of 50 g/L maximum, unless otherwise specified, and comply with South Coast Air Quality Management District (SCAQMD) Rule 1168, Adhesive and Sealant Applications.
- .2 Joint sealants:
 - .1 Shall perform as air tight and water-tight joints.
 - .2 Defects shall include, but are not limited to:
 - .1 Staining from abutting materials or filler.
 - .2 Migrating, bleeding into, or staining abutting materials.
 - .3 Unsightly surface deformation.
 - .4 Excessive colour change, chalking, or dust pick-up.
 - .5 Failing adhesively or cohesively where maximum elongation is less than 25% of designed width of exposed joints.
 - .6 Hardening to more than 25% over specified hardness.

2.2 Sealants

- .1 General:

Joint Sealants

- .1 Single source responsibility: Obtain joint sealant from a single manufacturer for each joint sealant type.
- .2 Colours: Sealant colours shall match colours of adjacent materials, as selected and approved by *Consultant*.
 - .1 Colours: shall be selected from manufacturer's full range of colours.
- .3 In accordance with ASTM C920-18 and other requirements indicated for each liquid-applied chemically curing sealant, including those referencing ASTM C920-18 classifications for type, grade, class, and uses.
- .4 For sealants to be applied to porous substrates:
 - .1 Provide products that have undergone testing in accordance with ASTM C1248-22 and have not stained porous joint substrates indicated for *Work*.
- .5 Sealant supplied shall not exude any material(s) which travel into adjacent materials, or travel onto surfaces of adjacent materials; causing damage, or attracting soiling, which becomes apparent during the service life of the building.
- .2 Interior general sealants:
 - .1 VOC limit: Maximum 50 g/L, unless otherwise indicated.
 - .2 Interior sealant; at joints with painted gypsum board: one-component paintable acrylic in accordance with ASTM C834-17 Type OP; or polyurethane in accordance with ASTM C920-18 Type S, Grade NS, Class 35.
 - .1 Acceptable *Products*:
 - .1 Acrylic sealants:
 - .1 Tremco, Inc. 'Tremflex 834'.
 - .2 Polyurethane sealants:
 - .1 Sika 'Sikaflex 1A'.
 - .3 Substitutions: in accordance with Section 01 25 00.
 - .3 Interior sealant; gap filler: at movement paintable joints in vertical surfaces: One-component polyurethane sealant in accordance with the following: ASTM C920-18, Type M or S, Grade NS, Class 25.
 - .1 Acceptable *Products*:
 - .1 Sika 'Sikaflex 15LM'.
 - .2 Substitutions: in accordance with Section 01 25 00.
 - .4 Interior sealant; at movement joints in vertical surfaces: one-component polyurethane sealant in accordance with the following: ASTM C920-18, Type M or S, Grade NS, Class 25.
 - .1 Acceptable *Products*:
 - .1 Sika 'Sikaflex NP 1'.
 - .2 Sika 'Sikaflex 15LM'.
 - .3 Tremco, Inc. 'Dymonic 100'.

Joint Sealants

.4 Substitutions: in accordance with Section 01 25 00.

.3 Specialty sealants:

.1 Interior sealant; mildew resistant one part silicone sealant; healthcare facilities: in accordance with FDA Regulation No. 21 CFR 177.2600, ASTM C920-18, Type S, Grade NS, Class 25, CAN/CGSB 19.22-M89.

.1 Acceptable *Products*:

.1 DOWSIL '786'.

.2 Substitutions: in accordance with Section 01 25 00.

2.3 Accessories

.1 General: *Provide* joint sealants, primers, backings, and fillers that are compatible with one another and with joint substrates and other sealants or joint fillers specified and approved for applications indicated under joint sealant scheduled and under conditions of service and application as demonstrated by joint sealant manufacturer based on proven test results and field experience. When incompatible, inform *Consultant* and change to compatible type acceptable to *Consultant*.

.2 Cylindrical sealant backings (backer rods): *Provide* joint backings that meet ASTM C1330-18, , sized 25 percent or greater than joint opening with proper density to control sealant depth and profile. Follow joint sealant manufacturer's recommendations with backing selections for optimum joint sealant performance, in accordance with the following schedule:

.1 Use ASTM C1330 Type O (open-cell polyurethane) or Type B (non-absorbent bi-cellular backing materials with surface skin) for vertical joints; round shape for open joints and triangular shape for angular joints.

.2 Use ASTM C1330 Type C (closed cell foam) for horizontal joints.

.3 Bond-breaker tape: Polyethylene tape or other approved plastic tape as recommended by joint sealant manufacturer to prevent 3-sided joint adhesion to rigid, inflexible joint fillers or joint surfaces at back of joint where such adhesion would restrict proper sealant movement or result in sealant failure.

.4 Masking tape: Non-staining, non-absorbent and compatible with joint sealants and adjacent surfaces.

.5 Sealant primers: Use primers only as recommended by sealant manufacturer where required to enhance adhesion of sealant to specific joint substrates indicated and as determined for use from pre-construction mock-up testing. Select primers in consultation with sealant manufacturer and manufacturer of substrate material which do not have a detrimental effect on sealant adhesion or in-service performance.

.6 Cleaners for nonporous surfaces:

.1 *Provide* non-staining, chemical cleaners of type which are acceptable to manufacturer of sealant and sealant backing material, which are not harmful to substrates and adjacent nonporous materials, and which do not leave oily residues or otherwise have a detrimental effect on sealant adhesion or in-service performance.

Joint Sealants

- .2 Provide cleaner conditioner required for glass and glazed surfaces as recommended by sealant manufacturer.

PART 3 - EXECUTION

3.1 Manufacturer's Recommendations

- .1 Unless specified otherwise herein, comply with the recommendations and directions of the manufacturer whose materials are being used in the work of this section.

3.2 Preparation

- .1 Protect adjacent work areas and finished surfaces from damage during joint sealant installation.
- .2 Clean and prepare joint surfaces and substrates in accordance with ASTM C1193-25 and outlined by joint sealant manufacturer's written requirements.
- .3 Prepare rusting or scaling surfaces using abrasive cleaning methods as recommended by joint sealant manufacturer prior to joint sealant installation. Remove and neutralize efflorescence, mould, mildew and algae prior to joint sealant installation.
- .4 Prepare finish-coated surfaces per joint sealant manufacturer's specific recommendations.
- .5 Test materials for indications of staining or poor adhesion before any sealing is commenced. Submit reports in writing to *Consultant* of results.
- .6 Do not proceed with installation of joint sealants under the following conditions:
 - .1 When ambient and substrate temperature conditions are outside limits permitted by joint sealant manufacturer, or are below 5°C (40°F).
 - .2 When joint substrates are wet.
 - .3 Where joint widths are less than those allowed by joint sealant manufacturer for applications indicated.
 - .4 Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

3.3 Masking

- .1 Where necessary to prevent contamination or marring surfaces of adjacent materials, mask areas adjacent to joints with masking tape prior to priming or sealing application. Remove tape immediately after joint has been completed and an initial set achieved.

3.4 Installation

- .1 Install in accordance with joint sealant manufacturer's installation written requirements for products, primers and applications indicated unless more stringent project-specific instructions or requirements apply.
- .2 Apply joint sealants for continuous waterproof sealant joint protection. Lap vertical joints over horizontal joints as recommended by sealant manufacturer. Comply with installation recommendations in ASTM C1193-25 for use of joint sealants as applicable to each specific sealant installation.

Joint Sealants

- .3 Install sealant primers only when recommended by sealant manufacturer and demonstrated at pre-construction tests after joint surface preparation has been completed and when surfaces are verified as clean and dry. Allow any primer installation to completely dry or cure prior to installation of backing or joint sealants. Primer is mandatory for gun applied sealants.
- .4 Install joint sealants using proven techniques that comply with the following and in proper sequence with installation of primers and backings.
 - .1 Using proper joint sealant dispensing equipment, place sealants by pushing sealant beads into opening to fully wet-out joint sealant substrates. Fill sealant joint opening to full and proper configuration.
 - .2 *Provide* uniform cross-sectional shapes and depths in relation to joint width for optimum sealant movement capability per joint sealant manufacturer's written requirements.
- .5 Joint sealant tooling is required for non-sag joint sealant installations. Immediately after placing fresh sealants and before skinning or curing begins, tool sealants using metal spatulas designed for this purpose in accordance with manufacturer's recommendations. Provide a smooth, uniform sealant finish, eliminating air pockets and ensuring good contact for optimum sealant adhesion within each side of the joint opening.
 - .1 Provide concave joint configuration as indicated per figure 5-A in ASTM C1193-25 unless otherwise indicated.
 - .2 Use tooling agents that are approved in writing by sealant manufacturer and that do not discolour sealants or adjacent surfaces.
 - .3 Remove excess sealant from surfaces adjacent to joint openings using metal spatula, promptly cleaning any sealant residue from adjacent finished surfaces. Remove masking after joint sealant is installed.
- .6 Allow single-component sealants to fully cure before adhesion testing is performed as recommended by joint sealant manufacturer.
- .7 Match approved sealant mock-up for colour, finish and overall aesthetics. Remove, refinish or re-install work not in compliance with the *Contract Documents*.
- .8 When surfaces of adjacent materials are to be painted, perform sealant work before these surfaces are painted.
- .9 Check form release agent used on concrete for compatibility with primer and sealant. If they are incompatible inform *Consultant* and change primer and sealant to compatible type, or clean concrete to sealant manufacturer's acceptance.
- .10 Install joint backing material, filler strips, gaskets, bond breakers and similar type material of comparable performance characteristics. Install bond breaker tape or packing over asphalt impregnated fibre board as recommended by sealant manufacturer.
- .11 Where joints are 12.7 mm (1/2") or deeper, insert backing material in continuous uniform compression with setback from finished face of adjoining materials equal to required depth of sealant (width/depth ratio) as specified herein.
- .12 On horizontal traffic surfaces, support joint filler against vertical movement which might result from traffic loads, including foot traffic.

Joint Sealants

- .13 Install bond breaker tape in bottom of joints in lieu of sealant backing where proper depth cannot be obtained when backing is installed.
- .14 Maintain correct sealant depth. Sealant depth shall be 1/2 the width of the joint, maximum depth shall be 12.7 mm (1/2"), minimum depth shall be 6 mm (1/4"). Comply with manufacturer's written recommendations.
- .15 Fillet bead sealant joints to be sized to provide proper contact area with substrates, in accordance with manufacturer's written recommendations.
- .16 Apply sealants using pressure-operated guns fitted with suitable nozzles in accordance with manufacturer's directions. Apply sealants in such manner as to ensure good adhesion to sides of joints and to completely fill voids in joints.
- .17 Apply sealants so that surfaces of joints are smooth, full bead, free from ridges, wrinkles, sags, air pockets and embedded impurities. Tool sealant surfaces to produce a smooth surface.
- .18 Install sealant with exterior face of sealant set back 10 mm (3/8") from face of adjacent materials at building movement joints, unless otherwise indicated.
- .19 Do not apply sealants to areas where installation of paints, coatings or flooring is in progress. Apply sealants after such work is complete and fully cured.

3.5 Interior Sealant Schedule

- .1 Include in work of this section sealants to seal open joints in surfaces exposed to view, and to make building weather-tight and air-tight, as applicable, as indicated, and as otherwise specified, except where specified under the work of other sections.
- .2 Install sealant to:
 - .1 Movement and control joints on exposed insitu concrete walls.
 - .2 Interior control and expansion joints in floor and wall surfaces.
 - .3 Raked out joints at junctions of masonry with concrete walls and columns, and at intersection of masonry walls and partitions where joint reinforcement is installed.
 - .4 Perimeters of exterior and interior door and window frames.
 - .5 Joints at tops of non-load bearing masonry walls at the underside of insitu concrete.
 - .6 Exposed interior control joints in gypsum board.
 - .7 Millwork junctions with walls.
 - .8 Floor finishes.
- .3 Mildew resistant sealant:
 - .1 Perimeter joints of wet fixtures such as:
 - .1 Sinks
 - .2 Showers.
 - .2 Counter/wall junctions at countertops.
 - .3 At wet areas not listed above.

Joint Sealants

3.6 Field Quality Control

- .1 Conduct quality control in accordance with Section 01 45 00.
 - .1 Inspection and testing:
 - .1 Field-adhesion testing: Installer to keep daily log of sealant installation recording self-performed field-adhesion test at each elevation of the project and as follows:
 - .1 Record field adhesion testing on digital video camera and submit to *Consultant*.
 - .2 Document and perform field adhesion testing in accordance with manufacturer's recommended field-adhesion requirements and submit written reports co-signed by sealant manufacturer's representative. Coordinate with Section 01 45 00.
 - .3 Perform 5 field adhesion tests for the first 300 m (1000 lineal feet) and one test in each 300 m (1000 lineal feet) of sealant joint length thereafter. One (1) test per floor height and per elevation is also recommended. When the sealant is used to weatherseal between 2 dissimilar substrates, the sealant adhesion to each side of the joint should be individually tested.
 - .4 Field test joint sealants in accordance with ASTM C1521-19(2025) Destructive Procedure (Method A) and in compliance with manufacturer's specific recommendations.
 - .5 Evaluation: In compliance with joint sealant manufacturer, joint sealants tested and not indicating adhesive failure within the substrates are considered satisfactory results. For joint sealants that fail to adhere to the substrate, clean, re-install and then re-test until satisfactory results are obtained.

3.7 Adjusting and Cleaning

- .1 Remove droppings and clean off excess sealant or sealant residue adjacent to sealant joint installations as the work progresses by methods approved by joint sealant manufacturer before material achieves initial set.
- .2 Do not damage adjacent surfaces with harmful removal techniques and protect finished surfaces beyond those that have been masked.
- .3 Remove and replace damaged joint sealants.
- .4 Remove temporary coverings and masking protection from adjacent work areas upon completion.

3.8 Protection

- .1 Protect installed sealants during and after final curing from damage resulting during construction.

END OF SECTION

Steel Doors and Frames

PART 1- GENERAL

1.1 Summary

- .1 Section includes:
 - .1 Hollow metal doors and panels (steel doors).
 - .2 Metal frames (steel frames, transom frames).

1.2 Administrative Requirements

- .1 Coordination:
 - .1 Cooperate fully with finish hardware distributor's representative during preparation of shop drawings and execution of shop fabrication.
 - .2 Coordinate installation of doors and frames with installation of hardware specified in Section 08 71 00.
- .2 Conduct a pre-installation meeting in accordance with Section 01 31 19.

1.3 Submittals

- .1 Submit required submittals in accordance with Section 01 33 00.
- .2 Submit copy of NAAMM-HMMA 840-24 standard.
- .3 *Product* data sheets:
 - .1 Submit manufacturer's *Product* data sheets for *Products* proposed for use in the work of this section.
- .4 Shop drawings:
 - .1 Include details of each door and frame type, finish hardware types and locations, frame profiles, door and frame elevations, mitre details, fire protection rating, glazing preparation details and anchor details and locations.
 - .2 Include schedule identifying each unit, with door marks and numbers relating to numbering on drawings and in door schedule.
 - .3 Electrified hardware requirements and preparations shall be clearly indicated on shop drawings.

1.4 Quality Assurance

- .1 Qualifications:
 - .1 Manufacturers:
 - .1 *Provide* doors and frames manufactured by a firm specializing in the design and production of hollow metal steel doors and frames.
 - .2 Manufacturer shall be a member in good standing of the Canadian Steel Door Manufacturers Association (CSDMA).

Steel Doors and Frames

1.5 Product Handling

- .1 Product handling shall be in accordance with Section 01 60 00 as supplemented by the requirements of this section.
- .2 Product handling shall be in accordance with CSDMA Guide Specification for Installation and Storage of Hollow Metal Doors and Frames.

1.6 Warranty

- .1 Warrant work of this section in accordance with Section 01 78 36.
- .2 Extended warranties:
 - .1 System:
 - .1 Labour, materials, and workmanship for work of this section.
 - .2 The warranty is a total system warranty, and includes hardware, sealants, hanging and fitting, and finishing.
 - .3 Duration: 2 years.
 - .2 Glass and glazing: in accordance with Section 08 80 00.
 - .3 Manufacturer's limited warranty:
 - .1 10 year warranty for finish adhesion and rust penetration.

PART 2 - PRODUCTS

2.1 Manufacturers

- .1 Baron Steel Doors & Frames.
- .2 Fleming- Door Products.

2.2 Performance/Design Requirements

- .1 Fire rating requirements:
 - .1 Fire rated labelled doors and frames: tested in accordance with CAN/ULC-S104-15 and listed by a nationally recognized agency having a factory inspection service and shall be constructed as detailed in Follow-Up Service Procedures/Factory Inspection Manuals issued by listing agency to individual manufacturers.
 - .2 Install fire labelled steel door and frame products in accordance with NFPA 80-2013, except where indicated otherwise.
- .2 Doors and frames shall function as intended, including but not limited to:
 - .1 Be in true alignment.
 - .2 Operate and swing freely, smoothly, and easily.
 - .3 Remain stationary at any point.
 - .4 Close evenly and tightly against stops without binding.
 - .5 Latch positively when doors are closed with moderate force.

Steel Doors and Frames

2.3 Materials

.1 Steel:

- .1 Fabricated from tensioned levelled steel in accordance with ASTM A924/A924M-22a, galvanized in accordance with ASTM A653/A653M-18, Commercial Steel CS, Type B.
- .2 Steel shall be free of scale, pitting, coil breaks, surface blemishes, buckles, waves, and other defects.
- .3 Minimum sheet thickness; uncoated steel sheet: in accordance with Appendix 1 of ANSI/NAAMM HMMA 861-14 "Guide Specifications for Commercial Hollow Metal Doors and Frames".
- .4 Finish: Minimum Galvanneal coating designation ZF120 (A40).

.2 Door core materials:

- .1 Honeycomb: Structural small cell 25 mm (1") maximum kraft paper 'honeycomb'. Weight: 36.3 kg (80 lb) per ream (minimum). Density: 16.5 kg/m³ (1.03 pcf) minimum, sanded to required thickness.
- .2 Temperature Rise Rated (TRR): Solid slab core of non-combustible, inorganic composite to limit temperature rise on the "unexposed" side of door to 250°C at 60 Minutes in accordance with CAN/ULC-S104-15, ASTM E2074-00e1 or NFPA 252-2022.

.3 Adhesives:

- .1 Heat resistant, single component, polyurethane reactive (water) hot melt, thermoset adhesive.
- .2 Lock seam doors: fire resistant, resin reinforced polychloroprene, high viscosity sealant-adhesive.

.4 Primer: rust inhibitive for touch-up.

.5 Finishing hardware: in accordance with Section 08 71 00.

.6 Miscellaneous:

- .1 Door silencers: single stud rubber or neoprene type.
- .2 Vision frame light kits for doors:
 - .1 Accurately fitted, mitred at corners and fastened to frame opening with counter-sunk oval head sheet metal screws. Locate exposed fasteners to glazing face as directed by *Consultant*.
 - .2 Finish:
 - .1 Primed.
 - .3 Acceptable *Product*:
 - .1 NGP 'Anemostat LoPro' Metal Vision Frame.
 - .2 Air Louver 'VSL Slimline' Metal Vision Frame.

Steel Doors and Frames

2.4 Fabrication - General

- .1 Fabricate steel doors, frames, transoms, sidelights and borrowed lights as applicable, to the design and dimensions indicated. Take field measurements where coordination with adjoining work is necessary.
- .2 Fabricate steel doors and frames to be rigid, neat in appearance and free from defects, warp, wave or buckle with all corners square unless otherwise indicated.
- .3 Operating clearances:
 - .1 Clearance at floor: make allowance for indicated finish flooring materials.
 - .2 Clearances for Fire-Rated Doors: As required by NFPA 80-2013.
 - .3 Clearances for Non-Fire-Rated Doors: Not more than 3 mm (1/8") at jambs and heads, except not more than 6 mm (1/4") between pairs of doors. Not more than 19 mm (3/4") at bottom.
- .4 Drill and tap or reinforce for mortised or surface mounted hardware in accordance with accepted hardware schedule, CSDMA, "Recommended Specifications for Commercial Steel Doors and Frames", NFPA 80-2013, or manufacturers recommendations.
- .5 Countersink exposed fasteners unless otherwise shown. Use flat or oval head screws.
- .6 Reinforce components to resist stresses imposed by hardware in use.
- .7 Allow for anticipated expansion and contraction of frames and supports.
- .8 Fit elements at intersections and joints accurately together, in true planes, and plumb and level.
- .9 Weld frame assemblies together. Weld continuously at joints exposed to view or at joints through which air or water could penetrate from the exterior of building to the interior.
- .10 Perform welding in accordance with CSA W59-24.
- .11 Mortise, reinforce, drill and tap to receive hardware and security devices using templates provided by respective *Supplier*.
- .12 Touch up finish damaged during fabrication.
- .13 Prepare doors or frames to receive seals where seals are indicated.
- .14 Attach labels to suit required fire-protection and temperature rise ratings.
- .15 Top and bottom void; for clean room doors: Space between bottom of door faces and between top of door faces shall be filled with brake formed sheet metal to achieve a flat smooth transition from vertical to horizontal surface. Metal/metal joints shall be tack welded every 100 mm (4") and filled with body filler and sanded smooth.

2.5 Fabrication - Steel Doors and Panels

- .1 Fabricate steel doors and panels to a thickness of 45 mm (1-3/4"), unless indicated otherwise.
- .2 Interior and non-insulated doors and panels:
 - .1 Face sheets fabricated from 1.06 mm (0.042") (18 gauge) steel.
 - .2 Honeycomb core.

Steel Doors and Frames

- .3 Longitudinal edges mechanically interlocked.
 - .1 Tack welded at top and bottom of door, 150 mm (6") on centre, and above and below each edge cutout, filled and ground smooth with no visible seams.
- .4 Top and bottom of clean room doors shall be provided with 16 gauge continuous flush steel non-removable door cap welded securely in place to achieve a flat smooth transition.
- .3 Temperature rise rated doors and panels:
 - .1 Face sheets fabricated from 1.06 mm (0.042") (18 gauge) steel.
 - .2 TRR asbestos free core.
 - .3 Longitudinal edges mechanically interlocked.
 - .1 Tack welded at top and bottom of door, 150 mm (6") on centre, and above and below each edge cutout, filled and ground smooth with no visible seams.
- .4 Fabricate of composite metal face construction with each face formed from flush sheet steel without visible seams, free of scale, pitting, coil brakes, buckles and waves.
- .5 Formed edges shall be true and straight with minimum radius for the thickness of steel used.
- .6 Lock and hinge edges shall be bevelled 3 mm in 50 mm (1/8" in 2") unless hardware or door swing dictates otherwise.
- .7 Top and bottom of doors shall be provided with inverted, recessed, 1.34 mm (0.053") (16 gauge) steel end channels, welded to each face sheet at 50 mm (2") on centre maximum.
- .8 Prior to shipment, mark each door with an identification number as shown on the approved submittal drawings.
- .9 Blank, reinforce, drill and tap doors for mortised, templated hardware. Locate hardware to manufacturer's standard unless indicated otherwise.
- .10 Holes 12.7 mm (1/2") and larger shall be factory prepared.
- .11 Glazing:
 - .1 For glazing use vision frame light kits as specified above.
 - .2 Glazing trim and stops shall be accurately fitted (within 0.39 mm (0.015") tolerance), butted at corners, with removable glazing stops located on the 'push' side of the door.

2.6 Fabrication - Steel Frames

- .1 General: Applicable to frames, transom panel frames, sidelights, and window assemblies.
- .2 Interior and non-thermally broken frames; welded:
 - .1 Fabricated from:
 - .1 1.34 mm (0.053") (16 gauge) steel.
 - .2 Supplied set-up and welded (SUW).
- .3 Factory assembled frame product shall be square, free of defects, warps or buckles.

Steel Doors and Frames

- .4 Set-up and welded corner joints (SUW):
 - .1 Profile welded–punch mitred, continuously welded on inside of the profile faces, rabbets, returns and soffit intersections, with exposed faces filled and ground to a smooth, uniform seamless surface, as defined in the CSDMA - “Recommended Specifications for Commercial Steel Door and Frame Products”.
- .5 Set-up and welded joints at mullions, sills and center rails:
 - .1 Coped accurately, butted and tightly fitted.
 - .2 At intersecting flush profile faces, securely weld, fill and grind to flush, smooth, uniform, seamless surface.
 - .3 At intersecting recessed profile faces, securely weld to concealed reinforcements, with exposed hairline face seams.
 - .4 At other intersecting profile elements make exposed face seams to hairline tolerance.
- .6 Where required due to site access, when required for co-ordination or installation, or shipping limitations, frame product shall be fabricated in sections for splicing in the field.
 - .1 Field spliced jambs, heads and sills shall be provided with 1.34 mm (0.053") (16 gauge) steel splice plates securely welded into one section, extending 100 mm (4") minimum each side of splice joint.
 - .2 Field splices at closed sections (mullions or center rails) shall be 1.34 mm (0.053") (16 gauge) steel splice angles securely welded to the abutting member. Face of splice angle shall extend 100 mm (4") minimum into closed sections when assembled.
 - .3 Field splice joints shall be welded, filled and ground to present a smooth uniform surface by the installation company responsible for installation after assembly.
- .7 On factory assembled frame product, provide 2 temporary steel shipping bars welded to the base of the jambs or mullions to maintain alignment during shipping and handling. Remove shipping bars prior to anchoring of frames to floor.
- .8 Each door opening shall be prepared for single stud door silencers. Silencers shall be shipped loose for installation by installer, after finish painting.
 - .1 Single interior doors: 3 at strike jamb.
 - .2 Pair of interior doors: 2 at header.
 - .3 Weather-stripped doors: none required.
 - .4 Sound, light, or smoke sealed doors: None required.
- .9 Prior to shipment, mark each frame with an identification number as shown on the approved submittal drawings.
- .10 Provide mullions and transom bars of closed construction type. For fixed condition, attach members to frame with butt-welded joints. For removable condition, attach members with removable mullion anchors.
- .11 Conceal fastenings unless otherwise indicated.

Steel Doors and Frames

- .12 Anchor frames to floor by 1.34 mm (0.053") (16 gauge) thick angle clips, welded to frame and *Provide* with 2 holes for floor anchorage.
- .13 Grind welded corners to a flat plane, fill with metallic paste filler and sand to uniform smooth finish.
- .14 Protect strike and hinge reinforcements using guard boxes welded to frames at masonry construction.
- .15 Reinforce head of frames wider than 1220 mm (48").
- .16 Brace frame units to prevent distortion in shipment and protect finish.

2.7 Hardware Reinforcements and Preparations

- .1 Door and frame product shall be blanked, reinforced, drilled and tapped at the factory for fully templated mortise hardware only, in accordance with the approved hardware schedule and templates provided by the hardware supplier.
- .2 Door and frame products shall be factory blanked and reinforced only for mortised hardware that is not fully templated.
- .3 Where surface mounted hardware, anchor hinges, thrust pivots, pivot reinforced hinges, or non-templated hardware are required frame product shall be reinforced only, with drilling and tapping done by field installation.
- .4 Templated holes 12.7 mm (1/2") diameter and larger shall be factory prepared, except mounting and through bolt holes, which shall be by installation on site. Templated holes less than 12.7 mm (1/2") diameter shall be factory prepared only when required for the function of the device (for knobs, levers, cylinders, thumb or turn pieces) or when these holes over-lap function holes.
- .5 Hinge reinforcements shall be 3.12 mm (0.123") (10 gauge) steel minimum, high frequency type shall be provided.
- .6 Frames shall be prepared for 114 mm (4.5") standard weight hinges minimum unless otherwise indicated.
- .7 Doors and frames in excess of 2450 mm (96") rabbet height shall be prepared for 114 mm (4.5") heavy weight 4.6 mm (0.180") hinges minimum.
- .8 Lock, strike and flush bolt reinforcements shall be 1.34 mm (0.053") (16 gauge) steel minimum, with extruded tapped holes that provide equivalent number of threads as 2.36 mm (0.093") (12 gauge).
- .9 Reinforcements for surface mounted hardware, concealed closers and holders and flush bolts shall be 1.06 mm (0.042") (18 gauge) steel minimum.
- .10 Reinforcements are not required for surface applied hardware supplied with thru-bolts and spacers or sex-bolts.
- .11 Provide hardware mortises on perimeter frame members to be grouted in masonry or concrete partitions with 0.66 mm (0.026") (22 gauge) steel grout guards.
- .12 Electrified hardware:

Steel Doors and Frames

- .1 Where electrically or electronically operated hardware is specified on the schedules or details or the final approved schedule and templates provided by the hardware supplier, hardware enclosures and/or junction boxes, where indicated on the templates, shall be provided and inter-connected with CSA approved 12.7 mm (1/2") diameter conduit and connectors.
- .2 Refer to electrical documents for general electrical rough-in details. At door locations indicated in electrical documents as requiring rough-in only of electrical (ie. where no electrically or electronically operated hardware is specified in the hardware schedule), provide enclosures, boxes, and conduit to permit future installation of devices without removal of grout, demounting of frames, or installation of exposed conduits.
- .3 Frames:
 - .1 Frames with electrified devices shall include electrical connection boxes sized to accommodate devices specified in Section 08 71 00. At time of frame manufacture, electrical connection boxes shall be supplied by Divisions 26, 27, and 28 for installation into frame by work of this section.
 - .2 Frame electrical connection boxes shall be positioned flush to edge of frame face return. Clearance shall be maintained to allow wall material to be consistently applied for length of frame member. Frame connection boxes shall be welded in place and positioned to allow necessary clearance for electrical trade to install conduit and connection components, with conduit layout in a manner that takes conduit up to ceiling in an uninterrupted configuration and to accommodate wire installation.
- .4 Doors:
 - .1 Doors with electrified devices shall be manufactured to include wire raceway in door panel to accommodate electrified devices, such as electric hinge, power transfer units, electrified locks, electrified door closures and electrified exit devices. Construction of raceways shall provide a continuous conduit or channel between entry and exit points to accommodate wire installation after door manufacture.
 - .2 Doors with electrified locks may require extended space to accommodate plug-type connection components or wire collection space. Coordinate with work of Section 08 71 00 and obtain hardware templates for electrified hardware clearly indicated on reviewed shop drawings and prior to door manufacture.

2.8 Frame Anchorage

- .1 Frame products shall be provided with anchorage appropriate to floor, wall and frame construction.
- .2 Each wall anchor shall be located immediately above or below each hinge reinforcement on the hinge jamb and directly opposite on the strike jamb.
- .3 Frame products for installation in new masonry walls shall be provided with steel adjustable wall anchors of the T-strap, stirrup or wire, 1.34 mm (0.053") (16 gauge) minimum or 3.96 mm (0.156") diameter wire. Straps shall be not less than 50 mm (2") x 254 mm (10") in size, corrugated and/or perforated.

Steel Doors and Frames

- .4 Frame products installed in steel stud and gypsum board partitions shall be provided with 0.81 mm (0.032") (20 gauge) steel snap-in or "Z" stud type anchors.
- .5 Jamb of frames in previously placed concrete, masonry or structural steel shall be punched and dimpled to accept machine bolt anchors, 6.4 mm (1/4") diameter, located not more than 150 mm (6") from the top and bottom of each jamb. Anchor preparations and guides shall also be located immediately above or below the intermediate hinge reinforcing and directly opposite on the strike jamb. Each preparation shall be provided with 1.34 mm (0.053") (16 gauge) anchor bolt guides.
- .6 Anchor bolts and expansion shell anchors for the above preparations shall be provided by the installation company.
- .7 Where frame product is installed prior to construction of the adjacent wall, each jamb shall be provided with 1.34 mm (0.053") (16 gauge) steel floor anchors. Each anchor shall be provided with 2 holes for mounting to the floor and shall be securely welded to the inside of the jamb profile.
- .8 On sidelights or windows exceeding 3 m (9'-10") in width, installed in stud partitions, channel extensions shall be provided from the top of the frame assembly to the underside of the structure above. Extensions shall be fabricated from 2.36 mm (0.093") (12 gauge) steel formed channels, mounting angles and adjusting brackets, with mounting angles welded to the inside of frame head. Formed channels, adjusting brackets and fasteners shall be shipped loose. Channels shall be mechanically connected to mounting angles and adjusting brackets with supplied fasteners, on site, by contractor responsible for installation.

2.9 Sizes and Tolerances

- .1 Widths of door openings shall be measured from inside of frame jamb rabbet with a tolerance of ± 1.6 mm (± 0.063 ").
- .2 Heights of door openings shall be measured from the finished floor (exclusive of floor coverings) to the head rabbet of the frame with a tolerance of ± 1.2 mm (± 0.047 ").
- .3 Unless finishing hardware dictates otherwise, doors shall be sized so as to fit the above openings and allow a 3 mm (1/8") clearance at jambs and head. A clearance of 19 mm (3/4") between the bottom of the door and the finished floor (exclusive of floor coverings) shall be provided. Tolerances on door sizes shall be ± 1.2 mm (± 0.047 ").
- .4 Manufacturing tolerances on formed frame profiles shall be ± 0.8 mm (± 0.031 ") for faces, door stop heights and jamb depths. Tolerances for throat openings and door rabbets shall be ± 1.6 mm (± 0.063 ") and ± 0.4 mm (± 0.016 ") respectively. Hardware cut-out dimensions shall be as per template dimensions, ± 0.4 mm (± 0.015 ").

2.10 Hardware Locations

- .1 Hardware preparations in frame product shall be as noted below and locations on doors shall be adjusted for clearances specified under "Sizes and Tolerances" heading in Section 08 11 13.

Steel Doors and Frames

- .2 Top of upper hinge preparation for 114.3 mm (4.5") hinges shall be located 180 mm (7.5") down from head, transom mullion or panel as appropriate. The top of the bottom hinge preparation for 114.3 mm (4.5") hinges shall be located 310 mm (12.625") from finished floor as defined under "Sizes and Tolerances" heading in Section 08 11 13. Intermediate hinge preparations shall be spaced equally between top and bottom cutouts.
- .3 Strike preparations for unit, integral, cylindrical and mortise locks and roller latches shall be centered 1033 mm (40-5/16") from finished floor. Strikes for deadlocks shall be centered at 1220 mm (48") from finished floor. Strikes for panic or fire exit hardware shall be located as per device manufacturer's templates.
- .4 Push and/or pulls on doors shall be centered 1070 mm (42") from finished floor.
- .5 Preparations not noted above shall be as per hardware manufacturer's templates.
- .6 Hardware preparation tolerances shall be in accordance with CSDMA, "Recommended Specifications for Commercial Steel Doors and Frames".

PART 3 - EXECUTION

3.1 Examination

- .1 *Provide* necessary grounds, bracing and strapping for fitting and adequate for securing of the work.
- .2 Cooperate with work of other sections to ensure fastenings set by others are provided and located, their work is installed to their specifications and that those responsible for back priming are notified in sufficient time for them to schedule work.

3.2 Installation - Steel Doors and Frames

- .1 Set frame product plumb, square, aligned, without twist at correct elevation in accordance with NAAMM-HMMA 840-24, maintaining clearances and hardware locations specified in Section 08 11 13.
- .2 Fire labelled product shall be installed in accordance with NFPA 80-2013.
- .3 Frame product installation tolerances:
 - .1 Plumbness tolerance, measured through a line from the intersecting corner of vertical members and the head to the floor, shall be ± 1.6 mm ($\pm 1/16$ ").
 - .2 Squareness tolerance, measured through a line 90° from one jamb at the upper corner of the product, to the opposite jamb, shall be ± 1.6 mm ($\pm 1/16$ ").
 - .3 Alignment tolerance, measured on jambs, through a horizontal line parallel to the plane of the wall, shall be ± 1.6 mm ($\pm 1/16$ ").
 - .4 Twist tolerance, measured at face corners of jambs, on parallel lines perpendicular to the plane of the wall, shall be ± 1.6 mm ($\pm 1/16$ ").
- .4 Brace frame product rigidly in position while building-in. Remove temporary steel shipping jamb spreaders. Install temporary wood spreaders at mid-point of frame rabbet height to maintain frame widths. Remove wood spreaders after product has been built-in.
- .5 Provide vertical support at center of head for openings exceeding 1250 mm (48") in width.
- .6 Secure anchorages and connections to adjacent construction.

Steel Doors and Frames

- .7 Adjust operable parts for correct clearances and function.
- .8 Steel surfaces shall be kept free of grout, tar or other bonding materials or sealers.
- .9 Remove grout or other bonding material from products immediately following installation.
- .10 *Provide* appropriate anchorage for floor and wall construction. Each wall anchor shall be located immediately above or below each hinge reinforcement on the hinge jamb and directly opposite the strike jamb. On each jamb, install 2 anchors for openings up to and including 1525 mm (60") high and install 1 anchor for each additional height of 760 mm (30") of height or fraction thereof, except as indicated below. Frames placed in previously placed concrete, masonry or structural steel shall be *Provided* with anchors located not more than 150 mm (6") from top and bottom of each jamb, and intermediate anchors at 660 mm (26") on centre maximum.
- .11 Secure frames set in previously constructed concrete or masonry openings by countersunk expansion bolts at same centres as for adjustable Tee wall anchors. Reinforce frame at fastening location to prevent indentation of frame by fastening device.
- .12 Fill and grind smooth "punch and dimpled" frame installations.
- .13 Prior to site touch-up, exposed surfaces of galvanneal steel to be finished shall be cleaned to remove foreign matter. Refer to paint manufacturers recommendations for additional information and requirements of Section 09 91 00.
- .14 Touch-up exposed field welds shall be finished to present a smooth uniform surface and with a rust inhibitive primer.
- .15 Touch-up exposed surfaces that have been scratched or otherwise marred during shipment, installation, and handling shall be with a rust inhibitive primer.
- .16 Finish paint in accordance with Section 09 91 00.
- .17 Install door silencers.
- .18 Properly fasten units and secure in place with concealed fixings wherever possible. Include grounds and furring where required.
- .19 Make allowance for deflection to ensure structural loads are not transmitted to frames.
- .20 Adjust operable parts for correct clearances and function.

3.3 Installation - Finishing Hardware

- .1 Install finishing hardware in accordance with CSDMA, "Recommended Specifications for Commercial Steel Doors and Frames", manufacturers' templates and instructions, and Section 08 71 00.

3.4 Adjusting and Cleaning

- .1 Adjust doors to swing freely, smoothly and easily, to remain stationary at any point, to close evenly and tightly against stops without binding, and to latch positively when doors are closed with moderate force.
- .2 Adjust hardware so that latches and locks operate smoothly and without binding, and closers act positively with the least possible resistance in use. Lubricate hardware if required by *Supplier's* requirements.

Steel Doors and Frames

- .3 Adjust doors equipped with closers to close doors firmly against anticipated wind and building air pressure, and to enable doors to be readily opened as suitable for function, location, and traffic.
- .4 Clean hardware after installation in accordance with *Supplier's* requirements.

END OF SECTION

Interior Aluminum Screens

PART 1- GENERAL

1.1 Summary

- .1 Section includes:
 - .1 Interior aluminum framing system.

1.2 Administrative Requirements

- .1 Conduct a pre-installation meeting in accordance with Section 01 31 19.

1.3 Submittals

- .1 Submit required submittals in accordance with Section 01 33 00.
- .2 *Product* data sheets:
 - .1 Submit manufacturer's *Product* data sheets for *Products* proposed for use in the work of this section.
- .3 Shop drawings:
 - .1 Submit engineered shop drawings.
 - .2 Clearly indicate fabrication details, plans, elevations, hardware, and installation details, including seismic design, connections and restraint.
- .4 Samples:
 - .1 Partition sample to show basic construction, glazed sections, trim, and finishes.

1.4 Closeout Submittals

- .1 Submit closeout submittals in accordance with Section 01 78 00.
- .2 Operation and maintenance data:
 - .1 Submit operation and maintenance data for incorporation into maintenance manual.

1.5 Quality Assurance

- .1 Qualifications:
 - .1 Execute the work of this section using workers skilled in the respective duties for which they are employed, and with minimum 3 years' experience in application of *Products*, systems, and assemblies specified.

1.6 Warranty

- .1 Warrant work of this section in accordance with Section 01 78 36.
- .2 Extended warranty:
 - .1 Labour, materials, and workmanship for work of this section.
 - .2 Duration: 2 years.

Interior Aluminum Screens

PART 2 - PRODUCTS

2.1 Manufacturers/Products

- .1 Subject to compliance with requirements, provide products by the following manufacturers:
 - .1 Insulgard Security Products 'BulletBlock 44/250 Architectural Aluminum Sash System'.
 - .2 Substitutions in accordance with Section 01 25 00.

2.2 Materials

- .1 Extruded aluminum: Controlled alloy billets of 6061 T6, to assure compliance with tight dimensional tolerances and maintain colour uniformity.

2.3 Finishes

- .1 Exposed aluminum surfaces:
 - .1 Clear anodized to AAMA 611-24, designation AA-M12C22A31.

2.4 Fabrication

- .1 Pre-machine jams and prepare for hardware, with concealed reinforcement plates, drilled and tapped as required and fastened within frame with concealed screws.
- .2 Fabricate components to allow secure installation without exposed fasteners.

PART 3 - EXECUTION

3.1 Installation

- .1 *Provide* 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 in accordance with manufacturers' requirements and recommendations, true, tightly fitted, and level or flush to adjacent surfaces, as suitable for installation. Adjust components to allow for irregularities in adjacent construction and relate accurately to finished ceiling and floor coverings.
- .3 Install frames plumb and square, securely anchored to substrates with fasteners recommended by frame manufacturer.
- .4 Use concealed installation clips to assure that splices and connections are tightly butted and properly aligned.
- .5 Secure clips to main structural components and not to snap-in or trim members.
- .6 Do not use screws or other fasteners that will be exposed to view when installation is complete.
- .7 Fit joints and junction between components tightly and in true planes, conceal joints where possible.

Interior Aluminum Screens

3.2 Field Quality Control

- .1 Conduct quality control in accordance with Section 01 45 00 and as follows:

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 Refinish damaged or defective *Work* so that no variation in surface appearance is discernible.

END OF SECTION

Automatic Sliding Entrance Doors

PART 1- GENERAL

1.1 Summary

- .1 Section includes:
 - .1 Automatic sliding entrance doors; Door D07.

1.2 Administrative Requirements

- .1 Conduct a pre-installation meeting in accordance with Section 01 31 19.

1.3 Submittals

- .1 Submit required submittals in accordance with Section 01 33 00.
- .2 *Product* data sheets:
 - .1 Submit manufacturer's *Product* data sheets for *Products* proposed for use in the work of this section.
- .3 Shop drawings:
 - .1 Submit engineered shop drawings.
 - .2 Indicate seismic design, connections and restraint.
 - .3 Clearly indicate each type of frame and screen, extrusion profiles, method of assembly, section and hardware reinforcement and mounting plates, locations of exposed fasteners, finishes, glazing systems, glass type, accessories, line of air barrier and drainage path, and as required to completely represent the proposed door system.
 - .4 Indicate fastening system for anchorage of door frame to opening, and structural design for each door type and size.
- .4 Samples:
 - .1 Submit samples of colour and finish prepared as specified on respective metal components.
 - .2 Identify samples as to treatment, thickness, alloy, framing composition, colour, manufacture, performance standard and portion of the work to which they apply.
 - .3 Fabrication shall not proceed without written acceptance of samples from *Consultant*.
- .5 Test reports:
 - .1 Submit relevant test report prepared by accredited independent testing laboratory, showing compliance with the design criteria of this section.

1.4 Closeout Submittals

- .1 Submit closeout submittals in accordance with Section 01 78 00.
- .2 Operation and maintenance data:

Automatic Sliding Entrance Doors

- .1 Submit manufacturer's operation and maintenance instructions for incorporation into the operation and maintenance manuals.

1.5 Quality Assurance

- .1 Qualifications:
 - .1 Execute the work of this section using workers skilled in the respective duties for which they are employed, and with minimum 3 years' experience in application of *Products*, systems, and assemblies specified.

1.6 Warranty

- .1 Warrant work of this section in accordance with Section 01 78 36.

PART 2 - PRODUCTS

2.1 Performance/Design Requirements

- .1 Reinforce units to withstand handling stresses, temperature changes, the effect of shrinkage forces, wind loads, dead and live loads, seismic loads, and related elements.
- .2 Design components to achieve sufficient freedom of movement of members to allow for thermal expansion and contraction within the range of air and surface temperatures as applicable to the location of the components without causing harmful buckling, opening of joints, distortion, undue stress on fasteners, breakage of sealants, or other detrimental effects.
- .3 Design light gauge aluminum *Products* to CAN/CSA S157-05/S157.1-05.
- .4 Design and anchor work so that there will be no objectionable distortion or seriously stressed fastenings as the metal expands and contracts. Design and fabricate expansion joints to ensure that they will be, and remain, permanently watertight. Locate joints as shown on reviewed shop drawings. provide necessary wind bracing as required.
- .5 Design mullions for maximum deflection of 1/175.
- .6 Design to drain to exterior face of the door assembly, any water entering at joints and any condensation occurring within the door assembly.

2.2 Automatic Sliding Entrance Systems

- .1 Subject to compliance with the requirements of the *Contract Documents*, provide one of the following automatic sliding entrance systems:
 - .1 Horton Automatics 'HD-Ballistic Sliding Door System with Electric Belt Drive Operator'.
 - .2 Substitutions: in accordance with Section 01 25 00.

2.3 Automatic Sliding Entrance Configuration

- .1 Bi-parting, fixed sidelite, door system:
 - .1 Configuration: Bi-parting, four equal panel door unit with two operable leaves and two fixed sidelite units.
 - .2 Traffic pattern: One-way.

Automatic Sliding Entrance Doors

- .3 Emergency breakaway capability: Exterior sliding leaves only.
- .4 Mounting: Perimeter mounted within rough opening with sliding panels sliding along sidelite.

2.4 Materials

- .1 Framing: Extruded aluminum with PVC thermal break, Aluminum Association alloy AA6063-T5 alloy and temper, to the following minimum thicknesses:
 - .1 Structural header sections: Minimum 5 mm (3/16").
 - .2 Structural frame sections: Minimum 3 mm (1/8").
 - .3 Structural panel sections: Minimum 3 mm (1/8").
- .2 Glass and glazing: Ballistic resistant units as specified in Section 08 80 00.
 - .1 Thickness: As required for minimum Level 2 certification.
- .3 Weatherstripping: durable, non-absorbing material resistant to deterioration by aging and weathering.
- .4 Frame sealant: One component elastomeric chemical curing, compatible with insulated glass unit sealants, to ASTM C920-18.
- .5 Fasteners; for aluminum framing: Commercial quality steel screws, zinc plated and case hardened.
- .6 Fasteners; for concrete/masonry: Commercial quality zinc plated steel concrete screws or bolts.
- .7 Galvanic/dissimilar metal corrosion inhibitor (isolation coating): in accordance with Section 01 73 00 and written requirements of manufacturers of metals affected.
- .8 Foamed-in-place insulation: in accordance with Section 07 21 00.
- .9 Air seal sealant: in accordance with Section 07 27 00.
- .10 Sealing of joints perimeter frame joints: in accordance with Section 07 92 00.

2.5 Door Units

- .1 Automatic sliding entrance doors shall include operator, header and track, jambs, sliding door panels, and sidelites.
- .2 Mounting configuration: as indicated on drawings.
 - .1 Within rough opening with sliding panels sliding along sidelite;
- .3 Door motion shall be or bi-parting as indicated on drawings.
- .4 Acceptable *Products*:
 - .1 Type 110: Slide-Swing panels shall slide along exterior side, breakout opening, as manufactured by Horton Automatics.
 - .2 Substitutions: in accordance with Section 01 25 00.
- .5 Header: Aluminum with removable face plate and capable of self-support up to length of 4877 mm (16').

Automatic Sliding Entrance Doors

- .1 Where indicated, provide transom panel of size and type indicated, mounted on header.
- .2 Header sizes to be:
 - .1 152 mm (6") by 203 mm (8").
- .6 Track: Aluminum track, 8 mm (5/8") wide and replaceable.
 - .1 Door-hanger rollers will acetabular ball bearing wheels 51 mm (2") diameter. Anti-derailing shall be accomplished by means of a separate adjustable roller.
- .7 Sliding panels and sidelites:
 - .1 Mortise and tenon type joints, neatly and mechanically secured. Sash consists of snap-in glass stops, snap-in glazing beads, and vinyl gaskets.
 - .2 Fabricate from aluminum, 95 mm (3-3/4") deep with medium stile horizontal and vertical rails. Weatherstripping to be along perimeter of sliding panels and swingout sidelites. Concealed guides to stabilize bottom of sliding panel.
 - .3 Emergency egress: Slide-swing panels shall swing out 90° from any position of slide movement and require no more than 222 N. (50 lbf) of force applied at the lock stile to open. Swing-slide panels and swing-out sidelites shall have torsion spring designed to re-close panel if pushed open in the direction of egress, and shall include intermediate horizontal rail. Units with emergency egress feature are UL listed as an exit way and are compliant with NFPA 101-2018.
- .8 Frames and jambs:
 - .1 Fabricated from aluminum, butt joints, neatly and mechanically secured by means of screws and formed aluminum corner brackets.
 - .1 44 mm (1-3/4") deep by 104 mm (4") wide.
- .9 Thresholds:
 - .1 Fabricate from aluminum, to following dimensions:
 - .1 12.7 mm (1/2") tall by 178 mm (7") wide.
- .10 Hardware:
 - .1 Hookbolt Lock latching into jamb or adjacent strike rail.
 - .2 9.5 mm (3/8") hex-bolt into breakout carrier frame.
 - .3 Keyed Cylinder mounted on exterior side with 29 mm (1-5/32") standard size cylinder.
 - .4 Thumbturn mounted on interior side.
 - .5 Lockbolt into breakout carrier frame or reverse into threshold.
- .11 Make allowances for deflection of structure and temperature movement. Ensure that structural loads are not transmitted to aluminum work.
- .12 Fit intersecting members to flush, hairline, and weather tight joints and mechanically fasten together.
- .13 Conceal fastenings from view, unless otherwise indicated.

Automatic Sliding Entrance Doors

- .14 Fabricate items fitting to the building from measurements taken on the *Work* as verified from the *Work* as built. Full responsibility for the proper coordination of the different components of the cladding and doors rests with this section.
- .15 Fabricate and assemble work of this section by skilled glazing installers. Do forming operations prior to finishing.

2.6 Operator

- .1 The electric operating mechanism shall be HD-Slide Series 2001 Belt Drive. Operator shall be mounted and concealed within the header. Operating force shall be accomplished through a 1/4 HP DC permanent magnet motor with worm gear transmission and 1800 RPM working with drive belt, attached door hangers, and idler pulley. Drive belt to be neoprene reinforced nylon, 13 mm (1") wide. Idler pulley to be reinforced, non-metallic material.
- .2 Microprocessor master control shall have programmable speed values for: open speed, close speed, open check, close check, and open cushion.
- .3 Control to have dedicated interface connection.
- .4 A revolution encoder shall instruct the control on sliding panel's speed and position. An adjustable reversing circuit will reopen door unit if closing path is obstructed.
 - .1 Maximum force required to prevent sliding panel from closing: 124.5 N (30 lbf).
- .5 Finger safety: When unit slides open, strike rail of sliding panel will stop short of adjacent sidelite; resulting opening is net slide.
- .6 Power 'On/Off' switch: Located inside header and when switched OFF, unit reverts to free manual operation (likewise during electrical power failure).
- .7 Operator:
 - .1 Autolock Fail Safe: If power fails the lock disengages.
 - .2 Power Fail Close: If power fails the door slides closed.

2.7 Sensor System

- .1 24 VAC, class II circuit.
- .2 Motion sensors: Microwave sensor shall be header-mounted each side of door unit for detection of traffic each direction.
- .3 Hold-open beams: Two LED pulsed infrared photoelectric beams to be mounted in vertical rails of sidelite or in jambs.

2.8 Finishes

- .1 Exposed aluminum surfaces; anodized to AAMA 611-24:
 - .1 Clear anodized to AA Designation AA-M12C21A31 or AA-M12C22A31 (Class II).

Automatic Sliding Entrance Doors

PART 3 - EXECUTION

3.1 Examination

- .1 Take dimensions at the *Place of the Work* to ensure that adjustments in fabrication or installation are incorporated, that allowance is made for possible deflection of structure at heads and that clearance to other constructions have been maintained.
- .2 Ensure that anchors and inserts, installed by others are adequate to meet specified requirements.

3.2 Installation

- .1 Door system shall be installed by factory-trained installers in accordance with door system manufacturer's written recommendations and reviewed shop drawings.
- .2 Install work plumb, square, level, free from warp, twist and superimposed loads.
- .3 Set sill into three continuous beads of silicone sealant and seal as required to prevent water leakage.
- .4 Provide galvanic/dissimilar metal corrosion inhibitor (isolation coating) in accordance with Section 01 73 00 and written requirements of manufacturers of metals affected.
- .5 Secure work in required position. Do not restrict thermal movement.
- .6 Install hardware in accordance with templates.
- .7 Adjust operable parts for correct function.
- .8 Install in accordance with CAN/CSA A440.4-19 and requirements of building code.
- .9 Fasten jambs at 450 mm (18") o/c maximum spacing with corrosion resistant anchors, and aluminum anchor plates as required.
- .10 Explosive actuated or powder actuated fasteners will not be permitted.

3.3 Electrical Wiring

- .1 Power shall be brought up to circuit breaker/disconnect switch adjacent to controller under Divisions 26, 27, and 28 and in conformance with requirements specified therein.
- .2 Wiring from motor to switches, controls, starters, safety devices and other items requiring power shall be carried out under work of this section in accordance with requirements of Divisions 26, 27, and 28.
- .3 Use EMT conduit for fixed wiring. Use purpose-made and approved type flexible cables or cords at applicable locations; adequately support so as not to impede access or foul moving parts of equipment.

3.4 Glazing

- .1 Glaze aluminum doors with specified glazing tapes, blocks, and spacer shims in accordance with Section 08 80 00.

3.5 Sealant

- .1 Apply sealant between frame members, sills and adjacent construction as a part of the work of this section and in accordance with Section 07 92 00.

Automatic Sliding Entrance Doors

3.6 Field Quality Control

- .1 Conduct quality control in accordance with Section 01 45 00.
- .2 Manufacturer's field review to be in accordance with Section 01 45 00.

END OF SECTION

Intensive/Critical Care Unit Sliding Doors

PART 1- GENERAL

1.1 Summary

- .1 Section includes:
 - .1 D02; single slide, automatic sliding door, smoke barrier type.

1.2 Administrative Requirements

- .1 Conduct a pre-installation meeting in accordance with Section 01 31 19.

1.3 Submittals

- .1 Submit required submittals in accordance with Section 01 33 00.
- .2 *Product* data sheets:
 - .1 Submit manufacturer's *Product* data sheets for *Products* proposed for use in the work of this section.
- .3 Shop drawings:
 - .1 Submit engineered shop drawings.
 - .2 Clearly indicate each type of frame and screen, extrusion profiles, method of assembly, section and hardware reinforcement and mounting plates, locations of exposed fasteners, finishes, glazing systems, glass type, accessories, and as required to completely represent the proposed door system.
- .4 Samples:
 - .1 Submit samples in accordance with Section 01 33 00.
 - .2 Submit samples of colour and finish prepared as specified on respective metal components.
 - .3 Identify samples as to treatment, thickness, alloy, framing composition, colour, manufacture, performance standard and portion of the work to which they apply.
 - .4 Fabrication shall not proceed without written acceptance of samples from *Consultant*.

1.4 Closeout Submittals

- .1 Submit closeout submittals in accordance with Section 01 78 00.
- .2 Operation and maintenance instructions:
 - .1 Submit manufacturer's operation and maintenance instructions for incorporation into the operation and maintenance manuals.

1.5 Quality Assurance

- .1 Qualifications:
 - .1 Execute the work of this section using workers skilled in the respective duties for which they are employed, and with minimum 3 years' experience in application of *Products*, systems, and assemblies specified.

Intensive/Critical Care Unit Sliding Doors

1.6 Warranty

- .1 Warrant work of this section in accordance with Section 01 78 36.
- .2 Extended warranty:
 - .1 System:
 - .1 Labour, materials, and workmanship for work of this section.
 - .2 The warranty is a total system warranty, and includes hardware, sealants, hanging and fitting, and finishing.
 - .3 Duration: 2 years.
 - .2 Glass and glazing: in accordance with Section 08 80 00.

PART 2 - PRODUCTS

2.1 Performance/Design Requirements

- .1 Design light gauge aluminum *Products* to CSA CAN3-S157-M83.
- .2 Design mullions for maximum deflection of 1/175.
- .3 Air infiltration rating: Maximum leakage rate at ambient temperature shall not exceed 5.2 L/s/m² of opening at 747 Pa (1 cfm/ft² of opening at 0.3" of water). At 400°F the rate of leakage shall not exceed 5.2 L/s/m² of opening at 747 Pa (1 cfm/ft² of opening at 0.3" of water).

2.2 Materials

- .1 Framing: Extruded aluminum, Aluminum Association alloy AA6063-T6 alloy and temper, to the following minimum thicknesses:
 - .1 Structural header sections: 5 mm (3/16").
 - .2 Structural frame sections: 3 mm (1/8").
 - .3 Structural panel sections: Commercial grade.
- .2 Glass: Tempered glass in accordance with Section 08 80 00.
 - .1 Thickness: 12 mm (1/2").
- .3 Glazing materials: In accordance with Section 08 80 00.
- .4 Weatherstripping: durable, non-absorbing material resistant to deterioration by aging and weathering.
- .5 Frame sealant: One component elastomeric chemical curing, compatible with insulated glass unit sealants, to ASTM C920-18.
- .6 Fasteners; aluminum framing: Commercial Quality steel screws, zinc plated and case hardened.
- .7 Fasteners; concrete/masonry: Commercial Quality zinc plated steel concrete screws or bolts.
- .8 Galvanic/dissimilar metal corrosion inhibitor (isolation coating): in accordance with Section 01 73 00 and written requirements of manufacturers of metals affected.

Intensive/Critical Care Unit Sliding Doors

- .9 Sealing of perimeter frame joints: in accordance with Section 07 92 00.

2.3 Finishes

- .1 Exposed aluminum surfaces; where indicated: Mill finished aluminum.
- .2 Exposed aluminum surfaces; anodized to AAMA 611-24:
 - .1 Clear anodized to AA Designation AA-M12C22A31.

2.4 Door Units

- .1 Automatic sliding entrance doors shall include operator, header and track, jambs, sliding door panel, and sidelite.
- .2 Mounting:
 - .1 Within rough opening with sliding panel sliding along sidelite.
- .3 Units will be single-slide.
- .4 Acceptable *Products*; 'Profiler-ICU Smoke Rated' as manufactured by Horton Automatics, types as follows:
 - .1 Type 110: Slide-swing panel shall slide along exterior side of fixed sidelite. Non-threshold application.
- .5 Header: Shall be aluminum with removable face plate. Transom of size and type indicated mounted on header. Header size to be:
 - .1 102 mm (4") deep by 63 mm (2-1/2") high.
- .6 Header track: Shall be aluminum, nylon covered and replaceable. Rollers will be steel, high quality ball bearing wheels 32 mm (1-1/4") diameter. Anti-Derailing shall be accomplished by means of a continuous aluminum extrusion full length of slide panel travel.
- .7 Sliding panels and sidelites:
 - .1 Panel construction:
 - .1 Corner block type with 4.8 mm (3/16") steel backup plate construction, mechanically secured with minimum of four hardened steel screws. Sash consists of snap-in glass stops, snap-in glazing beads and vinyl gaskets. Gasketing material is high temperature silicone and is to be captured in extruded aluminum door panel. Floor Smoke Seal is high temperature brush. Seals shall be factory installed to maintain UL 1784-15 rating.
 - .2 Slide-swing doors to be supplied with adjustable glass setting block to allow for adjusting of door to meet site conditions eliminating the need for additional shims.
 - .2 Fabricate from aluminum, 44 mm (1-3/4") deep with narrow stile horizontal and vertical rails. Weather-stripping to be along perimeter of sliding panel and swingout sidelite. Concealed guides to stabilize bottom of sliding panel.

Intensive/Critical Care Unit Sliding Doors

- .3 Emergency egress: Slide-swing panels shall swing out 90° from any position of slide movement and require no more than 222 N (50 lbf) of force applied at the lock stile to open. Swing-slide panels and swing-out sidelites shall have torsion spring designed to re-close panel if pushed open in the direction of egress, and shall include intermediate horizontal rail. Breakout mechanism shall provide support across full width of the door, in normal operating mode. In breakout mode, torsion assembly shall support weight of the door to minimize drop during emergency egress. Units with emergency egress feature are UL listed as an exit way and are compliant with NFPA 101-2009.
- .8 Frames and jambs:
 - .1 Fabricated from aluminum, butt joints, neatly and mechanically secured by means of screws and formed aluminum corner brackets, dimensions as follows:
 - .1 44 mm (1-3/4") deep by 102 mm (4") wide.
- .9 Hardware: Positive latching shall be provided as follows:
 - .1 Type 310: The slide-swing panel shall be provided with positive latch that will latch this panel in place when closed. A lever handle shall be provided on each side of the sliding panel to unlock the door. The swing-out sidelite shall be provided with positive latch that will latch this panel in place when closed. A lever handle shall be provided on exterior side of sidelite to unlock the panel.
- .10 Make allowances for deflection of structure and temperature movement. Ensure that structural loads are not transmitted to aluminum work.
- .11 Fit intersecting members to flush, hairline, and weather tight joints and mechanically fasten together.
- .12 Conceal fastenings from view, unless otherwise indicated.
- .13 Fabricate items fitting to the building from measurements taken on the *Work* as verified from the *Work* as built. Full responsibility for the proper coordination of the different components of the cladding and doors rests with this section.
- .14 Fabricate and assemble work of this section by skilled glazing installers. Do forming operations prior to finishing.

2.5 Fabrication

- .1 Make allowances for deflection of structure and temperature movement. Ensure that structural loads are not transmitted to aluminum work.
- .2 Fit intersecting members to flush, hairline, and weather tight joints and mechanically fasten together.
- .3 Conceal fastenings from view, unless otherwise indicated.
- .4 Fabricate items fitting to the building from measurements taken on the *Work* as verified from the *Work* as built. Full responsibility for the proper coordination of the different components of the cladding and doors rests with this section.
- .5 Fabricate and assemble work of this section by skilled glazing installers. Do forming operations prior to finishing.

Intensive/Critical Care Unit Sliding Doors

PART 3- EXECUTION

3.1 Examination

- .1 Take dimensions at the *Place of the Work* to ensure that adjustments in fabrication or installation are incorporated, that allowance is made for possible deflection of structure at heads and that clearance to other constructions have been maintained.
- .2 Ensure that anchors and inserts, installed by others are adequate to meet specified requirements.

3.2 Installation

- .1 Install work plumb, square, level, free from warp, twist and superimposed loads.
- .2 Secure work in required position.
- .3 Install hardware in accordance with templates.
- .4 Adjust operable parts for correct function.
- .5 Install in accordance with the requirements of the building code.
- .6 Fasten jambs at 450 mm (18") o/c maximum spacing with corrosion resistant anchors, and aluminum anchor plates as required.
- .7 Explosive actuated or powder actuated fasteners will not be permitted.
- .8 *Provide* galvanic/dissimilar metal corrosion inhibitor (isolation coating) in accordance with Section 01 73 00 and written requirements of manufacturers of metals affected.

3.3 Glazing

- .1 Glaze aluminum doors with specified glazing tapes, blocks, and spacer shims in accordance with Section 08 80 00.

3.4 Sealant

- .1 Apply sealant between frame members, sills and adjacent construction as a part of the work of this section and in accordance with Section 07 92 00.

3.5 Field Quality Control

- .1 Conduct quality control in accordance with Section 01 45 00.
- .2 Manufacturer's field review to be in accordance with Section 01 45 00.

END OF SECTION

Finish Hardware

PART 1- GENERAL

1.1 Summary

.1 Section includes:

- .1 Supply and off-load to place in a clean, dry, and secure room at the *Place of the Work*, which has been designated for storage of all finish hardware specified including necessary fastening devices.
- .2 Supply all finish hardware required and not supplied under other Sections.
- .3 Check and verify hardware information on door and frame shop drawings, prior to fabrication.
- .4 Packaging, labelling, provision of installation instructions, templates, fixings and similar items, and delivery to the *Work* site.
- .5 Give assistance at the *Place of the Work* to organize hardware storeroom and supply qualified staff to correctly categorize, mark, and arrange each item in groups to enable efficient dispensing in specified hardware groups for each door to installation trades.
- .6 Provide qualified staff at the *Place of the Work* promptly to assist installation trades subsequent to being requested and to ensure that hardware is being correctly installed.
- .7 Upon completion of installation of hardware, hardware *Supplier* shall arrange and conduct, in company of *Consultant* and *Contractor*, inspections to verify that all hardware is installed and functioning satisfactorily, and where necessary shall recommend adjustments of such items as closer arms, valves, door holders and latch and locksets. Report comments in writing to *Consultant* and *Contractor*.
- .8 Supply temporary locking cylinders and keys for construction purposes. Locks used for *Contractor's* security shall be keyed as required to conform to building operations' security requirements.

1.2 Administrative Requirements

.1 Coordination:

- .1 Coordinate work of this section to ensure information and material is promptly provided, to ensure orderly and expeditious progress of the *Work*, and to comply with schedule for completion.
- .2 Within 3 weeks of *Contract Award*, submit confirmed orders to manufacturers/*Suppliers* to *Consultant*.
- .3 Assist *Contractor* to organize hardware storeroom and supply qualified staff to correctly categorize, mark, and arrange each item in groups to enable efficient dispensing in specified hardware groups for each door to installation trades.
- .4 Coordinate the work of this section to ensure supplied hardware can function as required and can be installed within the particular details of the door and frame assemblies. Hardware that cannot be installed or will not function as intended will be replaced at no cost to the *Owner*.

Finish Hardware

- .2 Conduct a pre-installation meeting in accordance with Section 01 31 19.

1.3 Submittals

- .1 Submit required submittals in accordance with Section 01 33 00.
- .2 *Product* data sheets:
 - .1 Submit manufacturer's *Product* data sheets for *Products* proposed for use in the work of this section.
- .3 Schedules and samples:
 - .1 Prepare and submit for review, a finish hardware schedule with technical product data sheets for use in the *Work*. List type, selected manufacturer's name and number, location, mounting heights and finish of hardware, and complete cross reference to door schedule.
 - .2 The indication or omission of a hardware component on the hardware schedule does not remove the responsibility of this section to ensure that all hardware can be installed and will function as intended.
 - .3 Submit samples of complete line of hardware and finishes. Identify samples indicating hardware item numbers used in the Finish Hardware Schedule, manufacturer's numbers, names, types, finishes, sizes and indication of door location(s). Approved samples will be retained for comparisons and returned upon completion of the *Work*.
 - .4 Prepare and submit for review, a keying schedule recognizing *Owner* requirements which shall be determined after award of *Contract*.
- .4 Templates:
 - .1 Submit for distribution, 5 copies of templates, template information, installation instructions and details necessary to enable preparation for, and installation of finish hardware in accordance with Door Hardware Institute recommended procedures. Submit templates arranged and marked coincident with specified hardware designations.
 - .2 Submit promptly when requested, the foregoing information in 3-ring plastic hard-covered binders suitably identified.
 - .3 In lieu of templates and template information specified above, and at the sole discretion of door and frame manufacturers, submit manufacturer's standard book of template drawings for each hardware manufacturer.
- .5 Jigs:
 - .1 Submit template jigs for each component to be recessed to enable installation trades to prepare doors to preclude misalignment and improper fit.

1.4 Closeout Submittals

- .1 Submit closeout submittals in accordance with Section 01 78 00.
- .2 Operation and maintenance data:

Finish Hardware

- .1 Instruct the *Owner's* designated representative in proper care and preventative maintenance of hardware to assure longevity of operation.
- .2 Submit maintenance data for cleaning and maintenance of finish hardware.
- .3 Maintenance material:
 - .1 Submit to building maintenance staff prior to date of *Substantial Performance*, two sets of wrenches for door closers, locksets and fire exit hardware.

1.5 Quality Assurance

- .1 Qualifications:
 - .1 Execute the work of this section using workers skilled in the respective duties for which they are employed, and with minimum 5 years' experience in application of *Products*, systems, and assemblies specified.

1.6 Product Handling

- .1 Product handling shall be in accordance with Section 01 60 00 as supplemented by the requirements of this section.
- .2 Package each item of hardware individually, complete with trim and necessary fastenings, and accessories, including wrenches, keys, and other appurtenances required for correct installation. Mark each package as to contents and appropriate use in specified groups.
- .3 Items of hardware subject to handling when installed shall be submitted with an easily removable covering to protect against scratches, abrasions, coating with dissimilar finish materials on adjacent surfaces, and tarnishing.

1.7 Warranty

- .1 Warrant work of this section in accordance with Section 01 78 36.
- .2 Extended warranty:
 - .1 Manufacturer's standard extended warranties.
 - .2 Labour, materials, and workmanship for work of this section.
 - .1 Duration: 2 years.
 - .3 Closers:
 - .1 Duration: 5 years.

PART 2 - PRODUCTS

2.1 Performance/Design Requirements

- .1 Comply with codes and requirements of governing authorities, and as specified.
- .2 *Provide* hardware items with characteristics to meet specified fire ratings, and conform to exit requirements of governing authorities.

Finish Hardware

2.2 Materials

- .1 Finish hardware manufacturer is Dormakaba 'Best' unless otherwise indicated. Hardware shall be fabricated of same materials and shall have consistent colour and finish throughout Project and fully comply with the *Owner's* standards.
- .2 Supply with specified hardware screws, bolts, expansion shields, inserts, and other items and parts required for complete installation and functioning.

PART 3 - EXECUTION

3.1 Examination

- .1 Before furnishing any hardware, carefully check *Contract Documents*, verify door swings, door and frame materials and operating conditions, and assure that hardware will fit work to be attached.
- .2 Check shop drawings and frame and door lists affecting hardware type and installation, and verify to correctness thereof, or advise of required revisions. Check that doors, frames and panels requiring additional support are reinforced.
- .3 Point out special requirements to installer. Make final adjustment of hardware, in particular closer arms, valves and locksets, to work properly.

3.2 Installation

- .1 Install in accordance with manufacturer's written installation requirements. Refer also to installation requirements indicated, and specified in other sections of specifications.
- .2 Accurately locate and adjust hardware to meet manufacturer's written requirements. Use special tools and jigs as recommended.
- .3 Locate door stops to contact doors 75 mm (3") from latch edge.
- .4 Take delivery of finishing hardware and install, except hardware specified as part of work of another section. Check each item as received.
- .5 Set, fit and adjust hardware according to manufacturer's directions, at heights later directed by *Consultant*. Hardware shall operate freely. Protect installed hardware from damage and paint spotting.
- .6 Sound and weather seals:
 - .1 Install seals to continuously seal entire perimeter of doors. Secure in place with non-ferrous screws, in accurate alignment.
 - .2 Maintain integrity of seal at head of doors fitted with closers. Adapt seals as required to achieve specified performance.
- .7 Pre-drill kickplates and doors prior to installation of kickplates. Apply with water-resistant adhesive and countersunk stainless steel screws.
- .8 Set thresholds on two continuous beads of polyurethane caulking fastened with a minimum of 4 countersunk screws.

Finish Hardware

3.3 Electrified Hardware

- .1 Install electronic components, security components such as magnetic locks, sentronic hold open devices door status switches, card readers, processors, transformers, and other electric devices.
- .2 Power wiring will be supplied and installed by Electrical Divisions 26, 27, and 28 including conduit, boxes and other electrical appurtenances, including connections and terminations. Be responsible for ensuring that all wiring work is done in accordance with the *Suppliers* wiring diagrams and directions.
- .3 Arrange for testing and commissioning of system by the distributor of the system. Submit a copy of reports to the *Consultant*.

3.4 Keying

- .1 Construction Master Keys: Provide cylinders with feature that permits voiding of construction keys without cylinder removal. Provide 10 construction master keys.
- .2 Submit Construction Master Keying (CMK) and Grand Master Keying (GMK) upon completion of the work of this section.
- .3 Locks and latches shall be mortise lever type to match the *Owner's* standard and supplied with interchangeable cylinders and construction cores.

3.5 Field Quality Control

- .1 Field tests and inspections:
 - .1 Inspect the installation of finish hardware on an agreed frequency.
 - .2 Advise in writing of work being performed that will prejudice the installation or correct operation of items of hardware.
 - .3 Ensure items have been installed complete with required trim and accessories, and fastenings are adequately secured and approved. Ensure closer arms, valves, holder devices, locksets and latchsets are correctly adjusted.

3.6 Adjusting and Cleaning

- .1 Adjust doors to swing freely, smoothly and easily, to remain stationary at any point, to close evenly and tightly against stops without binding, and to latch positively when doors are closed with moderate force.
- .2 Adjust hardware so that latches and locks operate smoothly and without binding, and closers act positively with the least possible resistance in use. Lubricate hardware if required by *Supplier's* requirements.
- .3 Ensure that doors equipped with closers operate to close doors firmly against anticipated wind and building air pressure, and to enable doors to be readily opened as suitable for function, location and traffic.
- .4 Clean hardware after installation in accordance with *Supplier's* requirements.

END OF SECTION

DOOR HARDWARE

08 71 00

PROJECT: 
 SHSC – Emergency Department Renovation
 North York, ON

ARCHITECT: 
 70 University Avenue
 Suite 800
 Toronto, ON
 M5J 2M4

Prepared By: Chad Connors
 Date: August 13, 2026
 Revised:

Architectural Hardware Finishes

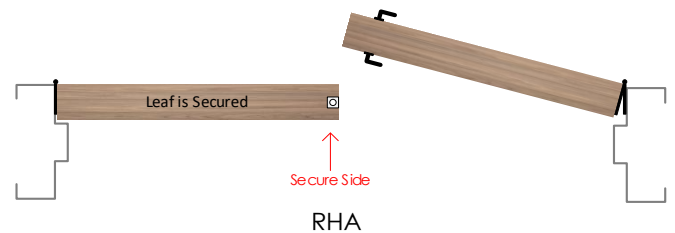
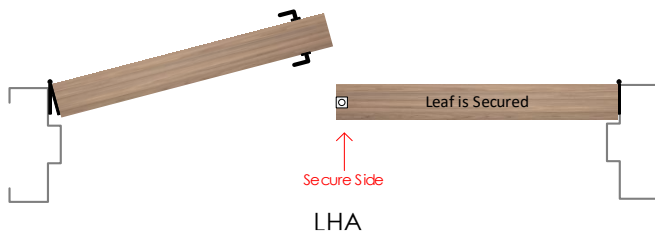
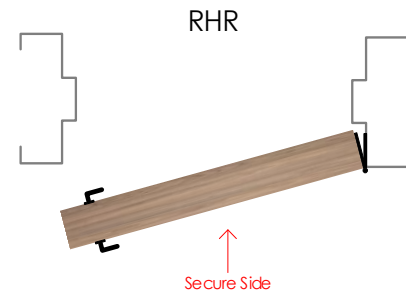
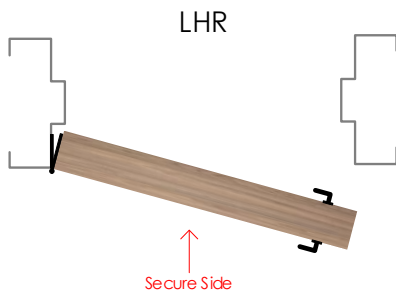
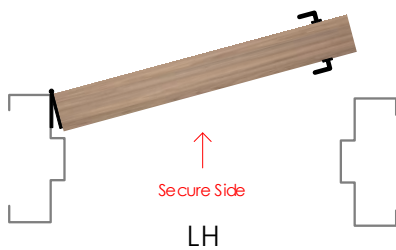
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Clear Anodized				628	689	US28
Satin Nickel	646		619	670		US15
Polished Nickel	645		618	669		US14
Satin Stainless Steel		630				US32D
Polished Stainless Steel		629				US32
Satin Chrome	652		626	702		US26D
Polished Chrome	651		625	672		US26
Satin Brass	633		606	667	678	US4
Polished Brass	632		605	666	677	US5
Satin Bronze	639		612	668	680	US10
Oil Rubbed Bronze	640		613	703	695	US10B
Flat Black / Anodized Black	631		622	671	693	US19

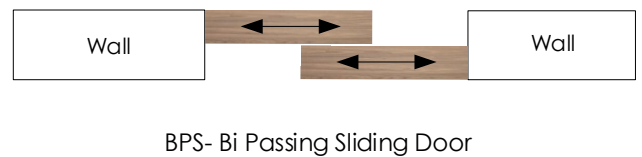
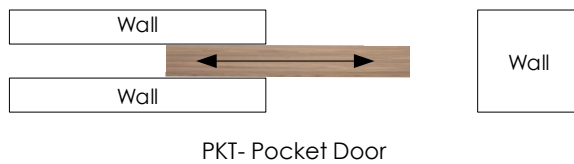
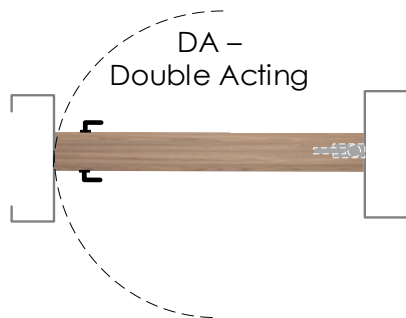
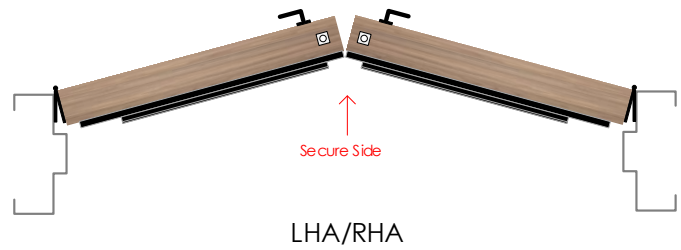
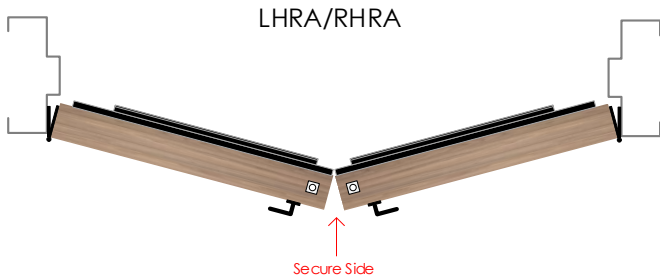
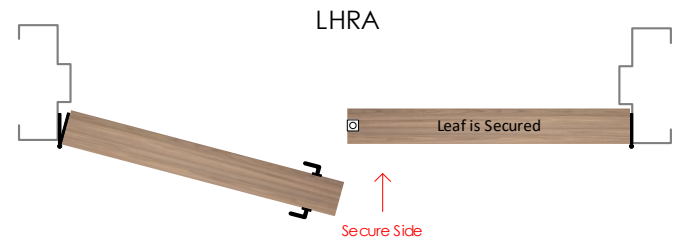
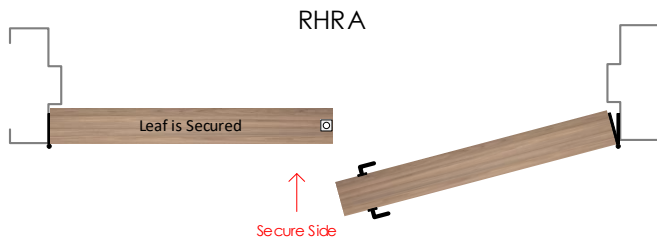
Door Handing's

Abbreviations

RH = Right Hand	RHA = Right Hand Active	SS = Single Slider
LH = Left Hand	LHA = Left Hand Active	BP = Bi-Parting Slider
RHR = Right Hand Reverse	RHA/LHA = Right & Left Hands Active	BF = Bi-Folding Slider
LHR = Left Hand Reverse	RHRA/LHRA = Right & Left Hand Reverse Active	TS = Telescopic Slider
RHRA = Right Hand Reverse Active	DA = Double Acting	PKT = Pocket Slider
LHRA = Left Hand Reverse Active	DE = Double Egress	

NOTE: The handing of a swing door is determined by placing yourself on the secured or keyed side of the door.





Products & Alternatives

NOTE: Only those products / brands listed here are acceptable and should be used to form a bid price. No unsolicited products will be considered. If acceptable alternates are listed here those too can be used to form a bid price provided, they are exactly the same as the specified item. If using an alternate product to form a price it is the bidder's responsibility to ensure that product is identical in every way to the specified item. If no alternates are listed, no alternate products are acceptable.

Product Type	Product#	Manufacturer	Alternate Manufacturer 1	Alternate Manufacturer 2
Cont. Hinge	SL11HD	Select		
Lockset	L9000 series	Schlage		
Electric Strike	1500C	HES		
Door Closer	4040XP	LCN		
Hold Open Door Closer	4314ME	LCN		
Manual Sliding Door	Profilor-ICU	Horton		
Auto Sliding Door	HD-Ballistic	Horton		
Auto Door Operator	SW200i	Besam		
Actuators	CM-41/3	Camden		
Overhead Stop	100S series	Glynn Johnson		
Coordinator	F7600	Standard Metal		
Kick/Armour Plate	K10	Standard Metal		
Half Frame Guard	K51	Standard Metal		
Threshold	CT-65	KN Crowder		
Smoke / Sound Seal	W-66	KN Crowder		
Door Sweep	W-24	KN Crowder		
Power Transfer	EPT-10	Von Duprin		

Symbols



- Door has a fire rating and all associated hardware must have a fire label to suit. Must comply with local requirements.



- Door is automatic and is equipped with an auto operator. Door must meet local barrier free codes



- Door has an electrical requirement and requires power to be brought to the appropriate location above the door or to the latch, for either security or barrier free applications. Refer to security & electrical drawings for further information.



- Door requires security card access. Refer to security / electrical drawings for further information.

Abbreviations

Door:

HMD = Hollow Metal Door
IHMD = Insulated Hollow Metal Door
ALD = Aluminum Door
SSD = Stainless Steel Door
ISSD = Insulated Stainless Steel Frame
STL = Steel Door
IC-ALD = Insulated Clad Aluminum Door
SCWD = Solid Core Wood Door
HCWD = Hollow Core Wood Door
FGD = Frameless Glass Door
FRP = Fiberglass Reinforced Plastic Door
OHD = Overhead Door

Frame:

HMF = Hollow Metal Frame
ALF = Aluminum Frame
Cased Open HMF = Cased Open Hollow Metal Frame
SSF - Stainless Steel Frame
STL = Steel Frame
WDF = Wood Frame
Cased Open WDF = Cased Open Wood Frame
Cased Open Drywall = Cased Open Drywall

Fire Ratings:

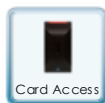
0 HR – Zero Hour Fire Rating / Smoke Barrier
20 MIN – 20 Minute Fire Rating
¾ HR – 45 Minute Fire rating
1 ½ HR – 90 Minute Fire Rating
2 HR – 120 Minute Fire Rating
3 HR – 180 Minute Fire Rating

Disclaimer

Weblinks:

Weblinks do change from time to time as manufacturers move around their websites, please inform us if you have a none functioning weblink.

HARDWARE SCHEDULE



Heading# 1

Opening Information					
Opening Type:	Single	Opening Size:	1215 x 2135 x 45	STC Rating	None
Door Material:	HMD	Frame Material:	HMF	Fire Rating	1 HR

1	Total Openings							
1	Door#	D01	Location:	Corridor	From	Clean Room AG121B	Handing:	RHR

By Hardware Supplier					
1	Cont. Hinge	SL11HD x 2108 x TIPIT	628 / US28 / Clear Anodized	Select	
1	Storeroom Lockset	L9080BDC-03B	630 / US32D / Satin Stainless Steel	Schlage	
1	Electric Strike	1500C-LBM	630 / US32D / Satin Stainless Steel	HES	
1	Hold Open Closer	4314ME-120v	689 / US28 / Painted Aluminum	LCN	
1	Armour Plate	K10F 864 x 1177 Tape (push side)	630 / US32D / Satin Stainless Steel	Standard Metal	
1	Kick Plate	K10A 208 x 1177 Tape (pull side)	630 / US32D / Satin Stainless Steel	Standard Metal	
2	Half Frame Guard	K51F x 864 Tape	630 / US32D / Satin Stainless Steel	Standard Metal	
1	Threshold	CT-65 x 1215	628 / US28 / Clear Anodized	KN Crowder	
1	Smoke / Sound Seal	W-66 x 5485	Black	KN Crowder	
1	Door Sweep	W-24 x 1215	628 / US28 / Clear Anodized	KN Crowder	
By Security Supplier					
2	Card Reader	To Suit Building System, By Security Supplier			
1	Magnetic Lock	To Suit Building System, By Security Supplier			
1	Key Switch	To Suit Building System, By Security Supplier			
1	Pull Station	To Suit Building System, By Security Supplier			
1	Access Controller	To Suit Building System, By Security Supplier			
1	Power Supply	In Central IT Location			
By Owner					
1	Permanent Cylinder	Provided by Owner			

Notes:

- Electrical contractor to confirm quantity of wires and wire locations with hold open door closer supplier prior to pulling wires.
- Final commissioning of all access control items, such as but not limited to electric strikes, request to exit sensors, door contacts, electrified exit devices, relays and magnetic locks is the responsibility of the Security Supplier.
- Hold open door closer to be tied to fire alarm and close on loss of power or fire alarm activation.
- Magnetic lock to be tied to fire alarm and release on loss of power or fire alarm activation.
- In event of emergency pull station will release magnetic lock.

-----End of Heading-----

Heading# 2

Opening Information					
Opening Type:	Single	Opening Size:	2134 x 2286	STC Rating	None
Door Material:	ALD	Frame Material:	ALF	Fire Rating	None

1	Total Openings							
1	Door#	D02	Location:	Clean Room AG121B	To	Decontamination Room AG121A	Handing:	SS

By Automatic Operator Supplier

1	Manual Sliding Door	Profiler-ICU Type 110 w/ breakout	628 / US28 / Clear Anodized	Horton	
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.....End of Heading.....



Heading#

3

Opening Information

Opening Type:	Pair	Opening Size:	1 - 1225 & 1 - 475 x 2135 x 45	STC Rating	None
Door Material:	HMD	Frame Material:	HMF	Fire Rating	None

1	Total Openings							
1	Door#	D03	Location:	Corridor	From	Decontamination Room AG121A	Handing:	RHRA

By Hardware Supplier

1	Cont. Hinge	SL11HD x 2108 x TIPIT	628 / US28 / Clear Anodized	Select	
1	Cont. Hinge	SL11HD x 2108 x TIPIT x EPT	628 / US28 / Clear Anodized	Select	
1	Power Transfer	EPT-10	689 / US28 / Painted Aluminum	Von Duprin	
1	Self-Latching Flush Bolt	F7805	630 / US32D / Satin Stainless Steel	Standard Metal	
1	Passage Set	L9010-03B	630 / US32D / Satin Stainless Steel	Schlage	
1	Electric Strike	1500C	630 / US32D / Satin Stainless Steel	HES	
1	Coordinator	F7666	600 / USP / Primed	Standard Metal	
1	Overhead Stop	106S	630 / US32D / Satin Stainless Steel	Glynn Johnson	
1	Smoke / Sound Seal	W-66 x 5970	Black	KN Crowder	

By Automatic Operator Supplier

1	Auto Operator	SW200i	628 / US28 / Clear Anodized	Besam	
2	Push Actuator	CM-41/3	630 / US32D / Satin Stainless Steel	Camden	
1	Relay	CX-33		Camden	

Notes:

- 120VAC is required at the head of the door for all barrier free door operators, 15A dedicated circuit. Wall/Frame must be reinforced for automatic operator mounting, all conduit with pull cords to back boxes for actuators, lights / sounders are to be provided by the electrical contractor. Electrical contractor to provide low voltage wires to actuator locations as required.
- Electrical contractor to confirm quantity of wires and wire locations with auto door operator supplier prior to pulling wires.

-----End of Heading-----



Heading#

4

Opening Information					
Opening Type:	Single	Opening Size:	915 x 2135 x 45	STC Rating	None
Door Material:	HMD	Frame Material:	HMF	Fire Rating	None

1	Total Openings							
1	Door#	D04	Location:	Corridor	From	Security Room AG103	Handing:	RHR

By Hardware Supplier					
1	Cont. Hinge	SL11HD x 2108 x TIPIT	628 / US28 / Clear Anodized	Select	
1	Storeroom Lockset	L9080BDC-03B	630 / US32D / Satin Stainless Steel	Schlage	
1	Electric Strike	1500C-LBM	630 / US32D / Satin Stainless Steel	HES	
1	Overhead Stop	104S	630 / US32D / Satin Stainless Steel	Glynn Johnson	
1	Door Closer	4040XP-PA	689 / US28 / Painted Aluminum	LCN	
1	Kick Plate	K10A 208 x 877 Tape	630 / US32D / Satin Stainless Steel	Standard Metal	
1	Smoke / Sound Seal	W-66 x 5185	Black	KN Crowder	
By Security Supplier					
1	Card Reader	To Suit Building System, By Security Supplier			
1	Door Contact	To Suit Building System, By Security Supplier			
1	Request to Exit	To Suit Building System, By Security Supplier			
1	Access Controller	To Suit Building System, By Security Supplier			
1	Power Supply	In Central IT Location			
By Owner					
1	Permanent Cylinder	Provided by Owner			

Notes:

- Final commissioning of all access control items, such as but not limited to electric strikes, request to exit sensors, door contacts, electrified exit devices, relays and magnetic locks is the responsibility of the Security Supplier.

-----End of Heading-----



Heading#

5

Opening Information					
Opening Type:	Single	Opening Size:	915 x 2135 x 45	STC Rating	None
Door Material:	HMD	Frame Material:	HMF	Fire Rating	None

1	Total Openings							
1	Door#	D05	Location:	Waiting Area Zone B AG190A	To	Security Room AG103	Handing:	LH

By Hardware Supplier					
1	Cont. Hinge	SL11HD x 2108 x TIPIT	628 / US28 / Clear Anodized	Select	
1	Storeroom Lockset	L9080BDC-03B	630 / US32D / Satin Stainless Steel	Schlage	
1	Electric Strike	1500C-LBM	630 / US32D / Satin Stainless Steel	HES	
1	Overhead Stop	104S	630 / US32D / Satin Stainless Steel	Glynn Johnson	
1	Door Closer	4040XP-REG ST-1630	689 / US28 / Painted Aluminum	LCN	
1	Mounting Plate	4040XP-TJ	689 / US28 / Painted Aluminum	LCN	
1	Kick Plate	K10A 208 x 877 Tape	630 / US32D / Satin Stainless Steel	Standard Metal	
1	Threshold	CT-65 x 915	628 / US28 / Clear Anodized	KN Crowder	
1	Smoke / Sound Seal	W-66 x 5185	Black	KN Crowder	
1	Door Sweep	W-24 x 915	628 / US28 / Clear Anodized	KN Crowder	
By Security Supplier					
1	Card Reader	To Suit Building System, By Security Supplier			
1	Door Contact	To Suit Building System, By Security Supplier			
1	Request to Exit	To Suit Building System, By Security Supplier			
1	Access Controller	To Suit Building System, By Security Supplier			
1	Power Supply	In Central IT Location			
By Owner					
1	Permanent Cylinder	Provided by Owner			

Notes:

- Final commissioning of all access control items, such as but not limited to electric strikes, request to exit sensors, door contacts, electrified exit devices, relays and magnetic locks is the responsibility of the Security Supplier.

-----End of Heading-----



Heading#

6

Opening Information					
Opening Type:	Single	Opening Size:	915 x 2135 x 45	STC Rating	None
Door Material:	HMD	Frame Material:	HMF	Fire Rating	None

1	Total Openings							
1	Door#	D06	Location:	Corridor	To	Security Room AG103	Handing:	RH

By Hardware Supplier					
1	Cont. Hinge	SL11HD x 2108 x TIPIT	628 / US28 / Clear Anodized	Select	
1	Storeroom Lockset	L9080BDC-03B	630 / US32D / Satin Stainless Steel	Schlage	
1	Electric Strike	1500C-LBM	630 / US32D / Satin Stainless Steel	HES	
1	Overhead Stop	104S	630 / US32D / Satin Stainless Steel	Glynn Johnson	
1	Door Closer	4040XP-REG ST-1630	689 / US28 / Painted Aluminum	LCN	
1	Mounting Plate	4040XP-TJ	689 / US28 / Painted Aluminum	LCN	
1	Kick Plate	K10A 208 x 877 Tape	630 / US32D / Satin Stainless Steel	Standard Metal	
1	Smoke / Sound Seal	W-66 x 5185	Black	KN Crowder	
By Security Supplier					
1	Card Reader	To Suit Building System, By Security Supplier			
1	Door Contact	To Suit Building System, By Security Supplier			
1	Request to Exit	To Suit Building System, By Security Supplier			
1	Access Controller	To Suit Building System, By Security Supplier			
1	Power Supply	In Central IT Location			
By Owner					
1	Permanent Cylinder	Provided by Owner			

Notes:

- Final commissioning of all access control items, such as but not limited to electric strikes, request to exit sensors, door contacts, electrified exit devices, relays and magnetic locks is the responsibility of the Security Supplier.

-----End of Heading-----



Heading# 7

Opening Information					
Opening Type:	4-Leaf	Opening Size:	2438 x 2337	STC Rating	None
Door Material:	ALD	Frame Material:	ALF	Fire Rating	None

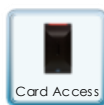
1	Total Openings							
1	Door#	D07	Location:	Corridor Entry	To	Corridor	Handing:	BI-PART

By Automatic Operator Supplier					
1	Auto Sliding Door	Perimeter Mount HD-Ballistic Series 2001 Type 110 Bi-Parting 4 panel sliding door w/ sensors & breakout	628 / US28 / Clear Anodized	Horton	
By Security Supplier					
1	Remote Release Button	To Suit Building System, By Security Supplier			
1	Door Contact	To Suit Building System, By Security Supplier			
1	Access Controller	To Suit Building System, By Security Supplier			
1	Power Supply	In Central IT Location			
By Owner					
1	Permanent Cylinder	Provided by Owner			

Notes:

- 120VAC is required at the head of the door for all barrier free door operators, 15A dedicated circuit. Wall/Frame must be reinforced for automatic operator mounting, all conduit with pull cords to back boxes for actuators, lights / sounders are to be provided by the electrical contractor. Electrical contractor to provide low voltage wires to actuator locations as required.
- Electrical contractor to confirm quantity of wires and wire locations with auto door operator supplier prior to pulling wires.
- Final commissioning of all access control items, such as but not limited to electric strikes, request to exit sensors, door contacts, electrified exit devices, relays and magnetic locks is the responsibility of the Security Supplier.

.....End of Heading.....



Heading#

8

Opening Information					
Opening Type:	Single	Opening Size:	1219 x 2135 x 45	STC Rating	None
Door Material:	HMD	Frame Material:	HMF	Fire Rating	1 HR

1	Total Openings							
1	Door#	D08	Location:	Corridor Entry	To	Waiting Area Zone B AG190A	Handing:	LH

By Hardware Supplier					
1	Cont. Hinge	SL11HD x 2108 x TIPIT	628 / US28 / Clear Anodized	Select	
1	Storeroom Lockset	L9080BDC-03B	630 / US32D / Satin Stainless Steel	Schlage	
1	Electric Strike	1500C-LBM	630 / US32D / Satin Stainless Steel	HES	
1	Overhead Stop	106S	630 / US32D / Satin Stainless Steel	Glynn Johnson	
1	Armour Plate	K10F 864 x 1177 Tape (pull side)	630 / US32D / Satin Stainless Steel	Standard Metal	
1	Kick Plate	K10A 208 x 1177 Tape (push side)	630 / US32D / Satin Stainless Steel	Standard Metal	
2	Half Frame Guard	K51F x 864 Tape	630 / US32D / Satin Stainless Steel	Standard Metal	
1	Threshold	CT-65 x 1219	628 / US28 / Clear Anodized	KN Crowder	
1	Smoke / Sound Seal	W-66 x 5489	Black	KN Crowder	
1	Door Sweep	W-24 x 1219	628 / US28 / Clear Anodized	KN Crowder	
By Automatic Operator Supplier					
1	Auto Operator	SW200i	628 / US28 / Clear Anodized	Besam	
2	Push Actuator	CM-41/3	630 / US32D / Satin Stainless Steel	Camden	
1	Relay	CX-33		Camden	
By Security Supplier					
2	Card Reader	To Suit Building System, By Security Supplier			
1	Magnetic Lock	To Suit Building System, By Security Supplier			
1	Key Switch	To Suit Building System, By Security Supplier			
1	Pull Station	To Suit Building System, By Security Supplier			
1	Access Controller	To Suit Building System, By Security Supplier			
1	Power Supply	In Central IT Location			

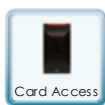
By Owner

1	Permanent Cylinder	Provided by Owner			
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Notes:

- 120VAC is required at the head of the door for all barrier free door operators, 15A dedicated circuit. Wall/Frame must be reinforced for automatic operator mounting, all conduit with pull cords to back boxes for actuators, lights / sounders are to be provided by the electrical contractor. Electrical contractor to provide low voltage wires to actuator locations as required.
- Electrical contractor to confirm quantity of wires and wire locations with auto door operator supplier prior to pulling wires.
- Final commissioning of all access control items, such as but not limited to electric strikes, request to exit sensors, door contacts, electrified exit devices, relays and magnetic locks is the responsibility of the Security Supplier.
- Hold open door closer to be tied to fire alarm and close on loss of power or fire alarm activation.
- Magnetic lock to be tied to fire alarm and release on loss of power or fire alarm activation.
- In event of emergency pull station will release magnetic lock.

-----End of Heading-----



Heading#

9

Opening Information					
Opening Type:	Single	Opening Size:	915 x 2135 x 45	STC Rating	None
Door Material:	HMD	Frame Material:	HMF	Fire Rating	None

1	Total Openings							
1	Door#	D09	Location:	Circulation Corridor	To	Medication Room AG160Y	Handing:	LH

By Hardware Supplier					
1	Cont. Hinge	SL11HD x 2108 x TIPIT	628 / US28 / Clear Anodized	Select	
1	Storeroom Lockset	L9080BDC-03B	630 / US32D / Satin Stainless Steel	Schlage	
1	Electric Strike	1500C-LBM	630 / US32D / Satin Stainless Steel	HES	
1	Overhead Stop	104S	630 / US32D / Satin Stainless Steel	Glynn Johnson	
1	Door Closer	4040XP-REG ST-1630	689 / US28 / Painted Aluminum	LCN	
1	Mounting Plate	4040XP-TJ	689 / US28 / Painted Aluminum	LCN	
1	Armour Plate	K10A 864 x 1177 Tape (pull side)	630 / US32D / Satin Stainless Steel	Standard Metal	
1	Kick Plate	K10A 208 x 1177 Tape (push side)	630 / US32D / Satin Stainless Steel	Standard Metal	
2	Half Frame Guard	K51 x 864 Tape	630 / US32D / Satin Stainless Steel	Standard Metal	
1	Threshold	CT-65 x 915	628 / US28 / Clear Anodized	KN Crowder	
1	Smoke / Sound Seal	W-66 x 5185	Black	KN Crowder	
1	Door Sweep	W-24 x 915	628 / US28 / Clear Anodized	KN Crowder	

By Security Supplier					
1	Card Reader	To Suit Building System, By Security Supplier			
1	Door Contact	To Suit Building System, By Security Supplier			
1	Request to Exit	To Suit Building System, By Security Supplier			
1	Access Controller	To Suit Building System, By Security Supplier			
1	Power Supply	In Central IT Location			
By Owner					
1	Permanent Cylinder	Provided by Owner			

Notes:

-
- Final commissioning of all access control items, such as but not limited to electric strikes, request to exit sensors, door contacts, electrified exit devices, relays and magnetic locks is the responsibility of the Security Supplier.

-----End of Heading-----

End of Door Hardware Schedule

Glass and Glazing

PART 1- GENERAL

1.1 Summary

- .1 Section includes:
 - .1 Glass and glazing.

1.2 Administrative Requirements

- .1 Conduct a pre-installation meeting in accordance with Section 01 31 19.

1.3 Submittals

- .1 Submit required submittals in accordance with Section 01 33 00.
- .2 *Product* data sheets:
 - .1 Submit manufacturer's *Product* data sheets for *Products* proposed for use in the work of this section.
- .3 Shop drawings:
 - .1 Show details of each type of glazing system in conjunction with the framing system indicating type of glass, sizes, shapes, glazing material and quantity. Show details indicating glazing material, glazing thickness, bite on the glass and glass edge clearance.
 - .2 Indicate analysis of glass including maximum deflection and allowable stresses from imposed dead/live loads and thermal loads.
- .4 Samples:
 - .1 Submit minimum 305 mm (12") square samples of each type of glass indicated or scheduled.
 - .1 Submit 3 control samples for each glass type showing maximum range of visible difference between units.
- .5 Submit sample glazing warranty.

1.4 Closeout Submittals

- .1 Submit closeout submittals in accordance with Section 01 78 00.
- .2 Operation and maintenance data:
 - .1 Submit maintenance and cleaning instructions for glass and glazing for incorporation into the operating and maintenance manuals.

1.5 Quality Assurance

- .1 Qualifications:
 - .1 Execute the work of this section using workers skilled in the respective duties for which they are employed, and with minimum 5 years' experience in application of *Products*, systems, and assemblies specified.

Glass and Glazing

- .2 Manufacturers: manufacturers shall have a minimum of 10 years of fabrication experience.

1.6 Warranty

- .1 Warrant work of this section in accordance with Section 01 78 36.
- .2 Extended warranty:
 - .1 General extended warranty:
 - .1 Labour, materials, and workmanship for work of this section.
 - .2 Duration: 2 years.
 - .2 Special product warranty for laminated glass products:
 - .1 Warranty shall cover deterioration due to normal conditions of use and not to handling, installing, and cleaning practices contrary to the glass manufacturer's published instructions. Warranty shall be manufacturer's standard form in which laminated-glass manufacturer agrees to replace laminated-glass units.
 - .2 Duration: 5 years from date of manufacture for laminated glass.
 - .3 Special product warranty for tempered glass products:
 - .1 Warrant that tempered glass will not break spontaneously as a result of Nickel Sulfide (NiS) inclusions at a rate exceeding 0.8% (8/1000) for a period of five years from the date of manufacture. Warranty shall be manufacturer's standard form in which tempered-glass manufacturer agrees to replace tempered-glass units.
 - .2 Duration: 5 years from date of manufacture for fully tempered glass.

PART 2- PRODUCTS

2.1 Performance/Design Requirements

- .1 General:
 - .1 Publications: Comply with recommendations in the publications below, except where more stringent requirements are specified or indicated. Refer to these publications for glazing terms not otherwise defined in this section.
 - .1 NGA's GANA Glazing Manual.
 - .2 NGA Engineering Standards Manual.
 - .3 NGA Laminated Glazing Reference Manual.
 - .4 GANA Sealant Manual.
- .2 Regulatory requirements:
 - .1 Fire rated glass:
 - .1 Each lite shall bear permanent, non-removable label by accredited and recognized independent testing agency certifying it for use in tested and rated fire protective assemblies.
- .3 Glass strength:

Glass and Glazing

- .1 Design glass in conformance with the building code and under conditions indicated determined in accordance with ASTM E1300-16 and the following requirements:
 - .1 Minimum thickness of annealed or heat-treated glass products to be selected so the worst case probability of failure does not exceed the following:
 - .1 8 breaks per 1000 for glass installed vertically less than 15 degrees from the vertical plane and under wind action.
 - .2 *Provide* annealed, heat strengthened, and tempered lights where required by the building code, and where required for the various solar exposures on the building.
 - .3 Glass thicknesses and glass types specified, indicated, or scheduled in the *Contract Documents* are minimums required. Modify glass thickness as required to satisfy design and building code requirements, and requirements of authorities having jurisdiction, and any such modifications shall be clearly indicated on shop drawings.
- .4 Energy performance: in accordance with the following:
 - .1 The glazing schedule.
- .5 Provide glass products of uniform appearance, reflectivity, hue, shade, visible light transmittance, and colour when viewed from distance of 3 m (10 ft) to 30 m (100 ft) perpendicular to the glass or from 45 degree angle to the glass.
- .6 Protect laminated glass interlayer from damage or discolouration resulting from contact with deleterious and incompatible sealants, substances, and materials. Comply with manufacturer's recommended installation requirements.

2.2 Glass Manufacturers

- .1 Subject to compliance with the requirements of the Contract Documents, provide primary glass by one of the following float glass manufacturers:
 - .1 Cardinal Glass Industries.
 - .2 Guardian Industries, LLC.
 - .3 Pilkington North America.
 - .4 Vitro Architectural Glass.

2.3 Glass Materials

- .1 General:
 - .1 Single source responsibility:
 - .1 Coated glass and tinted glass; for each type and condition required:
 - .1 *Provide* primary glass obtained from a single source and plant.
 - .2 *Provide* coating obtained from single source.
 - .2 *Provide* each type of glazing accessory from a single manufacturer or fabricator and from a single production run.
- .2 Annealed (float) glass:

Glass and Glazing

- .1 Clear, annealed glass, 6 mm (1/4") thick minimum, in accordance with CAN/CGSB 12.3-M91, Glazing Quality, or with ASTM C1036-25, Type I, Class 1 (clear), Quality-Q3.
- .3 Heat treated (tempered or heat strengthened) float glass:
 - .1 In accordance with CAN/CGSB 12.1-2017 with ASTM C1048-25, Kind FT (fully tempered), Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3.
 - .2 Minimum thickness: 6 mm (1/4").
 - .3 Fabrication process: By horizontal (roller-hearth) process with roller-wave distortion parallel to bottom edge of glass as installed unless otherwise indicated.
 - .4 For uncoated glass, comply with requirements for Condition A in accordance with ASTM C1048-25.
 - .5 For coated vision glass, comply with requirements for Condition C (other coated glass) in accordance with ASTM C1048-25.
 - .6 Heat strengthened glass shall have surface compression of 24-52 MPa (3,500-7,500 psi).
- .4 Ballistic-resistant glass:
 - .1 Acceptable *Product*:
 - .1 Insulgard Security Products 'BulletBlock Armor-Gard BaluIN23'.
 - .2 Provide ballistic-resistant glass and glazing materials listed and tested in accordance with UL 752-13 and as follows:
 - .1 Ballistic impact level:
 - .1 Level 2.
 - .2 Glazing type:
 - .1 Glass-clad polycarbonate.
 - .3 Glazing colour:
 - .1 Clear.

2.4 Fire-Rated Glass

- .1 Fire-protective rated, impact safety resistant glass, non-wired:
 - .1 In accordance with CAN/ULC-S104-15/CAN/ULC-S106-15, CPSC 16 CFR 1201 (Cat. I and II).
 - .2 Film faced and non-film faced glazing:
 - .1 Fire-protective-rated and impact safety-rated, transparent glazing material and listed for use in doors, sidelites, transoms, and borrowed lites in both interior and exterior applications, not functioning as a barrier.
 - .2 Surface finish:
 - .1 Premium Grade: transparent glass, polished for superior optical clarity.

Glass and Glazing

- .3 Acceptable *Product*:
 - .1 Safti First 'SuperLite II-XL'.
 - .2 Saint Gobain 'Keralite Select F'.
 - .3 Schott 'Pyran Platinum F'.
 - .4 Technical Glass Products 'FireLite NT'.
- .3 Non-film faced glazing:
 - .1 Fire-protective-rated and impact safety-rated, transparent glazing material with no exposed film facing, and listed for use in doors, sidelites, transoms, and borrowed lites in both interior and exterior applications, not functioning as a barrier to heat.
 - .2 Surface finish:
 - .1 Premium Grade: transparent glass, polished for superior optical clarity.
 - .3 Acceptable *Product*:
 - .1 Safti First 'SuperLite II-XL'.
 - .2 Saint Gobain 'Keralite Select L'.
 - .3 Schott 'Pyran Platinum L'.
 - .4 Technical Glass Products 'FireLite Plus'.
- .2 Fire-resistive rated, impact safety resistant, heat barrier glass (non-wired):
 - .1 In accordance with CAN/ULC-S104-15/CAN/ULC-S106-15, CPSC 16 CFR 1201, Category II.
 - .2 Glass with intumescent interlayer:
 - .1 Fire-resistive-rated and impact safety-rated, clear, high visible light transmission glass laminated with an intumescent interlayer, and listed for use in doors, sidelites, transoms, borrowed lites, and wall applications in both interior and exterior applications, and functioning as a barrier to both radiant and conductive heat.
 - .2 Acceptable *Product*:
 - .1 Safti First 'SuperLite II-XL'.
 - .2 Saint Gobain 'ContraFlam'.
 - .3 Technical Glass Products 'Pilkington Pyrostop'.

2.5 Glazing Materials (Non-Fire Rated)

- .1 Glazing materials; general: Select glazing sealants, tapes, gaskets and additional glazing materials of proven compatibility with other materials they will contact, including glass products, seals of insulating glass units and glazing channel substrates, under conditions of installation and service, as demonstrated by testing and field experience.
- .2 Glazing gaskets: Moulded or extruded gaskets of profile and hardness required to maintain watertight seal, made from one of the following:

Glass and Glazing

- .1 Except at silicone glazing: preformed, EPDM to ASTM C864-05(2019).
- .2 At silicone glazing: preformed silicone to ASTM C1115-17(2022).
- .3 Setting blocks: Moulded or extruded material with Shore, Type A Durometer hardness of 85, plus or minus 5, made from one of the following:
 - .1 Except at silicone glazing: preformed, EPDM to ASTM C864-05(2019).
 - .2 At silicone glazing: preformed silicone to ASTM C1115-17(2022).
- .4 Spacers: Moulded or extruded blocks or continuous extrusions of hardness required by glass manufacturer to maintain glass lites in place for installation indicated made from one of the following:
 - .1 Except at silicone glazing: preformed, EPDM to ASTM C864-05(2019).
 - .2 At silicone glazing: preformed silicone to ASTM C1115-17(2022).
- .5 Edge blocks: Moulded or extruded material of hardness needed to limit glass lateral movement (side walking) made from one of the following:
 - .1 Except at silicone glazing: preformed, EPDM to ASTM C864-05(2019).
 - .2 At silicone glazing: preformed silicone to ASTM C1115-17(2022).
- .6 Cleaners, primers and sealers: Type recommended by sealant or gasket manufacturer.
- .7 Polyurethane foam glazing tape:
 - .1 High density, closed-cell, flexible, non-extruding tape, adhesive backed one side only; recommended by manufacturer for exterior applications with nominal pressure in glazing channel.
 - .2 Acceptable *Products*: As recommended by manufacturer suitable for conditions of application and use.
- .8 Speak hole:
 - .1 Acceptable *Products*:
 - .1 Insulgard Security Products 'SafeChange Backer Plate Speak Thru'.
 - .2 Substitutions: in accordance with Section 01 25 00.
- .9 Pass through trays:
 - .1 Description: 18 gauge stainless steel pass through tray for use in security barriers and windows.
 - .2 Finish: #4 brushed satin.
 - .3 Configuration:
 - .1 Counter recessed.
 - .4 Acceptable *Products*:
 - .1 Insulgard Security Products 'Currency / Pass Thru Trays'.
 - .2 Substitutions: in accordance with Section 01 25 00.

Glass and Glazing

2.6 Glazing Materials (Fire Rated)

- .1 Glazing tape; fire-rated glass (non-wired):
 - .1 Closed cell polyvinyl chloride (PVC) foam, coiled on release paper over adhesive on two sides, maximum water absorption by volume of 2 percent, designed for compression of 25 percent to effect an air and vapour seal.
- .2 Silicone sealant: One-part neutral curing silicone, medium modulus sealant, to ASTM C920-18, Type S; Grade NS; Class 25 with additional movement capability of 50 percent in both extension and compression (total 100 percent); Use (Exposure) NT; Uses (Substrates) G, A, and O as applicable.
 - .1 Acceptable *Products*:
 - .1 DOWSIL '795'.
 - .2 Momentive 'Silglaze-II 2800'.
 - .3 Tremco 'Spectrem 2'.
- .3 Setting blocks: Neoprene or other resilient blocks of 40 to 50 Shore A durometer hardness, adhesive-backed on one face only, tested for compatibility with specified glazing compound.
- .4 Cleaners, primers, and sealers: Type recommended by manufacturer of glass and gaskets.

2.7 Fabrication of Glazing Units

- .1 Fabricate glazing units in sizes required to fit openings, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product manufacturer and referenced glazing publications, to comply with system performance requirements.
 - .1 Allow for thermal movements from ambient and surface temperature changes acting on glass framing members and glazing components.
- .2 Clean-cut or flat-grind vertical edges of butt-glazed monolithic lites to produce square edges with slight chamfers at junctions of edges and faces.
- .3 Grind smooth and chamfer, and polish exposed glass edges and corners, unless otherwise indicated.

PART 3- EXECUTION

3.1 Examination

- .1 Examine framing, glazing channels, and stops, with glazing installer present, for compliance with the following:
 - .1 Manufacturing and installation tolerances, including those for size, squareness, and offsets at corners.
 - .2 Inspect butt and mitre joints in framing. Seal joints found to be open with a compatible sealant prior to glazing.

Glass and Glazing

- .3 Glazing pockets and surfaces are free of dust, construction debris, and contaminants.
- .4 Presence and functioning of weep systems.
- .5 Minimum required face and edge clearances in accordance with FGIA and NGA/GANA standards.
- .6 Effective sealing between joints of glass-framing members.
- .2 Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 Preparation

- .1 Clean glazing channels and other framing members receiving glass immediately before glazing. Remove coatings not firmly bonded to substrates.
- .2 Examine glazing units to locate exterior and interior surfaces. Label or mark units as needed so that exterior and interior surfaces are readily identifiable. Do not use materials that will leave visible marks in the completed work.
- .3 Clean contact surfaces with solvent and apply primers to surfaces to receive tapes and sealants in accordance with the manufacturer's requirements. Ensure surfaces are free of moisture and frost.

3.3 Glazing - General

- .1 Comply with combined written requirements of manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.
- .2 Adjust glazing channel dimensions as required by conditions during installation to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances.
- .3 Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass is glass with edge damage or other imperfections that, when installed, could weaken glass and impair performance and appearance.
- .4 Clean glazing rebate surfaces of traces of dirt, dust, or other contaminants.
- .5 Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction testing.
- .6 Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.
- .7 Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.
- .8 Provide spacers for glass lites where length plus width is greater than 1270 mm (50").
 - .1 Locate spacers directly opposite each other on both inside and outside faces of glass. Install correct size and spacing to preserve required face clearances, unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and to comply with system performance requirements.

Glass and Glazing

- .2 Provide 3.2 mm (1/8") minimum bite of spacers on glass and use thickness equal to sealant width.
- .9 Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel.
- .10 Set glass lites in each series with uniform pattern, draw, bow, and similar characteristics.
- .11 Set glass lites with proper orientation so that coatings face exterior or interior as specified.
- .12 Glaze hollow metal doors and frames specified under work of Section 08 11 13 using tape glazing installation.
- .13 Install fire rated glazing in accordance with fire rated glazing *Product* manufacturer's written requirements and with current fire-resistance listing for each *Product*. Field cutting or tampering is not permissible.

3.4 Tape Glazing

- .1 Position tapes on fixed stops so that, when compressed by glass, their exposed edges are flush with or protrude slightly above sightline of stops.
- .2 Install tapes continuously, but not necessarily in one continuous length. Do not stretch tapes to make them fit opening.
- .3 Cover vertical framing joints by applying tapes to heads and sills first and then to jambs. Cover horizontal framing joints by applying tapes to jambs and then to heads and sills.
- .4 Place joints in tapes at corners of opening with adjoining lengths butted together, not lapped. Seal joints in tapes with compatible sealant approved by tape manufacturer.
- .5 Do not remove release paper from tape until right before each glazing unit is installed.
- .6 Centre glass lites in openings on setting blocks and press firmly against tape by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centres of openings.

3.5 Gasket Glazing (Dry)

- .1 Allow gaskets to relax and cut compression gaskets to lengths recommended by gasket manufacturer to fit openings to suit frame dimensions.
- .2 Insert soft compression gasket between glass and frame or fixed stop so it is securely in place with joints miter cut and bonded together at corners.
- .3 Installation with drive-in wedge gaskets: Centre glass lites in openings on setting blocks and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centres of openings. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.

Glass and Glazing

- .4 Installation with Pressure-Glazing Stops: Centre glass lites in openings on setting blocks and press firmly against soft compression gasket. Install dense compression gaskets and pressure-glazing stops, applying pressure uniformly to compression gaskets. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.
- .5 Install gaskets so they protrude past face of glazing stops.

3.6 Sealant Glazing (Wet)

- .1 Install continuous spacers, or spacers combined with cylindrical sealant backing, between glass lites and glazing stops to maintain glass face clearances and to prevent sealant from extruding into glass channel and blocking weep systems until sealants cure. Secure spacers or spacers and backings in place and in position to control depth of installed sealant relative to edge clearance for optimum sealant performance.
- .2 Force sealants into glazing channels to eliminate voids and to ensure complete wetting or bond of sealant to glass and channel surfaces.
- .3 Tool exposed surfaces of sealants to provide a substantial wash away from glass.

3.7 Field Quality Control

- .1 Conduct quality control in accordance with Section 01 45 00.
 - .1 Perform testing on:
 - .1 Surface compression tests on heat strengthened and tempered glass.
- .2 Manufacturer's field review to be in accordance with Section 01 45 00.

3.8 Adjusting and Cleaning

- .1 Immediately remove sealant and compound droppings from finished surfaces. Remove labels after work is completed.
- .2 Final cleaning of glass in accordance with Section 01 77 00.

END OF SECTION

Applied Films

PART 1- GENERAL

1.1 Summary

- .1 Section includes:
 - .1 One way window film; applied to interior glazing.

1.2 Submittals

- .1 Submit required submittals in accordance with Section 01 33 00.
- .2 *Product* data sheets:
 - .1 Submit manufacturer's *Product* data sheets for *Products* proposed for use in the work of this section.
- .3 Samples:
 - .1 Submit 3 - 200 mm x 200 mm (8" x 8") samples of each specified film type, pattern and colour.

1.3 Closeout Submittals

- .1 Submit closeout submittals in accordance with Section 01 78 00.
- .2 Operation and maintenance data:
 - .1 Submit maintenance and cleaning instructions for incorporation into operating and maintenance manuals.
 - .2 Submit reports recording demonstration and training provided to *Owner*.

1.4 Quality Assurance

- .1 Qualifications:
 - .1 Execute the work of this section using workers skilled in the respective duties for which they are employed, and with minimum 3 years' experience in application of *Products*, systems, and assemblies specified.

1.5 Warranty

- .1 Warrant work of this section in accordance with Section 01 78 36.
- .2 Extended warranty:
 - .1 System:
 - .1 Labour, materials, and workmanship for work of this section.
 - .2 Duration: 2 years.

PART 2- PRODUCTS

2.1 Performance/Design Requirements

- .1 Applied film shall function as intended, and exhibit none of the following:

Applied Films

- .1 Bubbling.
- .2 Cracking.
- .3 Crazing.
- .4 Delamination.
- .5 Discolouration.
- .6 Peeling.

2.2 Materials

- .1 Applied films; one-way window film:
 - .1 Acceptable *Products*:
 - .1 3M 'One-Way Mirror Window Film'
 - .2 Substitutions: in accordance with Section 01 25 00.

PART 3- EXECUTION

3.1 Examination

- .1 Examine glass surfaces to receive film and verify that they are free from defects and imperfections which will affect the final appearance of installed film. Correct such deficiencies before starting film application.

3.2 Preparation

- .1 Prepare surfaces for film application in accordance with film manufacturer's written requirements.
- .2 Window and window framing will be cleaned thoroughly with a neutral cleaning solution. Surface of glass shall be bladed with industrial razor to ensure the removal of any foreign contaminants in accordance with film manufacturer's instructions.
- .3 Towelling or other absorbent material shall be placed on the window sill or sash to absorb moisture accumulation generated by the film application.

3.3 Installation

- .1 Applied film; interior application:
 - .1 Apply film to indicated surface of glazing units in accordance with film manufacturer's written requirements, applied plumb, true and level over clean glazing, without air bubbles, wrinkles, blisters, and other defects.
 - .2 After installation, applied film shall be flat with no obvious concentrations of moisture, free of creases, free of tears, with no moisture dimples when viewed under normal conditions.
 - .3 Film edges shall be cut neatly and square at a uniform distance of 1.5 mm (1/16") to 0.79 mm (1/32") from frame.

Applied Films

3.4 Adjusting and Cleaning

- .1 Clean film and glass surfaces so they are free of foreign matter using cleaners recommended by film manufacturer.

3.5 Demonstration

- .1 Demonstration shall be in accordance with Section 01 79 00.
- .2 Instruct *Owner's* representative on proper care and maintenance for work of this section.

3.6 Protection

- .1 Comply with manufacturer's written requirements respecting protection.

END OF SECTION

Metal Supports for Gypsum and Cement Board

PART 1- GENERAL

1.1 Summary

- .1 Section includes:
 - .1 Metal support systems for interior gypsum board assemblies.

1.2 Submittals

- .1 Submit required submittals in accordance with Section 01 33 00.
- .2 *Product* data sheets:
 - .1 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 Submit engineered shop drawings for the following:
 - .1 Seismic connections and restraint of wall and ceiling systems.
 - .2 Interior locations where noted as "engineered" or "structural".
- .4 Test and evaluation reports:
 - .1 Submit certified test results for each required fire resistance rated assembly for work of Section 09 22 00.

1.3 Quality Assurance

- .1 Qualifications:
 - .1 Execute the work of this section using workers skilled in the respective duties for which they are employed, and with minimum 5 years' experience in application of *Products*, systems, and assemblies specified. In addition:

PART 2 - PRODUCTS

2.1 Performance/Design Requirements - Engineered Interior Metal Support Systems

- .1 Design system members to withstand own dead load and 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, design the wall 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*.
- .4 Seismic design: Design and install suspended ceiling system to withstand the effects of earthquake motions in accordance with ASTM E580/E580M-24a.
- .5 Seismic design requirements for partition and ceiling assemblies shall comply with building code requirements.

Metal Supports for Gypsum and Cement Board

2.2 Performance/Design Requirements - Fire Resistance Rated Assemblies

- .1 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.

2.3 Materials - General

- .1 Sheet metal thicknesses specified in Section 09 22 00 indicate the minimum base steel thickness excluding coating.
- .2 Protective coatings for metal supports and framing:
 - .1 Minimum corrosion protection: Z120 (G40) ASTM A653/A653M-18.
 - .2 Heavy duty corrosion protection where scheduled or indicated: Z275 (G90) ASTM A653/A653M-18.
- .3 Sheet metal screws: minimum coating thickness of 0.008 mm (0.0003") of zinc. Other coatings providing equal or better corrosion protection may be used, subject to acceptance of *Consultant*.
- .4 Screws:
 - .1 Steel screws: equal to or exceeding minimum diameter indicated on shop drawings.
 - .2 Penetration beyond joined materials shall be not less than 3 exposed threads.
 - .3 Thread types and drilling capability shall conform to manufacturer's recommendations.
- .5 Galvanic/dissimilar metal corrosion inhibitor (isolation coating): in accordance with Section 01 73 00 and written requirements of manufacturers of metals affected.

2.4 Partition Support Materials

- .1 Interior non-loadbearing channel stud framing: in accordance with ASTM C645-24; roll formed from galvanized steel sheet, minimum thickness 0.836 mm (0.0329") unless otherwise indicated or required.
 - .1 Steel studs at door jambs and where indicated: 1.720 mm (0.0677") minimum thickness.
- .2 Interior floor and ceiling tracks (runners): in accordance with ASTM C645-24; in widths to suit stud sizes.
 - .1 Metal thickness: to match studs.
 - .2 For openings wider than 914 mm (36"), provide 0.836 mm (0.0329") minimum thickness for header.
- .3 Deflection track: Steel sheet top runner manufactured to prevent cracking of finishes applied to interior partition framing resulting from deflection of structure above; in metal thickness not less than indicated for studs and in width to accommodate depth of studs.
- .4 Interior floor and ceiling track (runner) fasteners:
 - .1 To concrete and masonry: Use stub nails or power-driven fasteners.

Metal Supports for Gypsum and Cement Board

- .1 Power actuated fastening systems are not permitted.
- .2 To suspended acoustic ceiling tile grid: Manufactured to fit applicable ceiling grid profile:
 - .1 Acceptable *Products*:
 - .1 CGC 'Partition Clip'.
 - .2 Substitutions: in accordance with Section 01 25 00.
- .5 Bracing channels: Minimum 19 mm x 10 mm x 1.087 mm (3/4" x 3/8" x 0.0428") cold rolled galvanized steel.

2.5 Ceiling Support Materials and Systems

- .1 General: Size ceiling support components in accordance with ASTM C754-20 unless otherwise indicated, and as required for seismic design, connections and restraint of wall and ceiling assemblies.
- .2 Main runners: Steel channels, hot or cold rolled; Z180 (G60) galvanized.
- .3 Hanger wire:
 - .1 In accordance with ASTM A641/A641M-19(2025), soft, Class 1 galvanized, minimum 4.064 mm (0.160", 8 AWG).
- .4 Hanger rods and flats: Mild steel with zinc coating, galvanized for exterior applications.
 - .1 General: Size devices for load imposed by completed system as determined in accordance with ASTM E488/E488M-22 and as required for seismic loading and restraint in accordance with reviewed shop drawings.
 - .1 Power actuated fastening systems are not permitted.
 - .2 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.
 - .3 Fasteners exposed to weather, condensation, and corrosion: Zinc-plated or stainless steel fasteners in applicable product lines specified in preceding paragraphs.
 - .4 Hangers: in accordance with ASTM C754-20 for maximum ceiling area and loads to be supported.
- .5 Interior concrete ceiling anchors:
 - .1 Acceptable *Products*:
 - .1 ITW Ramset/Red Head 'Dynabolt Sleeve Anchor TW-1614' or 'Redi-Drive Tie Drive' or 'Redi-Drive' with angle clip.
 - .2 ITW Ramset/Red Head 'Trubolt' or 'Dynabolt' anchors complete with galvanized angle clip.
 - .3 Hilti 'Kwik-Bolt 3' and 'HHDCA 1/4 Ceiling Hangers'.
 - .4 Substitutions: in accordance with Section 01 25 00.

Metal Supports for Gypsum and Cement Board

- .5 Runner (carry) channels: 1.367 mm (0.0538") thick cold rolled steel, in accordance with ASTM C754-20, with minimum 228 MPa yield strength:
 - .1 38 mm x 12.7 mm (1-1/2" x 1/2") where supported at centres of 914 mm (36") maximum.
 - .2 38 mm x 19 mm (1-1/2" x 3/4") where supported at centres of 1220 mm (48") maximum.
 - .3 Finish: primer painted or zinc coated.
- .6 Provide compression posts and other system components as required for seismic anchorage, connections and restraint.

2.6 Furring

- .1 Furring channels: 0.836 mm (0.0329") 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: Galvanized steel z-shaped furring members; in accordance with ASTM A653/A653M-18, G60, 0.836 mm (0.0329") 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, load rating, and spacing to support materials carried by assembly as required for seismic loading and restraint in accordance with reviewed shop drawings.

2.7 Accessories

- .1 Backer plates:
 - .1 Metal backer plates: Steel, galvanized; fastened to studs for attachment of surface mounted fittings and accessories minimum 150 mm (6") wide x length and width to suit size of items to be attached; x minimum base metal thickness as follows:
 - .1 0.836 mm (0.0329").
 - .2 Elimination of backer plates or direct attachment of accessories or equipment to studs shall not be permitted.

PART 3 - EXECUTION

3.1 Installation General

- .1 Install in accordance with ASTM C754-20 and manufacturer's written requirements, except as modified by Section 09 22 00. Do not bridge building expansion joints with support system. Frame both sides of joints with furring and other supports as indicated.
- .2 Install studs, framing, shimming, and furring to provide proper support for gypsum board to achieve the following installation tolerances:
 - .1 Do not exceed 3 mm (1/8") in 3 m (10') variation from plumb, level, and plane.
 - .2 Do not exceed 10 mm (3/8") from drawings locations.
 - .3 Do not exceed 1.5 mm (1/16") variation between planes of abutting edges or ends.

Metal Supports for Gypsum and Cement Board

- .4 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.
- .5 In double stud walls, do not bridge across studs on opposite sides of wall with gypsum board or metal cross bracing.
- .3 Cooperate with and give direction to trades erecting framing and furring over which the work of Section 09 22 00 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.
 - .1 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.
 - .2 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 Section 09 22 00 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 in accordance with manufacturer's engineered load tables, to meet allowable deflection without permanent deformation.
 - .1 Maximum allowable deflection: L/360.
- .8 Provide galvanic/dissimilar metal corrosion inhibitor (isolation coating) in accordance with Section 01 73 00 and written requirements of manufacturers of metals affected.

3.2 Blocking

- .1 Attach to framing backer plates to support the load of, and to withstand the withdrawal and shear forces imposed by, items installed upon the work of Section 09 22 00.

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, 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.

Metal Supports for Gypsum and Cement Board

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 along runner channels in accordance with ASTM C754-20, 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:
 - .1 Align accurately and lay out according to partition layout.
 - .2 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.

Metal Supports for Gypsum and Cement Board

- .3 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:
 - .1 Provide studs at 400 mm (16") on centre, and as specially spaced in accordance with details indicated.
 - .2 Provide studs not more than 50 mm (2") from abutting walls, openings and each side of corners.
 - .3 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 Coordinate simultaneous erection of studs with installation of service lines. When erecting studs ensure web openings are aligned.
- .11 Coordinate erection of studs with installation of door/window frames and special supports or anchorage for work specified in other sections.
- .12 Unless otherwise indicated, partitions, together with gypsum board facings, shall extend above ceilings to underside of structure above.
- .13 Chase walls:
 - .1 Provide chase walls consisting of two parallel steel stud partitions.
 - .2 Provide cross bracing consisting of metal furring, located at quarter points on each pair of studs. Attach cross bracing to studs with metal screws.
- .14 Lateral support bracing channels:

Metal Supports for Gypsum and Cement Board

- .1 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.
- .2 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.
- .15 Install steel stud reinforcement 1.720 mm (0.0677") at door frames and brace above ceiling. Secure to top and bottom structure with angle brackets and anchors.
- .16 Where ductwork passes through a fire rated wall, *Subcontractor* is to coordinate with the mechanical *Subcontractor* to obtain from the fire damper manufacturer's technical data on how the wall is to be assembled to meet the fire rating requirements that the manufacturer has tested for their damper. *Subcontractor* is not to board up this wall on both sides until *Consultant* has reviewed location and approved this installation.
- .17 Partitions that are tied to the ceiling or hung from the structure, shall be laterally braced to the building structure.

3.7 Control Joints

- .1 Control joints: in accordance with Section 09 29 00.

3.8 Field Quality Control

- .1 Conduct quality control in accordance with Section 01 45 00.
 - .1 Independent inspection and testing company responsibilities:
 - .1 Perform random load tests for ceiling anchor installation.
 - .2 Fixings shall be tested to a load of 1.5 times the applied working load. The pass criterion shall be that no significant movement of the fixing is apparent. A visual check shall be sufficient.
 - .3 For test loads up to 0.25 kN (light weight ceilings less than 10kg/m²) tests may be done by the use of a simple spring balance.
 - .4 For test loads over 0.25 kN, tests shall be done using a test meter.
 - .5 Test a minimum of 2% of installed anchors but no fewer than 2, chosen at random and spread evenly.
 - .6 The failure of a fixing in proof testing shall require investigation and an increase in testing rate.
 - .1 For one failure: double the test rate to 1 in 10 and a minimum of 6.
 - .2 For more than one failure: test 100% of the job, review the fixing specification and installation method.

END OF SECTION

Gypsum Board

PART 1- GENERAL

1.1 Summary

- .1 Section includes:
 - .1 Gypsum board; wall and ceiling applications.
 - .2 Gypsum board accessories and miscellaneous related materials.

1.2 Submittals

- .1 Submit required submittals in accordance with Section 01 33 00.
- .2 *Product* data sheets:
 - .1 Submit manufacturer's *Product* data sheets for *Products* proposed for use in the work of this section.
- .3 Shop drawings:
 - .1 Indicate fastener spacing and locations for curved partitions.
 - .2 Indicate access door and panel locations including sizes and finishing requirements.
- .4 Fire-rated assembly listings and STC assembly ratings:
 - .1 Submit fire-rated assembly listings for each required fire resistance rated assembly for work of this section.
 - .2 Submit STC assembly ratings for each required STC rated assembly for work of this section.

1.3 Quality Assurance

- .1 Qualifications:
 - .1 Execute the work of this section using workers skilled in the respective duties for which they are employed, and with minimum 10 years' experience in application of *Products*, systems, and assemblies specified. In addition:

1.4 Product Handling

- .1 Product handling shall be in accordance with Section 01 60 00 as supplemented by the requirements of this section.
- .2 Handle gypsum panel products and accessories in accordance with GA 216-24 and GA 801-23.

PART 2 - PRODUCTS

2.1 Performance/Design Requirements

- .1 Single source responsibility:
 - .1 Provide gypsum board *Products* from one manufacturer for the work of this section.
- .2 Fire resistance rating:

Gypsum Board

- .1 Construct fire resistance rated assemblies in accordance with listing and CAN/ULC S101-14.
- .3 Paper-faced gypsum board: in accordance with ASTM C1396/C1396M-17.
- .4 Glass mat gypsum board: in accordance with ASTM C1658/C1658M-18.
- .5 Fire rated in accordance with listed assemblies where indicated: Type X or Type C.
- .6 Set bottom edge of gypsum board at 12 mm (0.5") minimum above the finished floor level and seal the gap in accordance with CSA Z8000.

2.2 Gypsum Board Panels

- .1 Gypsum board; paper faced:
 - .1 Acceptable *Products*:
 - .1 CertainTeed 'Easi-Lite'.
 - .2 CGC 'Sheetrock Brand Ultralight Panel'.
 - .3 Georgia-Pacific 'ToughRock Lite-Weight Gypsum Board'.
- .2 Gypsum board; fire-rated; glass mat faced:
 - .1 Acceptable *Products*:
 - .1 CertainTeed 'GlasRoc Interior Drywall'.
 - .2 CGC 'Sheetrock Brand Glass-Mat Panels Mold Tough Firecode X'.
 - .3 Georgia-Pacific 'DensArmor Plus Fireguard and Fireguard C'.
- .3 Gypsum board; interior mould and moisture resistant, glass mat:
 - .1 Resistant to mould growth with highest level of performance (score of 10) when tested to ASTM D3273-21.
 - .2 Acceptable *Products*:
 - .1 CGC 'Sheetrock Brand Glass-Mat Panels Mold Tough Regular/Firecode X'.
 - .2 Georgia-Pacific 'DensArmor Plus Fireguard'.
 - .3 Substitutions: in accordance with Section 01 25 00.
- .4 Gypsum board; impact resistant:
 - .1 Mould and moisture resistant: in accordance with ASTM D3273-21, with a panel score of 10.
 - .2 Glass mat faced:
 - .1 Impact resistance performance in accordance with ASTM C1629/C1629M-24:
 - .1 Surface abrasion surface damage: Level 3.
 - .2 Surface indentation surface damage: Level 1.
 - .3 Soft-body impact penetration: Level 3.
 - .4 Hard Body Impact resistance: Level 2.
 - .2 Acceptable *Products*:

Gypsum Board

- .1 CGC 'Sheetrock Brand Glass-Mat Panels Mold Tough VHI Firecode X'.
- .2 Substitutions: in accordance with Section 01 25 00.
- .5 Gypsum board; flexible for special curved applications, paper faced:
 - .1 Gypsum core panel with enhanced core to allow for flexibility.
 - .2 Thickness: 6.4 mm (1/4").
 - .3 For multiple layer application to achieve 12.7 mm (1/2") thick minimum overall thickness, flexible style for tight bending radii.
 - .4 Acceptable *Products*:
 - .1 CertainTeed '1/4" Flex Drywall'.
 - .2 CGC 'SHEETROCK 1/4" Flexible Gypsum Panels'.
 - .3 Substitutions: in accordance with Section 01 25 00.

2.3 Attachment Materials

- .1 Screws; for gypsum board: bugle head, fine thread, self-tapping, Type G, Type W, Type S, or Type S-12 to suit framing type and metal gauge in accordance with GA GA 216-24, with corrosion resistant finish, and in accordance with ASTM C1002-07/ASTM C954-18.
 - .1 Screw sizing:
 - .1 #6 x 25 mm (1") for single thickness board fastening.
 - .2 #6 x 32 mm (1-1/4") for single thickness 15.9 mm (5/8") board fastening.
 - .3 #7 x 41 mm (1 5/8") for double thickness board fastening.
 - .4 25.4 mm (1"), 41 mm (1-5/8"), and 51 mm (2") for triple thickness board fastening, at stud locations, and 38 mm (1-1/2") Type G screws for attaching face sheet to base sheets, in accordance with board manufacturer's written requirements.

2.4 Accessories

- .1 Accessories: in accordance with ASTM C1047-19 unless otherwise indicated, maximum length pieces per location. Flanges shall be free from dirt, grease, or other material that adversely affects the bond of joint treatment or decoration.
- .2 Trims; one of the following:
 - .1 Galvanized or aluminum-coated steel sheet, rolled zinc, plastic, or paper-faced galvanized-steel sheet.
 - .1 Shapes, including:
 - .1 Corner bead.
 - .1 Mechanically fastened corner beads at impact resistant gypsum walls.
 - .2 Casing trim.
 - .3 Reveal trims.

Gypsum Board

- .4 Control joints, certified by manufacturer for use at fire resistance rated assemblies as required.
- .2 Vinyl moulding:
 - .1 Trim-Tex 38 mm (1-1/2") inside radius corner trim including 3 way inside corner trim and termination trim.
- .3 Aluminum: extruded accessories of profiles and dimensions as indicated or required.
 - .1 Alloy and temper with not less than the strength and durability properties in accordance with ASTM B221 (ASTM B221M), Alloy 6063-T5.
 - .2 Shapes:
 - .1 Z reveal.
 - .2 Reveals and moldings at round columns.
 - .3 Acceptable manufacturers:
 - .1 Fry Reglet.
 - .2 Gordon Interior Specialties.

2.5 Related Support Assemblies and Backer Plates

- .1 Metal support systems and backer plates at interior assemblies: in accordance with Section 09 22 00.

2.6 Joint Treatment Materials

- .1 General: in accordance with ASTM C475/C475M-17(2022).
- .2 Joint tape: in accordance with manufacturer's written requirements.
- .3 Joint compound for interior gypsum board: For each coat use formulation that is compatible with other compounds applied on previous or for successive coats.
 - .1 Prefilling: Use setting-type compound as recommended by panel board manufacturer.
 - .2 Embedding and first coat: Use setting-type or taping compound as recommended by panel board and trim accessory manufacturers.
 - .3 Fill and finish coats: Use sanding type setting-type or taping compound as recommended by panel board manufacturer.

2.7 Acoustic Wall Assembly Materials

- .1 Acoustic sealant; concealed locations: to meet material requirements as listed in Part 9 of ASTM C919-24, including ASTM C834-17 or ASTM C920-18:
 - .1 Acceptable *Products*:
 - .1 Hilti Canada Corp 'CS-S SA Light'.
 - .2 Pecora 'BA-98'.
 - .3 Pecora 'AC-20 FTR'.

Gypsum Board

- .4 Tremco 'Tremflex 834'.
- .5 Substitutions: in accordance with Section 01 25 00.
- .2 Acoustic sealant; exposed locations, acrylic:
 - .1 Acrylic/latex acoustic sealant, Type S, Grade NS, Class 12.5 in accordance with ASTM C920-18, maximum VOC content 60 g/L, non-hardening or ASTM C834-17, Type OP, Grade -18° C.
 - .2 For exposed sealants use paintable sealant products, do use non-skinning type products where they are exposed to view or where sealant products may deteriorate (stain or bleed into) into painted surfaces.
 - .3 Acceptable *Products*:
 - .1 Hilti Canada Corp 'CS-S SA Light'.
 - .2 Pecora 'AC20 FTR'.
 - .3 Tremco 'Tremflex 834'.
 - .4 Substitutions: in accordance with Section 01 25 00.
- .3 Smoke and acoustic sealant; concealed and exposed locations, non-fire-rated acoustic assemblies:
 - .1 Acrylic smoke and acoustic sealant, in accordance with ASTM C834-17 maximum VOC content 60 g/L, paintable, Flame Spread Value of maximum 25 in accordance with CAN/ULC-S102-10.
 - .2 Sealant shall not deteriorate (stain or bleed into) painted surfaces.
 - .3 Acceptable *Products*:
 - .1 Hilti Canada Corp 'CS-S SA Light'.
 - .2 Tremco 'Tremstop Acrylic'.
 - .3 Substitutions: in accordance with Section 01 25 00.
- .4 Acoustic sealant for plenum locations: Smoke-seal sealant with flame-spread not more than 25 and smoke developed classification not more than 50 in accordance with CAN/ULC-S102-10, in accordance with Section 07 84 00.
- .5 Acoustic compound: premixed perlite plaster.
- .6 Acoustic (sound attenuation) insulation:
 - .1 Mineral-fibre sound attenuation batts: in accordance with CAN/ULC S702.1-14, Type 1, non-combustible in accordance with CAN/ULC-S114-18, formaldehyde-free.
 - .1 Acceptable *Products*:
 - .1 CertainTeed 'Lanaé NoiseReducer'.
 - .2 Johns Manville 'Sound-SHIELD'.
 - .3 Owens-Corning 'QuietZone'.
 - .4 Rockwool 'AFB evo'.

Gypsum Board

.5 Substitutions: in accordance with Section 01 25 00.

.2 Fasteners: use mechanical fasteners where required to secure insulation into position in accordance with insulation manufacturer.

2.8 Access Doors

.1 Access doors: in accordance with Divisions 21, 22, and 23 and Divisions 26, 27, and 28.

PART 3 - EXECUTION

3.1 Board Installation - General

- .1 Before installation of board commences, verify that internal services have been installed, tested, and approved; conduits, pipes, cables, and outlets are plugged, capped, or covered; and that fastenings and supports are in place.
- .2 Remove debris and rubbish from wall and ceiling cavities before enclosing with board.
- .3 General:
 - .1 Installation shall be in accordance with ASTM C840-18b, GA 216-24, GA 214-21, GA 600-24, and manufacturer's written requirements, except as otherwise indicated.
- .4 Install exposed gypsum board with face side out. Do not install imperfect, damaged or damp boards. Butt boards together for a light contact at edges and ends with not more than 1.6 mm (1/16") open space between boards. Do not force into place.
- .5 Cover both faces of stud partition framing with gypsum board in concealed spaces (above ceiling, and the like) unless otherwise indicated, except in chase walls which are properly braced internally.
- .6 Attach gypsum board to supplementary framing and blocking provided for additional support at openings and cut-outs.
- .7 Apply components of fire-rated assemblies in conformance with indicated designs.
- .8 Do not apply gypsum board in close proximity to hot pipes or heating ducts.
- .9 Apply board with long dimension perpendicular to supports, unless otherwise indicated.
- .10 Locate joints on opposite sides of partitions on different studs, and at least 305 mm (12") from opening jambs.
- .11 Install materials with the minimum number of joints. Tightly butt joints, without force, and neatly align them.
- .12 Form smooth joints at ends and at field cut edges of board panels.
- .13 Frame openings on every side. Provide clearances with services.
- .14 Work shall include bulkheads over doors, frames, screens, and changes in ceiling levels, pipe space and as indicated.
- .15 Provide clearances between work of this section and structural elements to prevent transference of structural loads in accordance with Section 09 22 00.
- .16 Fasten board to metal support members by metal gypsum board screws, 9.5 mm (0.374") minimum to, and 12.7 mm (1/2") maximum from, centre of joints.

Gypsum Board

- .1 Space screws:
 - .1 At fire rated board as per fire-rated assembly.
 - .2 At typical board walls at 400 mm (16") on centre at edges and field unless otherwise required.
 - .3 At typical board ceilings at 305 mm (12") on centre at edges and field unless otherwise required.
- .17 No joint will occur within 305 mm (12") of the corner of an opening.
- .18 Locate gypsum panel product joints so that no joint will align with the edge of an opening unless control joints are to be installed at these locations.
- .19 Tolerances:
 - .1 Do not exceed 3 mm (1/8") in 3 m (10') variation from plumb, level, and plane in exposed surfaces, except at end joint between gypsum board panels.
 - .2 Do not exceed 10 mm (3/8") from indicated location.
 - .3 Do not exceed 1.5 mm (1/16") variation between planes of abutting edges or ends.
 - .4 Surface flatness shall not exceed 1.5 mm (1/16") within 305 mm (12") straight edge. For non-tapered-edge end joints between boards, measure flatness tolerance with end of straight end at centreline of joint.

3.2 Fire Separations

- .1 Install fire-rated assemblies in accordance with assembly listing requirements in order to obtain fire ratings indicated and as required by authorities having jurisdiction.
- .2 Vertical bulkheads in ceiling spaces over fire rated partitions, doors and the like shall have same fire rating as the partition over which they occur. Such bulkheads shall be of gypsum board construction unless otherwise indicated.
- .3 Use fire rated gypsum wallboard as specified.
- .4 Where lighting fixtures, diffusers, and the like are recessed into fire rated ceilings or bulkheads, provide enclosure to maintain required fire rating. Form removable panel to give access to fixture outlet box.
- .5 Where fire hose cabinets or other fixtures or equipment are recessed in fire rated walls or partitions, provide gypsum board enclosure or backing to maintain required fire rating, unless otherwise detailed.

3.3 Curved Partition Installation

- .1 Install curved partitions in accordance with GA 226-19 in addition to standards specified in Section 09 29 00 for general board installation.
- .2 Gypsum panel preparation:
 - .1 Select length and cut panel so one unbroken panel covers curved surface and 300 mm (12") tangents at each end. Outside panel must be longer than inside panel to compensate for additional radius contributed by studs.

Gypsum Board

- .2 When wet panels are required, evenly spray water per manufacturer's written requirements on the surface to be in tension when panels are hung. Panels, while wet, should be bent to desired radius. Panels should be allowed to set in this shape prior to installation.
- .3 Gypsum panel erection:
 - .1 Apply gypsum panels horizontally with the wrapped edges perpendicular to studs.
 - .1 To form convex surfaces, begin installation at one end of the curved surface and fasten panel to studs as it is wrapped around the curve.
 - .2 To form concave surfaces, start fastening panel to the stud at the centre of the curve and work outward to the panel ends.
 - .4 Fastener locations and spacing in accordance with reviewed shop drawings.

3.4 Interior Mould and Moisture Resistant Gypsum Board Installation

- .1 Apply water resistant sealant to edges, ends, cut-outs which expose gypsum core and to fastener heads. Do not apply joint treatment on areas to receive tile finish.

3.5 Impact Resistant Board Installation

- .1 Install impact resistance gypsum board in accordance with gypsum board manufacturer's written requirements.
- .2 Where both impact resistant gypsum panels and plain gypsum board are used together on the same surface plane adjacent to one another, a smooth transition between the two types of boards is required. Finish the work in a manner such that the transition provides an inconspicuous joint when viewed by a person at normal viewing angles while standing in front of the boards from a distance of not less than 1000 mm (39").

3.6 Acoustic Wall Assemblies

- .1 Acoustical sealant and plaster:
 - .1 Apply acoustical sealant to seal gaps in accordance with ASTM C919-24 and in accordance with the STC rated assembly.
 - .2 Seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations. Locate edge trim and close off sound-flanking paths around or through assemblies, including sealing partitions above acoustical ceilings, in accordance with ASTM C919-24 and manufacturer's written requirements.
 - .3 Clean substrate, remove debris and deleterious substances.
 - .4 Apply sealant to close voids; no leaks around track and gypsum board.
- .2 Sound attenuation insulation:
 - .1 Install sound attenuation insulation to fill cavity unless otherwise indicated.
 - .2 Trim insulation to provide close-fit contact to framing assemblies and fill the partition cavity or acoustic insulation assemblies to thicknesses specified or indicated.

Gypsum Board

- .3 Maintain air space between backs of sound attenuation insulation and back of opposite partition face layer, as applicable.
- .4 Cut insulation to provide close-fit contact around electrical boxes, pipes, and other obstructions and penetrations through and within acoustic assemblies.
- .5 Extend acoustic partition assemblies to underside of structure. Incorporate approved provision to prevent transmittance of structural deflection to partition assembly.
- .6 Staple sound attenuation insulation where required by manufacturer's installation requirements.
- .7 Where studs are not faced with gypsum board on both sides, mechanically fasten wire mesh to non-faced side of stud to retain insulation.
- .8 Mechanically attach sound attenuation insulation in wall assemblies where cavity of wall assembly is greater than 150 mm (6").
- .9 Secure insulation in such a manner that it will not sag or settle away from required locations.
- .3 Sound flanking paths:
 - .1 Where sound rated partition walls intersect non rated gypsum board partition walls, extend sound rated construction to completely close sound flanking paths through non rated construction in accordance with ASTM C919-24 and with manufacturer's written requirements.
 - .2 Seal joints between face layers at vertical interior angles of intersecting partitions.

3.7 Accessories

- .1 At external corners install corner trim secured to framing at 230 mm (9-1/16") on centre on both flanges with screw fasteners or clinch tool.
- .2 Secure casing trim at board edges where exposed to view, where board butts against other materials with no trim to conceal junction, at perimeter of ceiling surfaces at tops of partitions where they stop against continuous ceiling surfaces, and where indicated.
- .3 Erect accessories straight, plumb or level, rigid and at proper plane.
- .4 Use full length pieces.
- .5 Make joints tight, accurately aligned and rigidly secured. Mitre and fit corners, free from rough edges. Secure in accordance with manufacturer's specifications unless otherwise required.
- .6 Installation tolerances:
 - .1 Alignment with board panels shall not exceed tolerances specified above.
 - .2 End joints shall be flush aligned to maximum offset of 0.5 mm (0.020").

3.8 Access Doors

- .1 Install access doors as supplied by Divisions 21, 22, and 23 and Divisions 26, 27, and 28.

Gypsum Board

- .2 Install access panels in locations to be determined by coordination with trades installing mechanical, electrical and other building services. Locations to be reviewed and confirmed by *Consultant*.
- .3 Rigidly secure frames to furring or framing systems.

3.9 Finishing

- .1 Provide levels of gypsum board finish for locations as follows, in accordance with GA 214-21.
 - .1 Level 1: Ceiling plenum areas and concealed areas, except provide higher level of finish as required to comply with fire resistance ratings and acoustical ratings.
 - .2 Level 2: Gypsum board substrate at applied hard surfaces, except remove tool marks and ridges.
 - .3 Level 4: Exposed gypsum board surfaces except where another finish level is indicated.
- .2 Interior gypsum board:
 - .1 Prefill:
 - .1 Use setting-type joint compound. Mix joint compound according to manufacturer's written requirements.
 - .2 Fill joints between boards flush to top of eased or beveled edge.
 - .3 Fill joints of gypsum board above suspended ceilings in fire rated partitions.
 - .4 Wipe off excess compound and allow compound to harden.
 - .5 Prefill joint gaps not greater than 3.2 mm (1/8") with either ready-mix or setting type joint compound; prefill joint gaps greater than 3.2 mm (1/8") with setting-type joint compound.
 - .2 Taping (Level 1):
 - .1 Butter taping compound into inside corners and joints.
 - .2 Centre tape over joints and press down into fresh compound.
 - .3 Remove excess compound.
 - .4 Tape joints of gypsum board above suspended ceilings.
 - .3 First coat (Level 2):
 - .1 Use taping or all-purpose drying-type compound.
 - .2 Immediately after bedding tape, apply skim coat of compound and allow to dry completely in accordance with manufacturer's written requirements.
 - .3 Apply first coat of compound over flanges of trim and accessories, and over exposed fastener heads and finish level with board surface.
 - .4 Cover fastener heads and accessories with 1 coat of joint compound.
 - .4 Second coat (Level 3): After first coat treatment is dried, apply second coat of compound over tape and trim, feathering compound 50 mm (2") beyond edge of first coat.

Gypsum Board

- .1 Cover fastener heads and accessories with total of 2 separate coats of joint compound.
- .5 Third coat (Level 4):
 - .1 After second coat has dried, sand surface lightly and apply thin finish coat to joints, fasteners and trim, feathering compound 50 mm (2") beyond edge of second coat.
 - .2 Allow third coat to dry. Apply additional compound, and touch-up and sand, to provide surface free of visual defects, tool marks, and ridges, and ready for application of finish.
 - .3 Finished joints will be accepted with a camber not greater than 1 mm (1/32") and shall be seamless, plumb, true and flush and with square, neat corners.
 - .4 Cover fastener heads and accessories with total of 3 separate coats of joint compound.
 - .5 Where new partitions align with existing gypsum board, apply required amount of skim coats to make transition inconspicuous from a distance of 914 mm (36").
 - .6 Completed installation at interface between new and existing construction shall provide an inconspicuous joint.
- .3 Interior mold and moisture resistant gypsum board: Treat fastener heads and joints with setting-type joint compound.
 - .1 For joints to be covered with tile, apply tape and joint compound bedding coat and skim coat only; do not apply finish coats.
 - .2 Do not crown joints or leave excess compound on panels.
 - .3 Remove tool marks and ridges.
 - .4 For fastener heads to be covered with tile, apply one coat of joint compound.
- .4 Joint compound:
 - .1 Apply finish coat of compound feathering 75 to 100 mm (3" to 4") beyond tape edges.
 - .2 Feather coats onto adjoining surfaces so that camber is maximum 0.79 mm (1/32").
- .5 Trim:
 - .1 Use same fasteners to anchor trim accessory flanges as required to fasten gypsum board to supports, unless otherwise recommended by trim manufacturer.
 - .2 Install metal corner beads at external corners.
 - .3 Install metal casing bead trim whenever edge of gypsum base would otherwise be exposed or semi exposed, and where gypsum base terminates against dissimilar material.
 - .4 Erect beads plumb or level, with minimum joints.
- .6 Control joints:

Gypsum Board

- .1 Provide control joints set in board facing. Support control joints with studs or furring channels on both sides of joint.
- .2 Provide control joints in locations required and as indicated on reviewed shop drawings.
 - .1 Review control joint locations with *Consultant* prior to installation.
- .3 Install control joints where a partition, wall, or ceiling traverses a construction joint (expansion, seismic, or building control element) in the building structure.
- .4 Install control joints where a wall or partition runs in an uninterrupted straight plane exceeding 9100 mm (30 linear feet).
- .5 Install control joints in interior ceilings:
 - .1 With perimeter relief:
 - .1 Linear dimensions between control joints shall not exceed 15000 mm (50 ft) and total area between control joints shall not exceed 230 m² (2500 ft²).
 - .2 Without perimeter relief:
 - .1 Linear dimensions between control joints shall not exceed 9100 mm (30 ft) and total area between control joints shall not exceed 84 m² (900 ft²).
- .6 Install control joints where ceiling framing members change direction.
- .7 Where a control joint occurs in an acoustical or fire-rated system, provide blocking behind the control joint by using a backing material such as 16 mm (5/8") Type X gypsum panel products, mineral fibre, or other tested equivalent. Construct through-wall control joints at fire-rated assemblies in accordance with assembly listing requirements.
- .8 Line up control joints with joints in other construction or with centre lines of mullions, columns, piers, or similar building elements, where accepted by *Consultant*.
- .9 Install control joints straight and true.
- .10 Ceiling height door frames may be used as control joints. Less than ceiling height frames shall have control joints extending to the ceiling from both corners. If control joints are not used, additional reinforcement is required at corners to distribute concentrated stresses.
- .11 Locate board joints so that no joint will align with the edge of an opening unless control joints are to be installed at these locations.

3.10 Adjusting and Cleaning

- .1 Clean up and remove surplus materials and rubbish resulting from the work of this section upon completion.
- .2 Clean off beads, casings, joint compound droppings and the like, leave the work of this section ready for painting trades.

END OF SECTION

Acoustical Tile Ceiling Systems

PART 1- GENERAL

1.1 Summary

- .1 Section includes:
 - .1 Acoustical tile ceiling systems.

1.2 Administrative Requirements

- .1 Coordination:
 - .1 Cooperate with mechanical and electrical *Subcontractors*.
 - .2 Coordinate layout and installation of acoustic ceiling units and suspension systems components with other work supported by or penetrating through ceilings, including light fixtures, HVAC equipment, partition system, fire suppression system components and other work required to be incorporated in or coordinated with the ceiling system.
- .2 Conduct a pre-installation meeting in accordance with Section 01 31 19.

1.3 Submittals

- .1 Submit required submittals in accordance with Section 01 33 00.
- .2 *Product* data sheets:
 - .1 Submit manufacturer's *Product* data sheets for *Products* proposed for use in the work of this section.
- .3 Shop drawings:
 - .1 Submit engineered shop drawings, including seismic design, connections and restraint.
 - .2 Submit manufacturer's standard details.
 - .3 Indicate lay-out, insert and hanger spacing and fastening details, splicing method for main and cross runners, location of access splines, and acoustical unit support at ceiling fixture.
 - .4 Submit reflected ceiling plans for special grid patterns as indicated.
- .4 Samples:
 - .1 Submit sample of each component of ceiling system. Samples shall fully represent materials to be supplied in colour, texture, finish and construction.
 - .2 Submit samples, load test data and design tables for each type of insert to be used in the *Work* for hanger supports.

1.4 Closeout Submittals

- .1 Submit closeout submittals in accordance with Section 01 78 00.
- .2 Maintenance data:

Acoustical Tile Ceiling Systems

- .1 Submit maintenance and cleaning instructions for acoustical ceiling systems for incorporation into the maintenance manuals.
- .3 Maintenance materials:
 - .1 Deliver for maintenance use, 2% of each type and colour of suspension components and acoustical tiles used in the *Work*.
 - .2 Pack panels in suitable containers, clearly dated and identified as to type and location of installation in the *Work*, and store where directed by *Owner*.

1.5 Quality Assurance

- .1 Qualifications:
 - .1 Execute the work of this section using workers skilled in the respective duties for which they are employed, and with minimum 3 years' experience in application of *Products*, systems, and assemblies specified. In addition:
- .2 Mock-ups:
 - .1 Construct in locations acceptable to *Consultant* a typical sample ceiling installation 10 m² (108 ft²) in area, complete with round column collars perimeter wall trim, and cut tegular tile demonstrating rectified edge. Modify sample as directed and as required to obtain approval. Upon acceptance retain sample as standard of quality for acoustical ceiling.
 - .2 Do not begin fabrication and erection of remainder of ceiling system until sample installation has been reviewed and accepted. Accepted sample may become a part of the final *Work*, subject of approval of *Consultant*.

1.6 Site Conditions

- .1 Interior temperature of building shall be between 15°C and 30°C, and relative humidity shall be not more than 70% before and during installation. Maintain uniform temperatures for 72 hours prior to commencement of the work of this section and maintain temperature until completion of the work of this section.

1.7 Warranty

- .1 Warrant work of this section in accordance with Section 01 78 36.
- .2 Extended warranties:
 - .1 System:
 - .1 Labour, materials, and workmanship for work of this section.
 - .2 Duration: 2 years.

PART 2- PRODUCTS

2.1 Performance/Design Requirements

- .1 Single source responsibility:

Acoustical Tile Ceiling Systems

- .1 For each type of acoustical ceiling tile, provide *Products* from one manufacturer for the work of this section, including support systems, accessory *Products*, and materials.
 - .1 Where manufacturer does not manufacture or supply required accessory *Products* and materials, any such accessory *Products* or materials supplied for use in the Work shall have approval from manufacturer for use as part of the final warrantied installation.
- .2 Acoustical tile *Products* installed as part of the work of this section shall be from same production run.
- .2 Design suspension systems for a maximum mid-span deflection not exceeding L/360 in accordance with ASTM C635/C635M-22 deflection test.
 - .1 Seismic design: Design suspended ceiling system to withstand the effects of earthquake motions.
- .3 Design suspension system to support safely, and without distortion, the superimposed loads of:
 - .1 Air supply diffusers and return grilles.
 - .2 Lighting fixtures.

2.2 Acoustical Tiles

- .1 Lay-in acoustical tiles (610 x 610 ACT):
 - .1 Acceptable *Products*:
 - .1 Match existing.
 - .2 Substitutions in accordance with Section 01 25 00.
- .2 Lay-in acoustical tiles (1220 x 610 ACT):
 - .1 Acceptable *Products*:
 - .1 Match existing.
 - .2 Substitutions in accordance with Section 01 25 00.

2.3 Metal Suspension Systems

- .1 Hanger anchorage devices: Screws, clips, bolts, concrete inserts or other devices applicable to the indicated method of structural anchorage for ceiling hangers and whose suitability for use intended has been proven through standard construction practices or by certified test data. Size devices for 3 x calculated load supported except size direct pull-out concrete inserts for 5 x calculated loads.
- .2 Concrete hanger anchors; post installed: Steel eye bolts and nuts to suit ceiling hangers with capability to sustain, without failure, a load equal to 4 times that imposed by ceiling construction, as determined by testing per ASTM E488/E488M-22, conducted by a qualified independent testing laboratory.
 - .1 Dynabolt Sleeve Anchor 'TW-1614' or Readi-Tie-Drive 'TD4-112' tie wire anchor by ITW Ramset/Red Head.

Acoustical Tile Ceiling Systems

- .2 Kwik-Bolt III 'HHDCA 1/4' tie wire anchor by Hilti Corporation.
- .3 Substitutions: in accordance with Section 01 25 00.
- .4 Fasteners exposed to weather, condensation, and corrosion: Zinc-plated or stainless steel fasteners in applicable product lines specified in preceding paragraphs.
- .3 Hangers and tie wire: Galvanized wire, recommended by manufacturer of suspension system, minimum 2.66 mm (0.1") (12 gauge).
- .4 Suspension system accessories:
 - .1 Splices, clips, and perimeter moulding, of manufacturer's standard type to suit the applicable conditions unless special conditions and access area are shown or specified.
 - .2 Wall moulding: shadow moulding, with exposed hemmed flange of same width and finish as exposed grid.
 - .3 Angle wall mouldings; hemmed with prefinished exposed flanges: match existing.
 - .4 Compression posts: galvanized steel telescoping compression posts to attached to main tees at each splayed wire location preventing upward movement of the ceiling grid system, designed for seismic applications, size to suit ceiling assembly, injection-moulded high impact clip snaps onto main tee for secure positive locking, spring steel top clip attaches to hanger wire, ICBO (International Conference of Building Officials) listed, tested and certified to a minimum compressive load of 408 kg (900 lb); DONN Compression Post as manufactured by CGC Interiors or approved alternative.
 - .5 Seismic clips: Ceiling system manufacturer's standard seismic clips designed and spaced to secure tiles in place.
- .5 Standard suspension system, non fire-rated:
 - .1 Heavy duty in accordance with ASTM C635/C635M-22, interlocking tee system, designed to support acoustical panels in patterns indicated with deflection of main tees less than L/360, consisting of main tees and cross tees. The system shall provide lock joint intersections of cross and main tees.
 - .1 Match existing grid width.
 - .2 Acceptable *Products*:
 - .1 Match existing.
 - .2 Substitutions: in accordance with Section 01 25 00.

2.4 Miscellaneous Materials

- .1 Acoustical sealant: Non-drying, non-hardening, non-skinning, non-staining, non-bleeding, gunnable sealant complying with requirements specified in Section 07 92 00.

Acoustical Tile Ceiling Systems

2.5 Metal Finish

- .1 Metal exposed in finished work shall have a pre-coated baked enamel finish in non-yellowing colour. Submit paint formulation of grid system to lighting fixture, speaker grille, sprinkler and diffuser manufacturers to ensure consistency of colour, sheen and texture of exposed metal components in the ceiling assemblies.
 - .1 Colour: Flat white.

PART 3- EXECUTION

3.1 Installation - General

- .1 Install ceiling panels and metal suspension system in accordance with manufacturer's directions. Where manufacturer's directions are at variance with Contract Documents, notify Consultant before proceeding with installation.
- .2 Do not commence installation until work above suspended ceiling has been completed, inspected and accepted.

3.2 Installation - Suspension System

- .1 Install suspension system rigid, secure, square, level and plumb, framed and erected to maintain dimensions and contours indicated, and in accordance with ASTM C636/C636M-19(2025), ASTM E580/E580M-24a, Cisca installation standards, and any other applicable national or local code requirements. Make allowance for thermal and structural movement.
 - .1 Install acoustical ceiling suspension system to resist seismic disturbance in accordance with ASTM E580/E580M-24a.
 - .2 Coordinate work of this section with work of the mechanical and electrical trades for seismic restraint. Install seismic fixture clamps, supplied by Divisions 21, 22, and 23 and Divisions 26, 27, and 28.
- .2 Attach hangers to structure with inserts and hanger supports. Do not use powder activated fasteners.
- .3 Support hangers for suspended ceiling grid independent of walls, columns, pipes and ducts.
- .4 Space hangers for ceilings at maximum 1220 mm (48") on centre in both directions. Provide additional hangers as required to comply with manufacturer's written installation requirements.
- .5 Locate hangers at not more than 150 mm (6") from ends of main tee members.
 - Seismic clips: Install seismic clips to secure tiles in place in accordance with ceiling system manufacturer's written requirements.
- .6 Install exposed tee members to pattern indicated. Securely attach hangers to main tee members.
- .7 Exposed tees shall be as long as possible to minimize joints. Make joints square, tight, flush and reinforce with splines. Distribute joints to prevent clustering in one area.

Acoustical Tile Ceiling Systems

- .8 Space tee bars to suit ceiling panels and as detailed, and to accommodate lighting fixtures, diffusers and return grilles.
- .9 Cooperate in the installation of ceiling systems, making adjustments where required to ensure that the lighting fixtures, supply diffusers, exhaust grilles and other built-in items properly fit into ceiling module and finish flush with rest of ceiling.
- .10 Restrict creep inside module panels so that strips are centred on module lines.
- .11 Install edge moulding as detailed where ceiling abuts vertical surfaces. Lap corners, use maximum lengths to minimize joints. Make joints square, tight and flush.
 - .1 Screw attach mouldings to substrates at intervals not more than 400 mm (16") on centre and not more than 210 mm (8") from ends, levelling with suspension system. Lap corners accurately and connect securely.

3.3 Installation - Tiles

- .1 Take precautions during installation to ensure tile edges are not chipped or otherwise damaged.
- .2 Minimize field cutting. Rectify cut tile edges of tile to match factory cut edge profile and colour.
- .3 Install acoustical tiles to form horizontal and level ceiling with parts flush and joints butted tightly to hairline appearance.
- .4 Distribute variations in colour and texture of panels to obtain a uniform appearance.

3.4 Installation - Tolerances

- .1 Allowable tolerances: in accordance with ASTM C636/C636M-19(2025).
- .2 Install suspension systems level to tolerance of 1:1200.
- .3 Install edge mouldings level to tolerance of 3 mm in 3660 mm (1/8" in 12'-0").

3.5 Field Quality Control

- .1 Conduct quality control in accordance with Section 01 45 00.

3.6 Adjusting and Cleaning

- .1 Replace uneven, defective or damaged materials and finishes, eliminate waves, remove soiled or stained areas.
- .2 Clean dirty and discoloured surfaces of acoustical units and suspension system according to manufacturer's recommendations.

END OF SECTION

Resilient Base and Accessories

PART 1- GENERAL

1.1 Summary

- .1 Section includes:
 - .1 Resilient base.

1.2 Administrative Requirements

- .1 Conduct a pre-installation meeting in accordance with Section 01 31 19.

1.3 Submittals

- .1 Submit required submittals in accordance with Section 01 33 00.
- .2 *Product* data sheets:
 - .1 Submit manufacturer's *Product* data sheets for *Products* proposed for use in the work of this section.
- .3 Samples:
 - .1 Selection samples:
 - .1 Submit manufacturer's range of pattern and colours available for *Consultant's* selection.
 - .2 Samples for verification: Submit 3 samples of the following:
 - .1 305 mm (12") long samples of each colour and type of base material. Include sample of outside corner of base.
- .4 Manufacturer's instructions:
 - .1 Submit manufacturer's installation instructions for *Products* proposed for use in the work of this section.

1.4 Closeout Submittals

- .1 Submit closeout submittals in accordance with Section 01 78 00.
- .2 Operation and maintenance data:
 - .1 Submit manufacturer's operation and maintenance instructions for inclusion in the operation and maintenance manuals.
- .3 Maintenance materials:
 - .1 Provide minimum 2% of each colour, pattern and type of resilient base required for this project.
 - .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 material.
 - .4 Tag and store where directed by *Owner*.

Resilient Base and Accessories

1.5 Quality Assurance

.1 Qualifications:

- .1 Execute the work of this section using workers skilled in the respective duties for which they are employed, and with minimum 5 years' experience in application of *Products*, systems, and assemblies specified.

.2 Mock-up:

- .1 Resilient base mock-up shall include at least one inside corner, one outside corner plus 20 m (65'-0") of straight run.

1.6 Site Conditions

- .1 Install materials of this section only when surfaces and air temperatures have been maintained between 21°C and 29.4°C for 7 days preceding installation, and will be so maintained during installation and for 48 hours thereafter. Maintain a minimum temperature of 13°C after above period.

1.7 Warranty

- .1 Warrant work of this section in accordance with Section 01 78 36.
- .2 Extended warranty:
 - .1 Labour, materials, and workmanship for work of this section.
 - .2 Duration: 2 years.

PART 2 - PRODUCTS

2.1 Performance/Design Requirements

- .1 Single source responsibility:
 - .1 Provide *Products* from one manufacturer for the work of this section, including accessory *Products* and materials.
 - .1 Where manufacturer does not manufacture or supply required accessory *Products* and materials, any such accessory *Products* or materials supplied for use in the Work shall have approval from manufacturer for use as part of the final warranted installation.
 - .2 Products installed as part of the work of this section shall be from same production run.

2.2 Resilient Base

- .1 Rubber base types:
 - .1 Manufactured from thermoplastic rubber formulation meeting ASTM F1861-21, Type TP, Group 1 (Solid).
 - .2 Acceptable manufacturers:
 - .1 Mannington.
 - .2 Roppe.

Resilient Base and Accessories

- .3 Tarkett.
- .4 Substitutions: in accordance with Section 01 25 00.
- .3 Rubber base; wall base:
 - .1 Acceptable *Products*:
 - .1 Tarkett 'Rubber Wall Base', 3.2 mm (1/8") thick, 100 mm (4") high, angled profile.
 - .2 Colour: to later selection by *Consultant* from manufacturer's full range.

2.3 Accessories

- .1 Primers and adhesives: Types as recommended by resilient product manufacturer compatible with materials and to suit substrate types.
- .2 Sealant: Mildew resistant sealant in accordance with Section 07 92 00.

PART 3 - EXECUTION

3.1 Examination

- .1 Verify that site conditions have been provided as requested and specified.
- .2 Substrates shall be firm, structurally sound, sufficiently porous, and dry.
- .3 Examine substrate to ensure clean lines, correct level and freedom from cracks, ridges, dusting, scaling and carbonation.
- .4 Examine substrates in advance of application of products to ensure that substrates are protected against entry of water and moisture.
- .5 Report conditions contrary to requirements preventing proper installation. Do not proceed with the installation until unsatisfactory conditions have been corrected.
- .6 Failure to call attention to defects or imperfections will be construed as acceptance and approval of the substrate. Installation indicates acceptance of substrates with regard to conditions existing at the time of installation.
- .7 Defective work resulting from application to unsatisfactory surfaces will be considered the responsibility of those performing the work of this section.

3.2 Preparation

- .1 Allow coiled material to lay flat for at least 24 hours at 18°C prior to installation, and maintain this temperature during installation.
- .2 Substrates shall be free of deleterious material that may inhibit bond strength or act as a bond breaker. Remove such contaminants and deleterious material using mechanical methods recommended by manufacturer. Do not use chemical abatement methods.
- .3 Fill gaps, voids, and cracks, and remove ridges, or other defects which will ghost or telegraph through finished product installation.
- .4 Expansion joints, isolation joints, and other movement joints in substrates shall not be filled with patching or levelling compound.

Resilient Base and Accessories

- .5 Sweep and vacuum clean substrates minimum 24 hours prior to alkalinity, moisture, and adhesion testing. Do not use sweeping compounds.
- .6 Notify *Consultant* of any substrate or levelling compound defects or installation conditions that may result in unsatisfactory performance.
- .7 Do not install products until they are same temperature as space where they are to be installed.
- .8 Sweep and vacuum clean substrates to be covered by floor coverings immediately before installation. Do not use sweeping compounds.
- .9 Where flooring adjoins thicker floor materials, apply levelling screed, feather out to make up difference in level between materials.
- .10 Spray paints, permanent markers and other indelible ink markers shall not be used to write on the back of the resilient material or used to mark the substrate as they could bleed through and permanently stain the resilient material. If such contaminants are present on the substrate they shall be mechanically removed prior to the installation of the resilient material.

3.3 Installation of Resilient Base

- .1 Spread adhesive to ribbed surface (back) of wall base with a 3 mm (1/8") square-notched trowel; allow slight set-up, then bring base into contact with substrate. Ensure full adhesion of base to substrate. Adhesive should cover 80% of back surface. Leave a 6 mm (1/4") uncovered space at the top of the wall base to prevent the adhesive from oozing onto the wall above the base when installed.
- .2 Position wall base on wall surface and roll with hand roller. Always roll back to starting point to prevent stretching the wall base.
- .3 Set base to ensure installation over finished flooring material is free of gaps.
- .4 Install base in longest lengths possible, minimum 2440 mm (8'). Adhere toe of base to substrate, and ensure edge of toe is straight.
- .5 Scribe and fit to door frames and other obstructions.
- .6 Joints shall be tightly fitted, straight and vertical, and not less than 610 mm (24") from corners.
- .7 *Provide* joints in base over substrate control joints.
- .8 Field-made inside corners:
 - .1 Install wall base to terminate into the corner with a mitre cut.
 - .2 Position another piece of wall base on opposing wall, without adhesive, approximately 25 mm (1") from the installed piece.
 - .3 Utilizing the dividers, place the hooked end at the top of the installed piece and the pointer end on the top of the uninstalled piece. Carefully, move the dividers downward in a straight vertical motion, allowing the hooked end of the dividers to follow the profile of the installed piece. At the same time, place adequate pressure on the pointer end to transfer and/or scribe the profile onto the surface of the uninstalled piece.

Resilient Base and Accessories

- .4 Use a utility knife to cut the pattern on the uninstalled wall base, apply adhesive, and position the trimmed section into place.
- .9 Field-made outside corners:
 - .1 Install wall base to terminate into the corner with a mitre cut.
 - .2 Stop application of adhesive to wall base approximately 450 mm (18") from the outside corner of the wall.
 - .3 Position the wall base at the corner and pencil line the back of the wall base where the bend is desired.
 - .4 Lay the wall base on the floor with the back up. Utilizing a top-set or pull-type gouge tool, make a shallow notch along the pencil line.
 - .5 Notch depth should not exceed one-quarter the total thickness of the wall base.
 - .6 Reposition the wall base corner on the wall. The corner of the wall should fit snugly into the notched recess on the back of the wall base.
 - .7 Apply adhesive and roll firmly into place.

3.4 Installation Tolerances

- .1 Resilient base: Install straight and level to variation of 3 mm (1/8") over 3 m (10'-0").
- .2 Transition trim: Install straight to variation of 3 mm (1/8") over 3 m (10'-0").

3.5 Field Quality Control

- .1 Conduct quality control in accordance with Section 01 45 00.

3.6 Adjusting and Cleaning

- .1 Remove adhesive from surfaces as work progresses in manner described by manufacturer.
- .2 Thoroughly clean surfaces in accordance with manufacturer's written requirements.

END OF SECTION

Resilient Sheet Flooring

PART 1- GENERAL

1.1 Summary

- .1 Section includes:
 - .1 Resilient sheet flooring.

1.2 Administrative Requirements

- .1 Conduct a pre-installation meeting in accordance with Section 01 31 19.
 - .1 In addition to the agenda specified under Section 01 31 19, the following items shall be addressed at the pre-installation meeting:
 - .1 Compatibility of materials.
 - .2 Preparation and type of substrate.
 - .3 Minimum requirements for lightweight concrete.
 - .4 Floor temperature.
 - .5 Climate controls.
 - .6 Testing requirements.

1.3 Submittals

- .1 Submit required submittals in accordance with Section 01 33 00.
- .2 *Product* data sheets:
 - .1 Submit manufacturer's *Product* data sheets for *Products* proposed for use in the work of this section.
- .3 Shop drawings:
 - .1 Show sheet flooring roll and width layout as related to *Consultant's* floor pattern including borders and accents including where flooring materials meet other floor materials.
 - .2 Show locations of seams, floor drains, floor plates, and where flooring meets other flooring.
- .4 Samples:
 - .1 Selection samples:
 - .1 Submit manufacturer's range of pattern and colours available for *Consultant's* selection.
 - .2 Samples for verification:
 - .1 Submit sample of vinyl sheet flooring, minimum 150 mm (6") x 150 mm (6") of each different colour and pattern of vinyl sheet flooring.
 - .2 Submit sample of heat-welding bead, minimum 150 mm (6") length of each colour.

Resilient Sheet Flooring

- .3 Submit seam samples for each vinyl sheet flooring product and colour with heat-welded seam. Sample shall be a minimum of 150 mm (6") x 254 mm (10") and shall be adhered to a rigid backing material with the seam running lengthwise and in the center of the sample.
- .4 Submit sample of fillet support at integral site formed flash cove bases,
- .5 Certificates:
 - .1 Submit a current copy of the training certificate and a letter from the flooring manufacturer issued from within the last 12 months for the *Subcontractor* and their individual persons working for this *Project* are qualified installers of the manufacturer's flooring system.
- .6 Test and evaluation reports:
 - .1 Submit moisture, alkalinity, and adhesive bond test results.

1.4 Closeout Submittals

- .1 Submit closeout submittals in accordance with Section 01 78 00.
- .2 Operation and maintenance data:
 - .1 Submit manufacturer's operation and maintenance instructions for inclusion in the operation and maintenance manuals.
- .3 Maintenance materials:
 - .1 Submit 2% 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*.

1.5 Quality Assurance

- .1 Qualifications:
 - .1 Execute the work of this section using workers skilled in the respective duties for which they are employed, and with minimum 5 years' experience in application of *Products*, systems, and assemblies specified.

1.6 Site Conditions

- .1 Install materials of this section only when surfaces and air temperatures have been maintained between 18.4°C and 29.4°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. Relative humidity shall be 50 +/- 10%.

1.7 Warranty

- .1 Warrant work of this section in accordance with Section 01 78 36.
- .2 Extended warranty:

Resilient Sheet Flooring

- .1 Labour, materials, and workmanship for work of this section.
- .2 Duration: 2 years.

PART 2 - PRODUCTS

2.1 Performance/Design Requirements

- .1 Single source responsibility:
 - .1 Provide *Products* from one manufacturer for the work of this section, including accessory *Products* and materials.
 - .1 Where manufacturer does not manufacture or supply required accessory *Products* and materials, any such accessory *Products* or materials supplied for use in the Work shall have approval from manufacturer for use as part of the final warranted installation.
 - .2 Products installed as part of the work of this section shall be from same production run.
- .1 Slip resistance: Floors shall have a wet Dynamic Coefficient of Friction (DCOF) of 0.6 or greater in accordance with ASTM D-2047.
- .2 Vinyl sheet flooring shall not:
 - .1 Become stained or discoloured due to slab markings.
 - .2 Delaminate from substrates.
 - .3 Have welded seams which separate.

2.2 Vinyl Sheet Flooring

- .1 Vinyl sheet flooring (RSF1) (RSF2):
 - .1 In accordance with ASTM F1913-19.
 - .2 Thickness:
 - .1 2 mm (0.08").
 - .3 Colour: to later selection by *Consultant* from manufacturer's full range.
 - .4 Acceptable *Products*:
 - .1 Gerfor 'Mipolam EVO'.
 - .2 Substitutions in accordance with Section 01 25 00.

2.3 Miscellaneous Materials

- .1 Seam construction:
 - .1 Hot welded joints, provide welding rod matched to floor pattern/colour selected.
 - .2 Colours: To later selected by *Consultant* from manufacturer's full colour range.
- .2 Primer/adhesives:
 - .1 Types as recommended by resilient flooring manufacturer compatible with materials and to suit substrate types and to comply with warranty requirements.

Resilient Sheet Flooring

- .2 Adhesives shall be appropriate for equipment, cart, and patient bed/stretchers rolling load traffic where applicable.
- .3 Patching and levelling compound:
 - .1 Trowel applied Portland cement based, moisture, mildew, and alkali-resistant.
 - .2 Minimum compressive strength after 28 days shall be minimum 3,500 psi when tested in accordance with ASTM C109/C109M-24 or ASTM C472.
 - .3 Gypsum based compounds are not acceptable.
 - .4 Acceptable manufacturers:
 - .1 Ardex.
 - .2 Mapei.
 - .3 Substitutions: in accordance with Section 01 25 00.
 - .5 Acceptable *Product*: type as recommended by flooring manufacturer.
- .4 Cleaning solution:
 - .1 Acceptable *Products*: type as recommended by flooring manufacturer.
- .5 Floor transition strips:
 - .1 Metal transition trim:
 - .1 Acceptable *Product*:
 - .1 Schluter 'Schiene'.
 - .2 Substitutions: in accordance with Section 01 25 00.
- .6 Sealant: Mildew resistant sealant in accordance with Section 07 92 00.

PART 3 - EXECUTION

3.1 Examination

- .1 Verify that site conditions have been provided as requested and specified.
- .2 Verify that substrates have been provided as specified without holes, protrusions, cracks greater than 1.6 mm (0.06") wide, unfilled control joints, depressions greater than 3 mm (1/8") deep, or other major defects.
- .3 Substrates shall be firm, structurally sound, sufficiently porous, and dry.
- .4 Examine substrate to ensure clean lines, correct level and freedom from cracks, ridges, dusting, scaling and carbonation.
- .5 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.
- .6 Report conditions contrary to requirements preventing proper installation. Do not proceed with the installation until unsatisfactory conditions have been corrected.

Resilient Sheet Flooring

- .7 Failure to call attention to defects or imperfections will be construed as acceptance and approval of the substrate. Installation indicates acceptance of substrates with regard to conditions existing at the time of installation.
- .8 Defective work resulting from application to unsatisfactory surfaces will be considered the responsibility of those performing the work of this section.

3.2 Preparation

- .1 Comply with recommendations of ASTM F710-22.
- .2 Allow products to acclimatize in installation area for a minimum 24 hour prior to installation.
- .3 Substrates shall be free of wax, oil, silicone, soap, grease, dust, solvents, sealers, curing compounds, hardeners, alkaline salts, excessive carbonation or laitance, mould, mildew, paints, varnish, asphalt, residual adhesives, adhesive removers, or other contaminants or deleterious material that may inhibit bond strength or act as a bond breaker. Remove such contaminants and deleterious material using mechanical methods recommended by manufacturer. Do not use chemical abatement methods.
- .4 Concrete substrates that are loose, sandy, scaly, or have a white powdery surface are not acceptable. Substrates shall be mechanically prepared.
- .5 Flooring substrates shall be smooth and level within a tolerance of 3 mm (1/8") in a 3 m (10'-0") radius.
- .6 Fill surface cracks, holes, score marks, depressions, and grooves, and repair surface spalls with Portland cement patching or levelling compound.
- .7 At door opening locations where finished flooring is adjacent to weather-stripping or automatic door bottoms provide trowel-applied levelling compound to provide full contact between finished flooring and weather-stripping or automatic door bottoms. Taper trowel-applied levelling compound to transition with adjacent flooring substrate to provide smooth and seamless transition at maximum slope of 3:1000 (height to distance) ratio.
- .8 Expansion joints, isolation joints, and other movement joints in substrates shall not be filled with patching or levelling compound.
- .9 Remove bumps, high spots, peaks and ridges to produce a uniform and smooth substrate.
- .10 Prepare substrates so that installation of flooring shall not show telegraphing of substrate.
- .11 Remove chalking and dusting and loose material from concrete surfaces with wire brushed or by scraping.
- .12 Sweep and vacuum clean substrates minimum 24 hours prior to alkalinity, moisture, and adhesion testing. Do not use sweeping compounds.
- .13 Notify *Consultant* of any substrate or levelling compound defects or installation conditions that may result in unsatisfactory performance.
- .14 Alkalinity, moisture, and adhesion bond testing:
 - .1 Test substrates in accordance with Field Quality Control paragraphs of Section 09 65 17 after mechanically preparing subfloor or applying patching and levelling compounds.

Resilient Sheet Flooring

- .2 Proceed with installation only after substrates pass testing. Document tests performed and submit in writing to *Consultant*.
- .15 Do not install floor coverings until they are same temperature as space where they are to be installed.
 - .1 In advance of installation ,move floor coverings and installation materials to acclimatize in spaces where they will be installed in accordance with flooring manufacturer's recommendations and installation instructions.
- .16 Sweep and vacuum clean substrates to be covered by floor coverings immediately before installation. Do not use sweeping compounds.
- .17 Where flooring adjoins thicker floor materials, apply levelling screed, feather out to make up difference in level between materials to achieve flush floor finish between adjacent flooring materials unless otherwise indicated.
- .18 Spray paints, permanent markers and other indelible ink markers shall not be used to write on the back of the flooring material or used to mark the substrate as they could bleed through and permanently stain the flooring material. If such contaminants are present on the substrate they shall be mechanically removed prior to the installation of the flooring material.

3.3 Flooring Installation

- .1 Verify product type, size, thickness, and colour prior to commencing installation. Do not install flooring with visual imperfections, colour variations or apparent defects.
- .2 Allow material to relax unrolled in installation areas in accordance with flooring manufacturer's recommendations and installation instructions.
- .3 Install rolls and cuts in sequence following manufacturer's installation requirements/diagrams.
 - .1 Lay flooring with joints parallel to building lines to produce symmetrical pattern and minimum joints.
 - .2 Place seams in inconspicuous and low-traffic areas, at least 150 mm (6") away from parallel joints in levelling underlayment, concrete joints, saw cuts and other type of joints.
 - .3 Avoid cross seams.
 - .4 Lay sheet flooring centered in corridors, with equal sized sheet to either side of center sheet.
 - .5 Mitre intersections at corridors typically. "T" type corridors shall be butt type installation.
 - .6 Terminate flooring at centerline of door in openings where adjacent floor finish or colour is dissimilar.
 - .7 Layout seaming uniformly, using full length flooring typically, minimum flooring size of not less than roll width. Limit quantity of less than full length floor pieces at corridors to maximum of 1.
 - .8 Layout flooring to match reviewed shop drawings floor pattern including borders and accents.

Resilient Sheet Flooring

- .9 Match edges of floor coverings for colour shading at seams.
- .4 Cutting and fitting sheets:
 - .1 Cut pieces to length allowing approximately 75 mm (3") to 150 mm (6") excess for trimming.
 - .2 Remove 12.7 mm (1/2") off the factory seam edge using an edge trimmer or straight edge and knife.
 - .3 Cut sheet and fit neatly around fixed objects without gaps.
 - .4 Position remaining sheets so that the top sheet overlaps the previous sheet by 12.7 mm (1/2") to 19 mm (3/4").
 - .5 Install one sheet at a time in wet adhesive.
 - .6 Roll the flooring immediately in both directions using 45 kg (100 lb) three-section roller.
 - .7 After the material has been laid and rolled in wet adhesive, underscribe the seam using the short scribes with a scribed pin right away.
 - .8 Cut the material along the scribe line using a hooked blade knife and holding it at an angle so to slightly undercut the material.
 - .9 Roll the seam with a hand roller.
 - .10 Cross seams:
 - .1 Straight edge and undercut at an angle the end of the first sheet.
 - .2 Spread adhesive and lay in wet adhesive.
 - .3 Roll the flooring immediately in both directions using 45 kg (100 lb) three-section roller.
 - .4 Overlap the second sheet at butt seam approximately 25 mm (1").
 - .5 Adhere second sheet except for last 450 mm (18") of butt seam; wait 20 – 30 minutes.
 - .6 Spread the adhesive for the last 450 mm (18"), lay in material, underscribe the seam to a neat, fit cut, and roll flooring immediately in both directions using 45 kg (100 lb) three-section roller.
- .5 Install drain clamping rings.
- .6 As installation progresses, roll flooring with 45 kg (100 lb) three-section roller to ensure full adhesion, remove adhesive ridges, and entrapped air.
- .7 Where cove base is not required, seal joint at wall with manufacturer's approved sealant.
- .8 Apply adhesive uniformly and at spreading rates in accordance with adhesive manufacturer's requirements. Do not spread more adhesive than can be covered by flooring before initial set takes place.
- .9 Obtain 100% adhesive coverage to flooring backing.

Resilient Sheet Flooring

- .10 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.
- .11 Heat-welded seams:
 - .1 Weld seams in accordance with ASTM F1516-13(2018).
 - .2 Wait minimum of 24 hours after flooring installation before grooving and heat welding seams.
 - .3 Prepare, weld, and trim seams to produce flat surfaces flush with adjoining floor covering surfaces.
 - .4 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.
 - .5 Using a weld plate and skiving knife to make first cut and allow weld rod to fully cure to room temperature.
 - .6 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.
 - .7 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.
 - .8 Roll the seam area with 45 kg (100 lb) three-section roller.
 - .9 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.
- .12 Flooring installation shall not show telegraphing of substrate. Flooring installation shall be homogenous free of substrate lines, pockets, bumps and unevenness.

3.4 Installation - Transition Trim

- .1 Protect exposed edges of flooring, where finished and unfinished areas adjoining, by means of a transition trim butting to and flush with the finished surface of the flooring covering material and securely adhered to the substrate material.
- .2 Coordinate transitions with work of other sections.
- .3 Prior to installation, allow coiled vinyl material to lay flat at ambient temperatures specified above and in accordance with manufacturer's recommendations and installation instructions.
- .4 Set to ensure installation is free of gaps.
- .5 Install in longest lengths possible.
- .6 Install straight to maximum allowable variation of 3 mm (1/8") over 3 m (10'-0").
- .7 Scribe and fit to obstructions.
- .8 Fit joints tightly, straight and vertical as applicable and not less than 610 mm (24") from corners.

Resilient Sheet Flooring

- .9 Mitre corners.

3.5 Field Quality Control

- .1 Conduct quality control in accordance with Section 01 45 00.

- .1 Field tests and inspections:

- .1 Moisture and alkalinity:

- .1 Test for moisture vapour transmission in accordance with ASTM F710-22 and ASTM F1869-23 or ASTM F2170-19a in accordance with manufacturer's written flooring installation requirements. Results must not exceed 170 $\mu\text{g}/\text{m}^2$ (3 lb per 1,000 ft^2) in 24 hours when tested to ASTM F1869-23, or exceed 75% when tested to ASTM F2170-19a.
- .2 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 F710-22.
- .3 For each test type: Conduct 3 tests for flooring applications up to 93 m^2 (1000 ft^2) in area, and 1 additional test for each additional 93 m^2 (1000 ft^2) of flooring area.

- .2 Adhesion bond test:

- .1 Proceed with bond test after substrates have been prepared and alkalinity and moisture test have been completed.
- .2 Select six substrate test areas, each 915 mm (3'-0") x 915 mm (3'-0") in size. Test areas shall be spaced a minimum 1220 mm (48") apart.
- .3 Cut 915 mm (3'-0") x 915 mm (3'-0") panels from specified material.
- .4 Using the specified adhesive, glue down each panel using adhesive manufacturer's recommended trowel.
- .5 After 72 hours, attempt to remove the panels of flooring by pulling up from the corners.

- .3 In addition to the requirements of Section 01 45 00, the independent inspection and testing company shall:

- .1 In the presence of *Consultant* and manufacturer's representative, review installation procedures, preparation of substrate, bond test requirements, inspection of welds, protection methods for finished floor, and ensure that installation of flooring meets specified requirements.
- .2 Provide a certificate in writing indicating that preparation and installation of flooring including welding of joints is in compliance with the requirements of the Contract Documents.

- .4 Repair areas as directed by inspection and testing company or *Consultant*, as a result of any inspection and testing work.

- .2 Manufacturer's field review to be in accordance with Section 01 45 00.

Resilient Sheet Flooring

- .3 Provide a certificate in writing indicating that preparation and installation of flooring including welding of joints is in compliance with the requirements of the Contract Documents.

3.6 Adjusting and Cleaning

- .1 Remove excess adhesive from surfaces of the sheet flooring as work progresses.
- .2 Thoroughly clean surfaces in accordance with manufacturer's recommendations.

3.7 Protection

- .1 Prohibit foot traffic on installed flooring for a period of 24 hours after installation. No heavy traffic, rolling loads, or furniture placement are permitted for a minimum of 72 hours after installation.
- .2 Protect new floors from time of final set of adhesive until final inspection.
- .3 Install floor protection in areas where work, repairs and installation of equipment, and foot traffic will occur.

3.8 Maintenance

- .1 Perform initial maintenance in accordance with the manufacturer's written requirements.
- .2 Initial cleaning shall be performed a minimum 7 days after installation.
- .3 Dust mop and vacuum flooring.
- .4 Mix a neutral pH cleaning solution according to products requirements. PH level shall be between 6 – 8 pH.
- .5 Apply solution to flooring by means of mop and bucket or an automatic scrubber. Do not flood the floor.
- .6 Secure a red pad to the automatic scrubber, and scrub in multiple directions. Ensure the pad down pressure is set on "low" to avoid excessive friction.
 - .1 Do not scrub flooring with rigid brushes, steel wool or abrasive pads.
 - .2 Test cleaning products on flooring samples prior to use.
 - .3 Do not scrub dry or partially dry rubber flooring.
 - .4 Do not tilt a floor machine to dig into marks or stains.
- .7 Vacuum soiled solution, and rinse flooring well with clear water.
- .8 Allow flooring to dry prior to applying protection.

END OF SECTION

Fluid-Applied Floor Coatings

PART 1- GENERAL

1.1 Summary

- .1 Section includes:
 - .1 Fluid-applied flooring (SEF1).

1.2 Administrative Requirements

- .1 Coordination:
 - .1 Advise other trades of fixtures and fittings not to be installed until floor coating materials are cured, such as: radiators, painting, decorating, floor-supported equipment or cabinetwork, caulking, plumbing, fixtures, and the like.
- .2 Conduct a pre-installation meeting in accordance with Section 01 31 19.
 - .1 Independent inspection and testing company shall attend the pre-installation meeting.

1.3 Submittals

- .1 Submit required submittals in accordance with Section 01 33 00.
- .2 *Product* data sheets:
 - .1 Submit manufacturer's *Product* data sheets for *Products* proposed for use in the work of this section.
- .3 Shop drawings:
 - .1 Submit shop drawings showing proposed divider strips and start / stop installation lines. Coordinate locations with slab control joints. Lay out divider strips symmetrically in rooms.
- .4 Samples:
 - .1 Submit 305 mm x 305 mm (12" x 12") samples of each specified material, in each specified colour to show successive applications of each coat for *Consultant's* approval.
 - .2 Submit 305 mm x 305 mm (12" x 12") sample of completed system on rigid backing, demonstrating texture and broadcast aggregate, colour, and sheen, for *Consultant's* approval.
- .5 Manufacturers' instructions:
 - .1 Submit substrate preparation guidelines, installation instructions, and general recommendations.
- .6 Submit for approval a list of the floor coating materials intended for use in the *Work* for each substrate condition before installation commences.
- .7 Include sample of warranty customized for this Project.

Fluid-Applied Floor Coatings

1.4 Closeout Submittals

- .1 Submit closeout submittals in accordance with Section 01 78 00.
- .2 Operation and maintenance data:
 - .1 Submit manufacturer's operation and maintenance instructions for inclusion in the operation and maintenance manuals.
 - .2 Submit manufacturer's list of acceptable cleaning chemicals for each epoxy floor system specified in this section.

1.5 Quality Assurance

- .1 Qualifications:
 - .1 Execute the work of this section using workers skilled in the respective duties for which they are employed, and with minimum 5 years' experience in application of *Products*, systems, and assemblies specified.
 - .2 Installation of systems specified in this section to be by a single *Subcontractor*.
- .2 Mock-ups:
 - .1 *Provide* mock-up panel 5 m² (53.8 ft²) minimum area, of coating system at the *Place of the Work* as part of final installation for approval by *Consultant*, location to be determined by *Consultant*. Mock-up will serve as a benchmark for installation of the system for the *Work*.
 - .2 Construct mock-up at the *Place of the Work* of cove base at door frames.

1.6 Site Conditions

- .1 Unless required otherwise by manufacturer's installation requirements, maintain ambient temperature of not less than 13°C and not more than 32°C, and a floor temperature of not less than 16°C from 24 hours before installation to at least 72 hours after installation. Maintain relative humidity of not higher than 80% during same period.

1.7 Warranty

- .1 Warrant work of this section in accordance with Section 01 78 36.
- .2 Extended warranty:
 - .1 Labour, materials, and workmanship for work of this section.
 - .2 Duration: 2 years.

PART 2 - PRODUCTS

2.1 Performance/Design Requirements

- .1 Single source responsibility:
 - .1 Provide *Products* from one manufacturer for the work of this section, including accessory *Products* and materials.

Fluid-Applied Floor Coatings

- .1 Where manufacturer does not manufacture or supply required accessory *Products* and materials, any such accessory *Products* or materials supplied for use in the Work shall have approval from manufacturer for use as part of the final warranted installation.
- .2 Material compatibility: Provide materials that are compatible with one another under conditions of service and application required, as demonstrated by manufacturer based on testing and field experience.
- .3 Slip resistance: Floors shall have a wet Dynamic Coefficient of Friction (DCOF) of 0.42 or greater in accordance with ANSI A326.3-21.
- .4 Floors and wall coatings shall not show spalling, cracking, or delamination.

2.2 Fluid-Applied Flooring

- .1 Solid colour, four component, troweled, epoxy mortar system
- .2 Thickness: 6 mm.
- .3 Colour: Cool Shale
- .4 Finish:
 - .1 Gloss.
- .5 Integral cove base: 150 mm high.
- .6 Primer: as recommended by flooring system manufacturer for specific installation.
- .7 Physical Requirements:
 - .1 Compressive Strength: 69 MPa (10,000 PSI), in accordance with ASTM C579.
 - .2 Tensile Strength: 12 MPa (1750 PSI), in accordance with ASTM C307.
 - .3 Flexural Strength: 27.5 MPa (4000 PSI), in accordance with ASTM C580.
 - .4 Abrasion Resistance (with application of epoxy top coat): 0.1 g, in accordance with ASTM D4060-14, Taber Abrader CS-17 wheel, 1000 g load, 1000 cycles.
- .8 Waterproofing; 100% solids, two component, liquid applied, urethane waterproofing membrane and crack bridging isolation layer:
 - .1 Acceptable *Product*: Stonhard 'Stonproof ME7'.
- .9 Epoxy top coat; a two-component, solvent-free, epoxy coating.
 - .1 Colour: Cool Shale.
 - .1 Number of coats: 2.
 - .2 Acceptable *Product*: Stonhard 'Stonkote GS4'.
- .10 Acceptable *Products* and Manufacturers:
 - .1 Stonhard 'Stonclad GS System with Stonproof ME7 and Stonkote GS4'.
 - .2 Substitutions: in accordance with Section 01 25 00.

Fluid-Applied Floor Coatings

PART 3- EXECUTION

3.1 Examination

- .1 Verify that specified site conditions exist before commencing the work of this section.
- .2 Examine surfaces to receive floor and wall coatings. Surfaces shall be smooth, sound, dry, and free from conditions that will adversely affect execution, permanence, or quality of work.
- .3 Verify that surfaces to receive coatings can be put into acceptable condition by means of preparation specified in this section.
- .4 Floor surfaces to receive coating shall be equivalent to a light steel trowel finish for new or patched concrete surface.
- .5 Examine floor surfaces to be coated for slope to drain irregularities which could create non-sloping or ponding conditions on the epoxy coating surface.
- .6 Verify that floor drains are installed flush with top of floor slabs.
- .7 Commencement of installation implies acceptance of surfaces as suitable to receive coating system.

3.2 Preparation

- .1 After acceptance of surfaces, prepare them as required to receive the work of this section. Remove projections and other conditions that may affect the installation of the flooring system.
- .2 Concrete slabs shall have sound surface free of dust, chemicals, grease, oil, laitance and curing agents.
- .3 Remove curing compounds, surface hardeners, existing flooring adhesives, and epoxy flooring coatings in accordance with manufacturer's written recommendations.
- .4 Fill open control joints, and other cracks and voids with sealant material compatible with floor coating materials.
- .5 Remove projections and other conditions which may affect installation of the coating.
- .6 Repair surface spalls and imperfections with patching compound approved by manufacturer.
- .7 Prepare concrete surfaces by mechanical method of steel shotblast, sandblast, or other method approved by coating manufacturer in accordance with International Concrete Repair Institute (ICRI) recommendations to achieve a CSP 3 profile. Thoroughly vacuum clean floors upon completion of blast operation. Substrate to be approved in writing by manufacturer prior to application of coating.
 - .1 Submit written report to *Consultant* following procedures for manufacturer's field review in accordance with Section 01 45 00.
- .8 Alkalinity and moisture testing:
 - .1 Test substrates in accordance with Field Quality Control paragraphs of Section 09 67 00 after mechanically preparing subfloor or applying patching and levelling compounds.

Fluid-Applied Floor Coatings

- .2 Proceed with installation only after substrates pass testing. Document tests performed and submit in writing to *Consultant*.
- .9 Cover or mask surfaces adjacent to those receiving coating to protect work of others and property from damage and soil.

3.3 Installation

- .1 General:
 - .1 Apply coatings with care to ensure that no laps, voids, or other marks or irregularities are visible, and with an appearance of uniform colour, sheen and texture, all within limitations of materials and areas concerned.
 - .2 Match colours and textures of approved samples.
 - .3 Make clean true junctions with no visible overlap between adjoining applications of coatings.
 - .4 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. Do not install flooring to floor drains occurring within finished floor areas.
 - .5 Place cloths and other disposable coating materials, that are a fire hazard, in closed metal containers and remove from building every night.
 - .6 Verify that spark-proof electrical equipment is used in area where inflammable materials are being applied.
 - .7 Erect barriers to prevent the entry and presence of personnel not performing work of this section during application of coatings, and for 48 hours following completion of application.
 - .8 Apply coating system in compliance with coating manufacturer's directions to produce a pinhole free surface that also provides a positive slope to drains in flooring system.
 - .9 Apply coatings in continuous manner, starting and stopping in straight lines centre at doorways or other building lines; haphazard installation continuation lines will not be permitted.
- .2 Application; flooring system:
 - .1 Terminate flooring in straight lines at centreline of door in openings where adjacent floor finish or colour is dissimilar.
 - .2 Install waterproofing and crack bridging system in accordance with manufacturer's recommendations.
 - .3 Fluid applied floor system installation to provide slope to drains as required, incorporating minimum 1% slope unless otherwise indicated.
 - .4 Trowelled or broadcast installation shall not show telegraphing of substrate or trowel or toolmarks.

Fluid-Applied Floor Coatings

- .5 Trowelled or broadcast installation shall be homogenous free of substrate lines, pockets, bumps and unevenness greater than 1.5 mm (1/16") in 300 mm (12"), not including texture.
- .6 Prime coat: mix components and apply primer over prepared substrate at manufacturer's recommended spreading rate, with timing of application coordinated with subsequent application of topping mix to ensure optimum adhesion between flooring materials and substrate.
- .7 Body coat: mix components and trowel apply body coats over tacky primer at spreading rates as recommended by manufacturer. Broadcast aggregate into wet body coat. Build up flooring system as required to provide positive slope to drains.
- .8 Clean surface prior to application of finish coat for approval by *Consultant*.
- .9 Finish coats: Squeegee apply finish coats over tacky primer at spreading rates as recommended by manufacturer.
- .10 Provide zinc termination strips, of appropriate thickness, at cove base and where flooring system meets different flooring types.
- .11 Install beads at top of bases, and apply coating to wall with cove formed at junction with floor.
- .12 Apply cove base to a height of 150 mm (6") on vertical surfaces unless shown otherwise. Apply a continuous and even radius at floor transition. Apply base screed at termination of base. Fill gaps between base screed and wall with underlayment material.
- .3 Use saw cut and chip method at termination locations unless otherwise indicated.
- .4 Joints: Where substrate is interrupted by expansion or control joints, provide joint in coating system to comply with details indicated, or if not indicated, as recommended by coating system manufacturer. Fill joints with specified compounds.
- .5 Match approved samples in sheen, colour and texture.

3.4 Field Quality Control

- .1 Conduct quality control in accordance with Section 01 45 00.
 - .1 Field tests and inspections:
 - .1 Moisture and alkalinity:
 - .1 Test for moisture vapour transmission in accordance with ASTM F1869-23 in accordance with manufacturer's written installation requirements. Maximum percentage of moisture acceptable is 1.8 kg/93 m² (4 lb/1000 ft²) in a 24 hour period, unless otherwise specified by manufacturer's printed literature.
 - .2 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 F710-22.

Fluid-Applied Floor Coatings

- .3 For each test type: Perform 3 tests for flooring applications less than 186 m² (2000 square feet) in area, and 1 test per additional 93 m² (1000 square feet).
- .1 Water test and inspection:
 - .1 Inspect waterproofing system installation during and upon completion of the work. Floor coating system shall not be completed until waterproofing system is inspected.
 - .2 Test for water leaks if instructed by Consultant.
- .2 Manufacturer's field review to be in accordance with Section 01 45 00.

3.5 Adjusting and Cleaning

- .1 Touch up and refinish minor defective work. Refinish entire coated surface areas where finish is damaged or otherwise unacceptable.
- .2 Remove promptly as work progresses spilled or spattered coating materials from surfaces of work performed under other sections. Clean surfaces on completion of work. Do not mar surfaces while removing.
- .3 Leave storage and mixing areas in same condition as equivalent spaces in project. Clean flooring just prior to final acceptance using materials and procedures recommended by flooring manufacturer.
- .4 Final cleaning is specified in Section 01 74 00.

END OF SECTION

Painting

PART 1- GENERAL

1.1 Summary

- .1 Section includes:
 - .1 Painting of interior paintable surfaces.
 - .2 Repainting of interior surfaces.
- .2 Paintable and non-paintable surfaces:
 - .1 Paint and finish paintable surfaces included in the *Work*, except where excluded by the *Contract Documents*.
 - .2 The following surfaces are considered non-paintable, except as otherwise indicated or scheduled:
 - .1 Material and equipment furnished prime and finish painted.
 - .2 Internal surfaces of steel tanks and stacks.
 - .3 Sprayed fire-resistive materials.
 - .4 Stainless steel, weathering steel, copper, bronze, chromium plate, nickel, anodized or lacquered or mill finished aluminum, Monel metal.
 - .5 Insulation, glass, plastic, brick, stone.
 - .6 Metallic and mastic insulation finishes.
 - .7 Abrasive material finishes on floors, stair treads, stair nosing and landings.
 - .8 Insulated electric cables.
 - .9 Machined parts of machinery and equipment.
 - .10 Concealed surfaces.
 - .11 Manufactured finish materials.

1.2 Administrative Requirements

- .1 Conduct a pre-installation meeting in accordance with Section 01 31 19.
 - .1 Agenda shall include review of preparation requirements for surfaces to be repainted, including clear identification of responsibility for preparation of DSD-4 surfaces. *Contractor* shall be solely responsible for determining which *Subcontractor* shall prepare of each DSD-4 surface.

1.3 Definitions

- .1 MPI Manual:
 - .1 MPI Manual shall mean the latest edition of either the Master Painters Institute Architectural Painting Specification Manual, or the Master Painters Institute Maintenance Repainting Specification Manual, or both, as applicable, and shall include Identifiers, Evaluation, Systems, Preparation, and Approved Product List. MPI Manual shall be as issued by the local MPI Accredited Quality Assurance Association having jurisdiction.

Painting

1.4 Submittals

- .1 Submit required submittals in accordance with Section 01 33 00.
- .2 *Product* data sheets:
 - .1 Submit manufacturer's *Product* data sheets and list of *Products* proposed for use in the work of this section as identified in 'Approved Product List' section of the MPI Manual. Correlate *Products* to Schedule furnished by *Consultant*.
- .3 Samples:
 - .1 Samples for initial paint colour and finish selection:
 - .1 Submit manufacturer's colour charts showing full range of colours available, including light and deep dark tones, for each type of finish material indicated for colour selection by *Consultant*.
 - .2 *Consultant* shall have complete freedom in choice of colours in compiling colour schedule and will not necessarily select colours from standard colour charts of manufacturer of *Products* specified.
 - .3 Submit 3 drawdowns of each selected colour for review by *Consultant* and resubmit to *Consultant* as required to obtain approval. Drawdown to be of specified colour, sheen, and paint formula for applicable surface.
 - .2 Samples for verification:
 - .1 Submit 3 samples on 200 mm x 305 mm (8"x 12") material of same type as that on which coating is to be applied, for *Consultant's* approval, at least 30 days before materials are required.
 - .2 Identify each sample as to *Project*, finish, formula, colour name, number, gloss name and number, date and name of *Contractor* and painting *Subcontractor*.
 - .3 Resubmit as required until colours and gloss value are approved.
- .4 MPI Manual:
 - .1 Maintain 1 copy of MPI Manual at site office for reference.

1.5 Closeout Submittals

- .1 Submit closeout submittals in accordance with Section 01 78 00.
- .2 Operation and maintenance data:
 - .1 Submit manufacturer's operation and maintenance instructions for inclusion in the operation and maintenance manuals.
- .3 Maintenance materials:
 - .1 Provide 2 sealed containers, each of 4 litres (1 gallon) capacity of each paint product in each colour used in the *Work* for *Owner's* maintenance use. Containers shall be new, clearly labelled with manufacturer's name, type of paint, colour and colour number. Store at *Place of the Work* where directed by *Owner*.

1.6 Quality Assurance

- .1 Qualifications

Painting

- .1 Execute the work of this section using workers skilled in the respective duties for which they are employed, and with minimum 3 years' experience in application of *Products*, systems, and assemblies specified.

1.7 Product Handling

- .1 Product handling shall be in accordance with Section 01 60 00 as supplemented by the requirements of this section.
- .2 Deliver painting materials in sealed, original labelled containers bearing manufacturer's name, brand name, type of paint or coating and colour designation, standard compliance, materials content as well as mixing and/or reducing and application requirements.
- .3 Store paint *Products* and materials in original labelled containers in secure (lockable), dry, heated and well ventilated single designated area meeting minimum requirements of both paint manufacturer and authorities having jurisdiction, and at a minimum ambient temperature of 7°C.
- .4 Protect floor and wall surfaces of storage area. Protect floors with sheets or clean plywood or metal pans where mixing is being carried out.

1.8 Site Conditions

- .1 Comply with environmental requirements of MPI Manual.
- .2 Perform no painting work when ambient air and substrate temperatures are below 10°C for both interior and exterior work, unless suitable weatherproof covering and sufficient heating and ventilation facilities are in place in accordance with MPI Manual.
- .3 Perform no painting work when relative humidity is above 85% or when dew point is less than 3°C (5°F) variance between air/surface temperature.

1.9 Warranty

- .1 Warrant work of this section in accordance with Section 01 78 36.
- .2 Extended warranties:
 - .1 System:
 - .1 Labour, materials, and workmanship for work of this section.
 - .2 Duration: 2 years.

PART 2- PRODUCTS

2.1 Performance/Design Requirements

- .1 Except where more stringent requirements are specified, the MPI Manual shall govern the work of this section.
- .2 Materials, preparation and workmanship shall be in accordance with requirements of the MPI Manual.
- .3 Painting systems:

Painting

- .1 Shall remain free from failure due to causes including: material failure; surface preparation less than that specified; and paint film thickness less than that specified, or when not specified, less than that coverage recommended by manufacturer.
- .2 Presence of any of following shall constitute failure: visible corrosion; film peeling, blistering, checking, scaling, embrittling or general film disintegration; and poor adhesion as determined by tape "peel-off" test procedures.

2.2 Materials

- .1 Products listed in MPI Manual shall be used in the *Work*, unless specified otherwise.
- .2 Paint and materials (primers, paints, coatings, varnishes, stains, lacquers, fillers, thinners, solvents, and the like) shall be in accordance with the MPI Manual "Approved Product" listing and shall be from a single manufacturer for each system used.
- .3 Other paint materials, such as linseed oil, shellac, and the like, shall be highest quality *Products* of an approved manufacturer listed in the MPI Manual and shall be compatible with other coating materials as required.
- .4 Paint materials shall have good flowing and brushing properties and shall dry or cure free of blemishes or sags.
- .5 Where required, paints and coatings shall meet flame spread and smoke developed ratings designated by building code requirements and/or authorities having jurisdiction.

2.3 Equipment

- .1 Painting and coating equipment in accordance with written requirements of MPI Manual.

2.4 Mixing and Tinting

- .1 Unless otherwise specified, paints shall be ready-mixed. Re-mix prior to application to ensure colour and gloss uniformity.
- .2 Paste, powder or catalyzed paint mixes shall be mixed in accordance with manufacturer's written requirements.
- .3 Perform colour tinting operations prior to delivery of paint to *Place of the Work*.
- .4 Where thinner is used, addition shall not exceed paint manufacturer's recommendations.

2.5 Colours and Gloss Levels

- .1 Paint colours and gloss levels shall be as selected by the *Consultant*. Locations as indicated or scheduled.
- .2 Colour and gloss schedule: in accordance with the Finishes Schedule.
- .3 Paint gloss shall be defined as the sheen rating of applied paint, in accordance with the following MPI values:

Gloss Level	Description	Units @ 60 degrees	Units @ 85 degrees
G1	Matte or Flat finish	0 to 5	10 maximum
G2	Velvet finish	0 to 10	10 to 35

Painting

G3	Eggshell finish	10 to 25	10 to 35
G4	Satin finish	20 to 35	35 minimum
G5	Semi-gloss finish	35 to 70	
G6	Gloss finish	70 to 85	
G7	High-Gloss finish	> 85	

PART 3 - EXECUTION

3.1 Examination

- .1 Verify that specified site conditions exist before commencing the work of this section.
- .2 Prior to commencement of work of this section, examine surfaces scheduled to be painted.
 - .1 For surfaces to be repainted, the degree of surface deterioration (DSD) shall be assessed using assessment criteria in accordance with the MPI Repainting Manual.
- .3 Check moisture content and alkalinity of surfaces to be painted.
 - .1 Check moisture content of surfaces to be painted using properly calibrated electronic moisture meter approved by paint manufacturer, and *Consultant*, or other approved method. Maximum moisture contents shall be in accordance with manufacturer's recommendations and as follows:
 - .1 Concrete and concrete masonry (clay and concrete brick/block): Maximum 12%.
 - .2 Gypsum board and plaster: Maximum 12%.
 - .3 Wood: Maximum 15%.
 - .2 Conduct moisture tests on concrete floors using cover patch test method.
 - .3 Test concrete, masonry and plaster surfaces for alkalinity.
- .4 Inspect surfaces to be coated for gouges, marks, nibs, and other defects and properly prepare patching, filling, smoothing or other surface preparation necessary to ensure satisfactory finish.
- .5 Report in writing any condition adversely affecting work of this section.
- .6 Proceed with work only when surfaces and conditions are satisfactory. Remove dust, grease, rust, scale and extraneous matter, tool and machine marks and insects from surfaces which could be detrimental to a satisfactory and acceptable finish.

3.2 Preparation

- .1 Comply with manufacturer's written requirements and recommendations in MPI Manual applicable to substrates and paint systems indicated.
- .2 Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
 - .1 After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.

Painting

- .3 Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, mildew, grease, and incompatible paints, encapsulants, and other deleterious materials.
- .4 Paint surfaces when moisture content or alkalinity of surfaces to be painted comply with Field Quality Control paragraphs in Section 09 91 00.
- .5 Concrete substrates: Remove release agents, curing compounds, efflorescence, and chalk.
- .6 Masonry substrates: Remove efflorescence and chalk.
- .7 Shop-primed steel substrates: Clean field welds, bolted connections, and areas where shop paint is abraded. Paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.
- .8 ZF75 and ZF120 galvanized-metal substrates: Remove grease and oil residue from galvanized sheet metal by methods to produce clean surfaces that promote adhesion of subsequently applied paints.
- .9 Aluminum substrates: Remove loose surface oxidation.
- .10 Wood substrates for paint finish:
 - .1 Scrape and clean knots, and apply coat of knot sealer before applying primer.
 - .2 Sand surfaces that will be exposed to view, and dust off.
 - .3 Prime edges, ends, faces, undersides, and backsides of wood.
 - .4 After priming, fill holes and imperfections in the finish surfaces with putty or plastic wood filler. Sand smooth when dried.
- .11 Substrates to be repainted:
 - .1 Prepare surfaces for repainting in accordance with MPI Repainting Manual requirements.

3.3 Installation

- .1 Do not paint unless substrates are acceptable and/or until Field Conditions (heating, ventilation, lighting and completion of work of other sections) are acceptable for applications of *Products*.
- .2 Apply primer, paint or stain in accordance with MPI Manual finish requirements based on Grade specified below in Section 09 91 00.
- .3 Schedule application of paints and coatings after cleaning to prevent field conditions causing flash-rusting, rusting, weathering or water damage to substrate, or other contamination of the substrate. Comply with MPI manual and manufacturer's written requirements, the most stringent of which shall govern.
- .4 Painting coats specified are intended to cover surfaces satisfactorily when applied at proper consistency and in accordance with manufacturer's recommendations.
- .5 Tint each coat of paint progressively lighter to enable confirmation of number of coats.
- .6 Unless otherwise approved by *Consultant*, apply a minimum of 4 coats of paint where deep or bright colours are used to achieve satisfactory results.

Painting

- .7 Sand and dust between each coat to provide an anchor for next coat and to remove defects visible from a distance up to 1000 mm (39").
- .8 Do not apply finishes on surfaces that are not sufficiently dry. Unless manufacturer's directions state otherwise, each coat shall be sufficiently dry and hard before a following coat is applied.
- .9 Prime coat of stain or varnish finishes may be reduced in accordance with manufacturer's directions.
- .10 Paint finish shall continue through behind wall-mounted items (i.e. chalk and tack boards) and exposed/ visible in complete work including interiors of cupboards and closets, tops of doors, trim, and the like, whether in sight line or not, including behind surface mounted fixtures and heating units.
- .11 *Consultant* shall have right to make changes in colour tone of finishes prior to final coat to obtain desired results without additional cost to *Owner*.
- .12 Access doors, prime coated butts and other prime painted hardware, registers, radiators and covers, exposed piping and electrical panels shall be painted to match adjacent surfaces in terms of colour, texture and sheen, unless otherwise indicated.

3.4 Field Quality Control

- .1 Conduct quality control in accordance with Section 01 45 00.
- .2 Paint and coating quality assurance inspection:
 - .1 Painted surfaces shall be considered to lack uniformity and soundness if any of the following defects are apparent to the *Consultant*:
 - .1 Brush / roller marks, streaks, laps, runs, sags, drips, heavy stippling, hiding or shadowing by inefficient application methods, skipped or missed areas, and foreign materials in paint coatings.
 - .2 Evidence of poor coverage at rivet heads, plate edges, lap joints, crevices, pockets, corners and re-entrant angles.
 - .3 Damage due to touching before paint is sufficiently dry or any other contributory cause.
 - .4 Damage due to application on moist surfaces or caused by inadequate protection from weather.
 - .5 Damage and/or contamination of paint due to blown contaminants (dust, spray paint, etc.).
 - .2 Painted surfaces shall be considered unacceptable if any of the following are evident under natural lighting source for exterior surfaces and final lighting source (including daylight) for interior surfaces to the *Consultant*:
 - .1 Visible defects are evident on vertical and horizontal surfaces when viewed at normal viewing angles from a distance of not less than 1000 mm (39").
 - .2 Visible defects are evident on ceiling, soffit and other overhead surfaces when viewed at normal viewing angles.

Painting

- .3 When final coat on any surface exhibits a lack of uniformity of colour, sheen, texture, and hiding across full surface area.
- .3 Painted surfaces rejected by the *Consultant* shall be made good at the expense of the *Subcontractor*. Small affected areas may be touched up; large affected areas or areas without sufficient dry film thickness of paint shall be repainted. Runs, sags of damaged paint shall be removed by scraper or by sanding prior to application of paint.
- .4 Painting *Subcontractor* shall obtain from *Contractor* written confirmation of specific surface preparation procedures and primers used for fabricated steel items from the fabricator/*Supplier* to ascertain appropriate and manufacturer compatible finish coat materials to be used before painting any such work.

3.5 Adjusting and Cleaning

- .1 Promptly as work proceeds and on completion of *Work*, remove paint where spilled, splashed or spattered during the progress of the *Work*. Keep the premises free from unnecessary accumulation of tools, equipment, surplus materials and debris; at the conclusion of the work leave the premises clean.

3.6 Interior Paint Systems

- .1 System references listed are based on MPI Manual and are Premium Grade, Low VOC (Green Seal GS-11), unless otherwise indicated:
 - .1 Concrete vertical surfaces: (including ceilings)
 - .1 INT 3.1A Latex finish (over primer).
 - .2 Primed ferrous metal; touch-up and finish coats required under this section:
 - .1 Ferrous metal fabrications: Prepared and primed in accordance with Section 05 50 00.
 - .2 INT 5.1R High performance architectural latex finish (over alkali resistant primer).
 - .3 Sprinkler pipe:
 - .1 Prepare substrate in accordance with coating manufacturer's recommendations.
 - .2 Penetrating sealer: AkzoNobel 'Devoe High Performance Coatings PRE-PRIME 167 Penetrating Sealer', 37.5 microns (1.5 mils) DFT.
 - .3 Finish coat: AkzoNobel 'Devoe Devran 224HS High Solids Epoxy Coating', 100-200 microns (4-8 mils) DFT.
 - .3 Galvanized metal: (doors, frames, railings, misc. steel, pipes, overhead decking, ducts, etc.)
 - .1 INT 5.3M High performance architectural latex.
 - .4 Plaster and gypsum board: (gypsum board and textured finishes)
 - .1 INT 9.2B High performance architectural latex finish (over latex primer/sealer).

Painting

- .2 INT 9.2E Epoxy (tile-like) finish.
- .3 Use high-hide primer sealer type at glass mat finished gypsum board.

3.7 Interior Repaint Systems

- .1 System references listed are based on MPI Repainting Manual and are Premium Grade, Low VOC (Green Seal GS-11), unless otherwise indicated:
 - .1 Concrete vertical surfaces: (including ceilings)
 - .1 RIN 3.1J High performance architectural latex.
 - .2 Structural steel and metal fabrications (columns, beams, joists, etc.)
 - .1 RIN 5.1R High performance architectural latex.
 - .3 Galvanized metal: (doors, frames, etc.)
 - .1 RIN 5.3J High performance architectural latex (do not use flat finish on doors and door frames).
 - .4 Plaster and gypsum board: (gypsum board and textured finishes)
 - .1 RIN 9.2B High performance architectural latex finish.
 - .2 RIN 9.2E Epoxy-modified latex finish.

END OF SECTION

Visual Display Surfaces

PART 1- GENERAL

1.1 Summary

- .1 Section includes:
 - .1 Marker boards (whiteboards).
 - .2 Related trim, adhesives, and fastenings.

1.2 Submittals

- .1 Submit required submittals in accordance with Section 01 33 00.
- .2 *Product* data sheets:
 - .1 Submit manufacturer's *Product* data sheets for *Products* proposed for use in the work of this section.
- .3 Shop drawings:
 - .1 Submit engineered shop drawings, including seismic design, connections and restraint.
 - .2 Show proposed system of anchorage and materials being supplied on shop drawings submitted for review.
 - .3 Show dimensional layouts, hardware items, anchorage devices, dimensions, description of materials and finishes, and all other pertinent information.
- .4 Samples:
 - .1 Submit 305 mm x 305 mm (12" x 12") samples of each *Product* specified, diagonally cut to show cross section through assembly, complete with accessories and trim.

1.3 Closeout Submittals

- .1 Submit closeout submittals in accordance with Section 01 78 00.
- .2 Operation and maintenance data:
 - .1 Submit manufacturer's operation and maintenance instructions for inclusion in the operation and maintenance manuals.

1.4 Quality Assurance

- .1 Qualifications:
 - .1 Execute the work of this section using workers skilled in the respective duties for which they are employed, and with minimum 3 years' experience in application of *Products*, systems, and assemblies specified.

1.5 Warranty

- .1 Warrant work of this section in accordance with Section 01 78 36.
- .2 Provide manufacturer's standard product warranty.

Visual Display Surfaces

PART 2 - PRODUCTS

2.1 Design/Performance Requirements

- .1 Trademarks and labels:
 - .1 No trademarks or labels will be accepted on exposed finished work.

2.2 Marker Boards (Whiteboards)

- .1 Acceptable manufacturers:
 - .1 ASI Visual Display Products.
 - .2 Claridge – CPE Design Solutions.
 - .3 Delta Products Ltd.
 - .4 Global School Products Inc.
- .2 Porcelain enamel board with porcelain enamel writing surface. Boards shall be manufactured in accordance with Porcelain Enamel Institute's standards. Gloss factor: 6-8 as measured by 45° glossmeter.
 - .1 Face Sheet: 28 gauge Porcelain Enamel Steel.
 - .1 Colour: White colour writing surface, designed for long lasting heavy duty marker writing surface, free of permanent marker staining.
 - .2 Core:
 - .1 11 mm (7/16") MDF.
 - .3 Backing: moisture barrier back.
- .3 Joints shall be absolutely flush and level, plumb true with edges finished square and fitted as closely as possible. Use concealed joint fasteners.
- .4 Particle board backing to CAN3-0188.1-M78, 6 mm (1/4") thick, with sanded faces.
- .5 Concealed mechanical joining system: join abutting panels with a spline as recommended by the manufacturer.
- .6 Trim:
 - .1 Aluminum trim in accordance with Trim Components paragraph below.

2.3 Trim Components

- .1 Acceptable Manufacturers:
 - .1 ASI Visual Display Products.
 - .2 Claridge – CPE Design Solutions.
- .2 Aluminum trim:
 - .1 Acceptable Products:
 - .1 ASI '9800 Series' trim or similar equivalent.
- .3 Extruded aluminum components, AA6063 T5 or approved alternative, 19 mm x 19 mm x 3 mm (3/4" x 3/4" x 1/8"), mitred corners.

Visual Display Surfaces

- .4 Finish: etched and clear anodized 0.051 mm (0.002") satin finish free from extruding draw marks and surface scratches.
- .5 Final assembly to have seamless/welded flush and level butt joints. No visible joints accepted and no intermediate trim.

2.4 Attachment Hardware

- .1 Use manufacturer's standard mounting hardware.

PART 3 - EXECUTION

3.1 Installation

- .1 Install in accordance with manufacturer's written installation requirements.
- .2 Locate seams as directed by the Consultant.

3.2 Installation - Trim Components

- .1 Install in accordance with manufacturer's written installation requirements.

3.3 Installation Tolerances

- .1 Install plumb, level, tight and secured. Comply with the following maximum tolerances:
 - .1 Within 1.5 mm (1/16") of plumb and level, and flush with adjacent panels.
 - .2 Within 25 mm (1") variation from indicated position.

3.4 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, 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

Privacy Screens

PART 1- GENERAL

1.1 Summary

- .1 Section includes:
 - .1 Privacy screens PRSCR001 at locations indicated.

1.2 Submittals

- .1 Submit required submittals in accordance with Section 01 33 00.
- .2 *Product* data sheets:
 - .1 Submit manufacturer's *Product* data sheets for *Products* proposed for use in the work of this section.
- .3 Shop drawings:
 - .1 Submit engineered shop drawings.
 - .2 Submit shop drawings showing details of items to be provided, including quantity, sizes, arrangement, trim, fastenings, materials, thicknesses and gauges, finishes and other pertinent data, including seismic design, connections and restraint.
 - .3 Clearly indicate fabrication details, plans, elevations, hardware, and installation details.
- .4 Samples: Submit duplicate samples of each finish specified.
- .5 Templates
 - .1 Submit templates to *Contractor* for use by installers and fabricators as required for proper location and installation of hardware.

1.3 Closeout Submittals

- .1 Submit closeout submittals in accordance with Section 01 78 00.
- .2 Operation and maintenance data:
 - .1 Submit manufacturer's operation and maintenance instructions for inclusion in the operation and maintenance manuals.

1.4 Quality Assurance

- .1 Qualifications:
 - .1 Execute the work of this section using workers skilled in the respective duties for which they are employed, and with minimum 3 years' experience in application of *Products*, systems, and assemblies specified.

Privacy Screens

PART 2 - PRODUCTS

2.1 Materials

- .1 Privacy screens; accordion design, hard surface type:
 - .1 Acceptable Product: Silentia 'Folding Screen'.
 - .1 Laminated panels; screen manufacturer's standard:
 - .1 Colour: to later selection by *Consultant*.
 - .2 Mounting method: Manufacturer's standard wall mounted bracket.
 - .1 Mounting orientation: as indicated or scheduled.
 - .3 Screen size: as indicated or scheduled.
 - .2 Substitutions in accordance with Section 01 25 00.

2.2 Fabrication

- .1 Fabricate work of this section using skilled craftsmen in accordance with the best practice in the shops of companies specializing in the work specified.
- .2 Fabricate work true to dimensions, square, plumb and level in accordance with final reviewed shop drawings. Accurately fit joints and intersecting members with adequate fastenings.
- .3 Provide finished work free from distortion and defects detrimental to appearance and performance.
- .4 Verify dimensions at the *Place of the Work* before preparing shop drawings or proceeding with shop work. Fit, shop assemble, and deliver to *Place of the Work* in the largest practicable sections.

PART 3- EXECUTION

3.1 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' specifications and installation requirements, true, tightly fitted, and level or flush to adjacent surfaces, as suitable for installation.
- .3 *Provide* reinforcing, fastenings and anchorage required for building in of products as recommended by manufacturer.
- .4 Fit joints and junction between components tightly and in true planes, conceal and weld joints where possible.

Privacy Screens

- .5 Fabricate products with materials and component sizes, metal gauges, hardware, reinforcing, anchors, and fastenings of adequate strength to ensure that Work will remain free of warping, buckling, opening of joints and seams, and distortion within limits of intended use.

3.2 Adjusting and Cleaning

- .1 Verify under work of this section that installed products function properly, and adjust them accordingly to ensure satisfactory operation.
- .2 Refinish damaged or defective work so that no variation in surface appearance is discernible.

END OF SECTION

Corner Guards and Wall Protection

PART 1- GENERAL

1.1 Summary

- .1 Section includes:
 - .1 Corner guards.
 - .2 Hand rail.
 - .3 Bumper guard.
 - .4 Crash rail.
 - .5 Sheet wall protection.

1.2 Submittals

- .1 Submit required submittals in accordance with Section 01 33 00.
- .2 *Product* data sheets:
 - .1 Submit manufacturer's *Product* data sheets for *Products* proposed for use in the work of this section.
- .3 Samples:
 - .1 Submit 3 samples, 300 mm (12") long or 300 x 300 mm (12 x 12") in size as applicable, for each *Product* in specified finish.
- .4 Shop drawings:
 - .1 Include plans, elevations, hardware, and installation details.
 - .2 Show seam locations.
- .5 Templates:
 - .1 Submit templates to *Contractor* for use by installers and fabricators as required for proper location and installation of hardware.

1.3 Site Conditions

- .1 Install materials of this section only when surfaces and air temperatures have been maintained between 18°C and 24°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. Relative humidity shall be 50% +/- 10%.

1.4 Warranty

- .1 Warrant work of this section in accordance with Section 01 78 36.
- .2 Extended warranty:
 - .1 Labour, materials, and workmanship for work of this section.
 - .2 Duration: 2 years.

Corner Guards and Wall Protection

PART 2 - PRODUCTS

2.1 General

- .1 Incorporate reinforcing, fastenings and anchorage required for building-in of *Products*.
- .2 Heights of corner guards are to be full wall heights.

2.2 Corner Guard Protection

- .1 Corner guard:
 - .1 Material: Stainless steel.
 - .2 Colour/finish: to later selection by *Consultant* from manufacturer's full range.
 - .3 Angle: 90 degrees.
 - .4 Leg length: Match existing.
 - .5 Mounting method: adhered.
 - .1 Adhesive: in accordance with corner guard manufacturer's written requirements.
 - .6 Acceptable *Products*:
 - .1 Match existing.
 - .2 Substitutions: in accordance with Section 01 25 00.

2.3 Bumper Guards

- .1 Bumper guards:
 - .1 Colour: to later selection by *Consultant* from manufacturer's full range.
 - .2 Acceptable *Product*:
 - .1 Match existing.
 - .2 Substitutions: in accordance with Section 01 25 00.
 - .3 Sealants: in accordance with Section 07 92 00.

2.4 Hand Rails

- .1 Hand rails:
 - .1 Colour: to later selection by *Consultant* from manufacturer's full range.
 - .2 Acceptable *Product*:
 - .1 Match existing.
 - .2 Substitutions: in accordance with Section 01 25 00.
 - .3 Sealants: in accordance with Section 07 92 00.

2.5 Crash Rails

- .1 Crash rails:

Corner Guards and Wall Protection

- .1 Colour: to later selection by *Consultant* from manufacturer's full range.
- .2 Acceptable *Product*:
 - .1 Match existing.
 - .2 Substitutions: in accordance with Section 01 25 00.
- .3 Sealants: in accordance with Section 07 92 00.

2.6 Sheet Wall Protection

- .1 Sheet wall protection:
 - .1 Acceptable *Product*:
 - .1 Match existing.
 - .2 Substitutions: in accordance with Section 01 25 00.
 - .2 Description:
 - .1 Colour: to later selection by *Consultant* from manufacturer's full range.
 - .2 Texture: to later selection by *Consultant* from manufacturer's full range.
 - .3 Fire performance:
 - .1 Flame spread: 25 in accordance with CAN/ULC-S102-10.
 - .4 Accessories:
 - .1 Division bars and corner trim: Panel manufacturer's standard length extruded vinyl pieces; longest length possible to eliminate end joints, colour to match panels.
 - .2 Manufacturer's standard adhesive and mounting hardware.

PART 3- EXECUTION

3.1 Installation

- .1 Install work to meet manufacturer's written requirements, 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 Installation for bumper guards, hand rails, crash rails:
 - .1 Mechanically fasten with top surface parallel to finished floor line to height indicated.
 - .2 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:
 - .1 Corner guard edges shall be smooth.

Corner Guards and Wall Protection

- .2 Adhere corner guards with continuous adhesive beads in accordance with manufacturer's written requirements.
- .3 Visible fasteners are not permitted.
- .4 Install corner guard shall be tightly fitted without gaps.
- .7 Sheet wall protection:
 - .1 Install sheet wall protection in accordance with sheet manufacturer's written recommendations.
 - .2 Provide required cut-outs for electrical outlets and wall penetrations.

END OF SECTION

Accessories

PART 1- GENERAL

1.1 Summary

- .1 Section includes:
 - .1 Coordination and installation of washroom accessories as supplied by *Owner* and installed by the *Contractor*.

1.2 Administrative Requirements

- .1 Coordination:
 - .1 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:
 - .1 Submit manufacturer's *Product* data sheets for *Products* proposed for use in the work of this section.
- .3 Samples:
 - .1 Submit 3 samples of each finish specified.
- .4 Shop drawings:
 - .1 Include plans, elevations, hardware, and installation details.

1.4 Closeout Submittals

- .1 Submit closeout submittals in accordance with Section 01 78 00.
- .2 Operation and maintenance data:
 - .1 Submit manufacturer's operation and maintenance instructions for inclusion in the operation and maintenance manuals.

PART 2 - PRODUCTS

- .1 Incorporate reinforcing, fastenings and anchorage required for building-in of *Products*.
- .2 Washroom accessories supplied by *Owner*; locations as indicated or scheduled, installed by *Contractor*:
 - .1 Sharps container.
 - .2 Narcotic Return Bin.
 - .3 Narcotic Disposal.
 - .4 Soap dispenser.

Accessories

- .5 Paper towel dispenser.
- .6 Clothes/robe hook.
- .7 Grab bars.
- .8 Mirrors.
- .3 Galvanic/dissimilar metal corrosion inhibitor (isolation coating): in accordance with Section 01 73 00 and written requirements of manufacturers of metals affected.

2.2 Fabrication

- .1 Fabricate *Products* with materials and component sizes, metal gauges, hardware, reinforcing, anchors, and fastenings of adequate strength to ensure that washroom accessories will remain free of warping, buckling, opening of joints and seams, and distortion within limits of intended use.

PART 3 - EXECUTION

3.1 Preparation

- .1 Verify that rough-in dimensions and blocking or back-up has been provided to comply with product manufacturer's written requirements.

3.2 Installation of Accessories

- .1 Comply with product manufacturers written requirements.
- .2 Install and secure fixtures rigidly in place using expansion shields in solid masonry or concrete, toggle bolts in hollow masonry or sheet metal screws at metal studs.
- .3 *Provide* galvanic/dissimilar metal corrosion inhibitor (isolation coating) in accordance with Section 01 73 00 and written requirements of manufacturers of metals affected.
- .4 Install on built-in concealed solid backing materials. Grab bar installation shall be able to withstand 250 kg downward force.
- .5 Verify locations and mounting heights with *Consultant* before roughing-in.

3.3 Barrier Free Installation Heights

- .1 Install accessories to permit operable parts and controls to be accessed in accordance with authorities having jurisdiction.

3.4 Installation Tolerances

- .1 Install accessories plumb, level, straight, tight and secured, centred between joints on masonry and tile walls to the following maximum tolerances:
 - .1 Plumb and level: 3 mm (1/8").
 - .2 Variation from indicated position: 3 mm (1/8").

Accessories

3.5 Adjusting and Cleaning

- .1 Verify under work of this section that installed *Products* function properly and adjust them accordingly to ensure satisfactory operation. Test mechanisms, hinges, locks, and latches and adjust and lubricate to ensure washroom accessories are in perfect working order.
- .2 Do not remove protective coatings until final cleaning, 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

Healthcare Equipment

PART 1- GENERAL

1.1 Summary

- .1 Section includes:
 - .1 Healthcare equipment types as follows (supply and installation by *Contractor*):
 - .1 Medical gas outlets; surface-mounted.

1.2 Administrative Requirements

- .1 Conduct a pre-installation meeting in accordance with Section 01 31 19.

1.3 Submittals

- .1 Submit required submittals in accordance with Section 01 33 00.
- .2 *Product* data sheets:
 - .1 Submit manufacturer's *Product* data sheets for *Products* proposed for use in the work of this section.
 - .2 Submit equipment manufacturer's handling and installation instructions, anchorage information, roughing-in dimensions, service requirements for installation of the work of this section.
- .3 Shop drawings:
 - .1 Submit engineered shop drawings for the following:
 - .1 Medical gas outlets, including anchoring and connections for the work of this section.
 - .2 Seismic design, connections and restraint.
 - .2 Clearly indicate, materials, finishes, fabrication details, dimensions, thicknesses, plans, elevations, hardware, fastenings, service connections and installation details.
 - .3 Indicate termination/connection points of services for medical gas outlets.
 - .4 Indicate proposed site connections, fasteners and methods.
- .4 Samples:
 - .1 Submit duplicate samples of each finish specified.
- .5 Templates:
 - .1 Submit templates to *Contractor* for use by installers and fabricators as required for proper location and installation of equipment.

1.4 Closeout Submittals

- .1 Submit closeout submittals in accordance with Section 01 78 00.
- .2 Operation and maintenance data:

Healthcare Equipment

- .1 Submit manufacturer's operation and maintenance instructions for inclusion in the operation and maintenance manuals.

1.5 Quality Assurance

- .1 Qualifications:
 - .1 Execute the work of this section using workers skilled in the respective duties for which they are employed, and with minimum 5 years' experience in application of *Products*, systems, and assemblies specified.

1.6 Warranty

- .1 Warrant work of this section in accordance with Section 01 78 36.
- .2 Extended warranty:
 - .1 Labour, materials, and workmanship for work of this section.
 - .2 Duration: 2 years.

PART 2 - PRODUCTS

2.1 Medical Gas Outlets

- .1 Acceptable *Products*:
 - .1 Amico 'Wall Outlet DISS O-DISWAL-L-OXY'.
 - .2 Amico 'Wall Outlet DISS O-DISWAL-L-AIR'.
 - .3 Amico 'Wall Outlet DISS O-DISWAL-L-VAC'.
 - .4 Substitutions: In accordance with Section 01 25 00.

PART 3 - EXECUTION

3.1 Installation - Healthcare Equipment

- .1 Install equipment in accordance with equipment manufacturer's written requirements and in accordance with reviewed shop drawings.
- .2 Submit manufacturer's information and templates required for installation of work of this section. Assist or supervise, or both, the setting of anchorage devices, and construction of other work incorporated with *Products* specified in work of this section in order that they function as intended.
- .3 Include reinforcing, anchorage and mounting devices required for the installation of each *Product*.
- .4 Verify locations and mounting heights with *Consultant* before roughing-in.
- .5 *Provide* galvanic/dissimilar metal corrosion inhibitor (isolation coating) in accordance with Section 01 73 00 and written requirements of manufacturers of metals affected.
- .6 Electrical *Subcontractor* shall be responsible for final electrical hook-up at service connection locations, as well as interconnection wiring on multi-sectional units. Coordinate work of this section with work of Divisions 26, 27, and 28.

Healthcare Equipment

- .7 Mechanical *Subcontractor* shall be responsible for final mechanical service connections. Coordinate work of this section with work of Divisions 21, 22, and 23.

3.2 Installation - Medical Gas Outlets

- .1 Install equipment in accordance with equipment manufacturer's written requirements and in accordance with reviewed shop drawings.
- .2 Submit manufacturer's information and templates required for installation of work of this section. Assist or supervise, or both, the setting of anchorage devices, and construction of other work incorporated with *Products* specified in work of this section in order that they function as intended.
- .3 Include reinforcing, anchorage and mounting devices required for the installation of each *Product*.
- .4 Verify locations and mounting heights with *Consultant* before roughing-in.
- .5 Mechanical *Subcontractor* shall be responsible for final mechanical service connections and testing, in accordance with authorities having jurisdiction and with requirements of Divisions 21, 22, and 23. Coordinate work of this section with work of Divisions 21, 22, and 23.

3.3 Field Quality Control

- .1 Conduct quality control in accordance with Section 01 45 00.
- .2 Testing:
 - .1 Test and commission equipment in accordance with equipment manufacturer's written requirements.
- .3 Manufacturer's field review to be in accordance with Section 01 45 00.

3.4 Adjusting and Cleaning

- .1 Upon completion of installation, inspect finishes and materials for damage and faulty installation. Make good or replace damaged finishes and materials as directed by *Consultant* at no cost to *Owner*.
- .2 Verify under work of this section that installed *Products* function properly, and adjust accordingly to ensure satisfactory operation.
- .3 Do not remove protective coatings until final cleaning in accordance with Section 01 77 00, or earlier if directed by *Consultant*.

3.5 Demonstration and Training

- .1 Conduct demonstration and training in accordance with Section 01 79 00.
- .2 Demonstration:
 - .1 Before acceptance of system, arrange for demonstration of equipment with authorized representatives of *Owner*, to be performed by competent representative of equipment manufacturer to assure proper function, operation and explanation. Give *Owner's* representative a minimum of 48 hours advance notice in writing of demonstration date.

Healthcare Equipment

- .2 Conduct comprehensive demonstration for *Owner's* staff on operation and care of equipment.

END OF SECTION



**Mechanical
Specifications**
FOR
EMERGENCY DEPARTMENT RENOVATIONS
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20 00 01

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END OF SECTION

MECHANICAL GENERAL REQUIREMENTS

20 01 01

GENERAL

1.1 General Contract Documents

- .1 Comply with General Conditions of the Contract, Supplementary Conditions of the Contract, and Division 01 - General Requirements.
- .2 Where content in this Specification section duplicates requirements in various Division 01 Specification sections, this section and the applicable Division 01 sections are to be read together and the most stringent requirements apply.

1.2 Work Included

- .1 Work to be done under Divisions 20, 21, 22, 23 and 25 to include furnishing of labour, materials and equipment required for installation, testing and putting into proper operation complete mechanical systems as shown, as specified, as intended, and as otherwise required. Complete systems to be left ready for continuous and efficient satisfactory operation.
- .2 Read drawings and specifications together as a whole and in conjunction with other such documents included under the Construction Contract.

1.3 Document Organization

- .1 Applicable Divisions for Mechanical Work:
 - .1 Division 20 - Common Work for Mechanical
 - .2 Division 21 - Fire Protection
 - .3 Division 22 - Plumbing and Drainage
 - .4 Division 23 - Heating, Ventilation and Air Conditioning (HVAC)
 - .5 Division 25 - Building Automation System
- .2 For clarity, any reference in the Contract Documents to Division 20 includes Divisions 21, 22, 23 and 25.
- .3 The Specifications for these Divisions are arranged in sections for convenience. It is not intended to recognize, set or define limits to any subcontract or to restrict Contractor in letting subcontracts.
- .4 Contractor is responsible for completion of work whether or not portions are sublet.

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

- .1 Division 20 contains common work requirements that are applicable as necessary to the Work of Divisions 21 to 25 and apply as if written in full within those Divisions.

1.5 Language

- .1 The specification is written as a series of instructions addressed to the Contractor, and by implication to subcontractors and to suppliers. For clarity and brevity, use is made of numbered lists and bulleted lists. Where a list follows a semi-colon (;) the punctuation is for clarity. Where a list follows a colon (:) the punctuation is to be read as a short-hand form of the verb "to be" or "to have" as context requires.
- .2 It is not intended to debate with the Contractor the reasons for these instructions, and words associated with justification for an instruction or restatement of anticipated performance have been omitted to avoid possible ambiguities.

1.6 Definitions and Abbreviations

- .1 Specification section 20 01 13 *Definitions and Abbreviations – Mechanical* contains general definitions and abbreviations that apply to one or more specification sections of this Division of the Work. Other specification sections of the mechanical Divisions of the Work may also include additional specific definitions and/or abbreviations that apply to that specification section.
- .2 The following general terms apply to Divisions 20 to 25 of the Work:
 - .1 The words "indicated", "shown", "noted", "listed" or similar words or phrases used in this Specification, mean that material or item referred to is "indicated", "shown", "listed" or "noted" on Drawings or in Specification.
 - .2 Wherever the word "listed" is used in conjunction with a product and a product certification standard (including but not limited to CSA, ULC, CGSB, BNQ, UL), it shall be understood to mean that the product is "listed" by an accredited 3rd party testing laboratory as being certified to the referenced product standard.
 - .3 Wherever the words "approved", or similar words or phrases are used in the Specification they shall be understood, unless the context otherwise provides, to mean that material or item referred to shall be "approved by" the Owner.
 - .4 Wherever the words "satisfactory", "as directed", "submit", "permitted", "reviewed", or similar words or phrases are used in the Specification they shall be understood, unless the context otherwise provides, to mean that material or item referred to shall be "satisfactory to", "as directed by", "submitted to", "permitted by", or "reviewed by" the Consultant.
 - .5 Instructions using any form of the word:
 - (a) "install" means to place in position and activate for service or use,
 - (b) "supply" means to procure and deliver materials to the place of the Work, or to make available labour or services for the stated purpose,
 - (c) "provide" means to supply material, labour and services to install the referenced item.
 - .6 The term "building code" means the edition of the applicable building code at the time of obtaining a building permit.
 - .7 Wherever manufacturers or manufacturer's products are identified in lists under the phrase "Standard of Acceptance", these are manufacturers and/or products which meet the project standards in regard to performance, quality of material and workmanship.

1.7 Examination

- .1 Examine any existing buildings, local conditions, building site, the specifications and drawings, and report any condition, defect or interference that would prevent execution of the work.
- .2 No allowance will be made for any expense incurred through failure to make these examinations of the site and the documents prior to Tender or on account of any conditions on site or any growth or item existing there which was visible or known to exist at time of Tender.
- .3 Before commencing work under this Division, examine the work of other Divisions of the Work and report any defect or interference.

1.8 Design Services

- .1 Provide specialty design services for elements of the Work where specified in other sections of Division 20. Drawings and specifications prepared by such specialty design service providers shall be sealed by a professional engineer licensed in the jurisdiction of the Work.

Product Substitutions

In the absence of requirements concerning product substitution requests in Division 01, Contractor may propose a substitute product to that which is specified in accordance with the following.

- .2 All proposed substitutions shall be submitted using the Consultant's product substitution form and include all information stated therein.
- .3 The use of a substitute article or material which the Contractor represents to be of at least equal quality and of the required characteristics for the purpose intended may be permitted, subject to the following provisions:
 - .1 a substitution will not be considered for reasons of meeting the construction schedule unless the contractor can demonstrate to the satisfaction of the Consultant they made all reasonable efforts to procure the specified product or material in a timely fashion,
 - .2 the manufacturer must advise the Consultant of this intention to use an alternative article or material before doing so,
 - .3 the burden of proof as to the quality and suitability of alternatives to be upon the manufacturer and they shall supply all information necessary as required by the Consultant at no additional costs to the contract,
 - .4 the Consultant shall be the sole judge as to the quality and suitability of alternative materials and their decision to be final,
 - .5 where use of an alternative material involves redesign or changes to other parts of the work, the costs and the time required to effect such redesign or changes will be considered in evaluating the suitability of the alternative materials,
 - .6 no test or action relating to the approval of substitute materials is to be made until the request for substitution has been made in writing by the manufacturer and has been accompanied by complete data as to the quality of the materials proposed. Such request to be made in ample time to permit appropriate review without delaying the work, taking into consideration that such a substitution request may be rejected and require providing the product or material as originally specified,
 - .7 whenever classification, listing, or other certification by a recognized standards body is a part of the specifications for any material, proposals for use of substitute materials is to be accompanied by reports from the equivalent body indicating compliance with the requirements of the specifications,
 - .8 the costs of all testing required to prove equality of the material proposed to be borne by the manufacturer.

2 SHIPPING, HANDLING AND STORAGE

Shipping

- .1 Provide adequate protection of equipment during shipping and handling so as to provide equipment at the Work site in ex-works condition when handled by commercial carrier systems.
- .2 Provide, as necessary, removable bracing of the internal components in each item of equipment so that the equipment can be moved on its side or back, without sustaining damage.
- .3 Where removeable internal bracing has been provided, the equipment to be provided with warning labels to call for the removal of the shipping bracing prior to energization.
- .4 Any component that is packaged or shipped separately is to be individually crated and tagged with unit number and the equipment number of the assembly to which it belongs.
- .5 Provide each "shipping section" with a permanently-attached, readily-visible identification tag bearing the equipment number of the assembly of which it is a part.

2.2 Storage

- .1 Store equipment and materials at the worksite to protect them from any damage until placed into its final location. Maintain similar protection of installed equipment and materials to protect against damage until they are turned over to the Owner. Make good any damage to equipment or materials up to the time of ready for takeover.
- .2 Store equipment in accordance with the manufacturer's instructions and not less than:
 - .1 stored in a dry, clean location,
 - .2 cover with polyethylene plastic sheeting,
 - .3 include a desiccant material under the protective sheeting to absorb moisture, or provide heated ventilated air
- .3 Provide adequate ventilation and temporary heating to prevent condensation of moisture within the equipment.

2.3 Provisions for Handling and Field Erection

- .1 For equipment that will require hoisting on site, provide removable side panels, lifting angles or lifting plates to accommodate the use of slings or crane hooks, for each shipping section.
- .2 For floor mounted equipment, provide on each shipping section removable steel channel base plates to permit use of pipe rollers or dollies without damaging the equipment.

OWNER'S SPECIAL REQUIREMENTS FOR EXISTING SITES

- .1 The following special requirements are in addition to the requirements of Division 01 of the Work.
- .2 Provide a written list of names for employees and sub-trades entering the building, advising which areas they need access to at least 48 hours prior to expected time of arrival. This lead time is required to prearrange security passes.
- .3 Security passes must be visibly worn at all times by all employees.
- .4 Trades people to strictly adhere to owner's building security procedures otherwise entrance into the building will be denied.
- .5 Trades people are to enter the entrance identified by the Owner.
- .6 Park vehicles in designated areas. Do not block driveways.
- .7 Use only the freight elevator to transport tools and material. Freight elevator door must be shut immediately after exiting the cab.
- .8 Do not disable or activate any electrical or mechanical system without prior approval by the Owner's Project Manager. Also, prior to disabling or activation of any electrical or mechanical system, obtain approval from Building Operations and Building Security.
- .9 Submit prior notification to Building Security Staff before any construction activity commences which will result in heat, smoke, dust or fumes, such as welding, saw cutting, soldering, spray painting, which might affect sensitive fire detection and protection equipment.
- .10 Provide at least **10 business days** prior notification to Building Operations for any fire system isolation requests.
- .11 Schedule work and meet with sub-trades daily on site, to show trades people the work areas and work to be done.
- .12 Trades-people are to supply and use their own tools. No tools, ladders or equipment, etc. will be loaned by the Owner.

- .13 Provide environmental cleaning of the job site daily during construction and upon completion. This includes above ceilings. Do not store materials or garbage on the loading dock.
- .14 Provide special care, attention and protection when transporting equipment and materials to prevent accidental damage to fire protection equipment, finishes, furnishings and fixtures.
- .15 "No Smoking" – this is a smoke-free building. Violators will be asked to leave and may be denied reentry. Smoking is not allowed on the roof.
- .16 If Building Operations deems that work on a particular system requires security escort, allow 48 hours to make appropriate arrangements.
- .17 For any open flame work, provide fire extinguishers and security fire watch.
- .18 Obtain the approval of the Building Manager for the storage of materials on site.
- .19 Perform a daily cleanup prior to leaving the site.
- .20 Secure oxygen and acetylene cylinders at all times and capped nightly.
- .21 Restore operating and redundant systems to their normal condition at the end of each work day unless otherwise approved by the Owner
- .22 At the conclusion of each work day, the Contractor's superintendent/supervisor is to advise the Building Manager on the day's activities and plans for the next day's work.

4 PROGRESS PAYMENT PROCEDURE

Schedule of Values

- .1 Provide schedule(s) of values for progress payments in accordance with this part.
- .2 Prepare and submit a schedule of values ("SOV") for the Division 20 Work.
- .3 Each SOV is to be in the sample format shown in Article "Attachments", specifically that the SOV is to include four sections for:
 - .1 Contract price work element breakdown, which includes:
 - (a) detailed breakdown by work element as agreed with the Consultant,
 - (b) line items for coordination drawings, as-built documents and operating manuals,
 - (c) a summary line item for authorized Cash Allowance disbursements (if applicable),
 - (d) line items for each Itemized Price (if applicable),
 - (e) line items for each Separate Price (if applicable and included in the Contract Price)
 - (f) a line item for the total of the original contract work element values,
 - (g) a summary line item for approved change instructions,
 - .2 Cash Allowance disbursement authorization, with separate work elements for each cash allowance,
 - .3 Approved Change Instructions, with separate work elements for each change instruction,
 - .4 Outstanding Change Instructions which are either not quoted or not yet approved.
- .4 Each work element in the SOV sections (except Outstanding Change Instructions) is to include:
 - .1 the original contract value and the percent of original contract total value (Contract Price section only),
 - .2 the completed to date amount and percent of original work element contract value,
 - .3 the previously billed amount and percent of original work element contract value,

- .4 the current billing (payment request) amount and percent of original work element contract value, and
- .5 the balance to complete amount and percentage of original work element contract value.
- .5 The required Contract Price work element breakdown will be determined by the Consultant, with the level of breakdown appropriate to the project such as
 - .1 by trade,
 - .2 by specification section or portion thereof,
 - .3 by labour vs material,
 - .4 by location in the building,
 - .5 or any combination of the above.
- .6 Submit a draft SOV for review and approval by the Consultant at least three weeks before the first request for progress payment. Do not submit requests for progress payments until the SOV has been reviewed and there are no outstanding comments from the Consultant.
- .7 Make requests for progress payments using the values on the reviewed SOV.
- .8 When a change in the Work has been approved by the Owner, include the approved changes on the SOV for the next payment application, whether or not payment is requested in full or in part for that change in that payment request period.

For each SOV, include a line item "Interference & Coordination Drawings" and include a value that is the greater of:

- .1 the value of the work or,
- .2 1% of the Division 20 contract price.

Payment of the indicated amount will not be made until satisfactory evidence of completion of this work element has been received by the Consultant. Where satisfactory documents are not received, a Change Directive and an associated Change Order will be issued to delete this work element and the amount from the Contract Price.

- .10 For each SOV, include a line item "As-Builts & Operating Manuals" and includes a value that is the greater of:
 - .1 the value of the work or,
 - .2 1% of the Division 20 contract price.

Payment of the indicated amount will not be made until satisfactory documents have been received by the Consultant. Where satisfactory documents are not received, a Change Directive and an associated Change Order will be issued to delete this work element and the amount from the Contract Price.]

5 CONSTRUCTION CHANGES

General

- .1 The valuation method to be used for a change instruction to the Work is to be determined by the Consultant from the following methods:
 - .1 by labour and material when the change instruction is by a Change Directive;
 - .2 by unit prices set out in the Contract or subsequently agreed upon for other change instructions;
 - .3 by a detailed quotation for other change instructions; or
 - .4 by a Cash Allowance Disbursement instruction.

5.2 Definitions

.1 The following definitions apply to this section

- .1 **Allpricer** – the material pricing guide/service provided by Allpricer Limited.
- .2 **MCAA manual** – the Mechanical Contractors Association of America publication *Labor Estimating Guide for Service* for labour units.
- .3 **Base wage rate** – the hourly rate actually paid to the trades person, determined in accordance with applicable collective bargaining agreement, or in their absence the actual gross wages paid to the worker.
- .4 **Job Site Impact Multiplier** – a multiplier expressed as a decimal number that is included in the Labour Rate to account for special job site conditions that affect labour availability, labour productivity, procurement of materials, and materials management, that are specific to the project and site conditions.
- .5 **Indirect labour** – any labour that is neither journey person labour that directly performs the work nor labour that directly supervises journey person(s).
- .6 **Labour Rate** – the actual fully burdened labour cost per hour of labour consumed by a trades person including statutory and regulatory burden, collective bargaining burden, and other project related burden. For greater clarity, the labour rate includes but is not limited to the following:
 - (a) base wage rate,
 - (b) vacation and statutory holiday pay,
 - (c) union deductions and additional union charges,
 - (d) Legislated burdens including EHT, WSIB, EI, CPP, RST on H/W
 - (e) wage-based taxes,
 - (f) job site impact multipliers,
 - (g) expendable small tools charge,
 - (h) project insurance,
 - (i) financing of payroll,
 - (j) estimating,
 - (k) rest breaks and idle time,
 - (l) safety including training, safety meetings, WHMIS, fall protection, personnel protection equipment, and safety committees,
 - (m) preparation and handling of shop drawings and other submittals,
 - (n) preparation of as-built documents, including operation and maintenance manuals,
 - (o) labour warranties,
 - (p) site facilities,
 - (q) clean-up,
 - (r) parking.
- .7 **Foreperson** – a first level supervisory position having direct control over the work performed by journeypersons.
- .8 **Journey person** – a person working in a skilled construction trade which may be prescribed by regulation, and includes apprentices.
- .9 **Labour Unit** – the number of journey person labour hours or part thereof, required to perform a specific construction task, and includes but is not limited to:
 - (a) receiving, unloading, stockpiling, distribution and handling of materials and equipment,
 - (b) rigging or erecting of materials or equipment,

- (c) fitting and joining of materials,
 - (d) pressure testing of piping and ductwork systems,
 - (e) testing of equipment and systems.
- .10 **Line materials** – components that make up a distribution network for fluid, power, or electronic/digital information, and includes:
- (a) piping, pipe fittings, valves (of all kinds), pipe strainers and other pipe mounted equipment,
 - (b) ducting, duct fittings, duct balancing dampers and other duct mounted equipment,
 - (c) conduit, cable tray, cable, conductors, and wiring,
 - (d) supports, hangers and restraints,
 - (e) vibration isolators and seismic restraints associated with line materials,
 - (f) instrumentation including gauges and sensors/transmitters,
 - (g) electrical, pneumatic, and hydraulic actuators for valves and dampers, and
 - (h) any coatings or other protective elements applied thereto including insulation and painting.
- .11 **Overhead** – administrative expenses of the Contractor's business and the project which are not included in a Labour Rate or Labour Unit. For greater clarity, overhead includes but is not limited to the following:
- (a) company office, storage, and fabrication spaces, and associated maintenance, utilities, and expenses,
 - (b) project site office, fabrication and storage spaces, washrooms, break rooms, and associated maintenance, utilities, and expenses,
 - (c) company office equipment, furniture and supplies,
 - (d) project site office equipment, furniture and supplies,
 - (e) labour time for project managers and project assistants,
 - (f) project site security,
 - (g) project site clean-up, recycling and waste disposal,
 - (h) materials management,
 - (i) property taxes, business licenses, and auto insurance,
 - (j) dues and subscriptions,
 - (k) postage and courier,
 - (l) advertising, telephone, IT services and equipment,
 - (m) legal and accounting fees and expenses,
 - (n) sales and marketing,
 - (o) salaries and benefits for company indirect labour including company management, sales force, dispatchers, estimators, clerical staff, and at-office general (non-trades) labour.
 - (p) all other indirect labour.
- .12 **Senior Foreperson** – the second (and subsequent) level supervisory position having direct control over one or more Forepersons, where the number of Forepersons supervised is in accordance with local regulatory requirements or collective bargaining agreements. ("Superintendent" or "Supervisor" has the same meaning).

5.3 Change Directive Method

- .1 Except where otherwise determined in the Construction Contract or Division 01 specification, the valuation of changes by the Change Directive method shall comply with the following:

- .1 the form of presentation of costs and methods of measurement shall be agreed to by Consultant and Contractor before proceeding with the change,
- .2 the adjustment in the Contract Price for a change carried out by way of Change Directive shall be determined on the basis of the cost of the Contractor's actual expenditures and savings attributed to the Change Directive. For clarity and by example, savings for deductions of similar materials, equipment, labour or services shall be valued at the same amount as for expenditures for additions of same.
- .3 labour costs will be determined based on actual time spent and the agreed labour rate, the actual cost of installed line materials and equipment, and the agreed fee for overhead and profit,
- .4 if the change results in a net decrease in Contract cost, the contract price will be decreased by the net decrease in the cost, without adjustment for the Contractor's percentage fee for overhead and profit,
- .5 the Contractor shall keep accurate records, in an agreed upon form, of time, quantities and invoiced costs and present an account of the cost of the change in the Work, together with vouchers, material receipts and invoices,
- .6 this time and material method shall be used until such time as a total cost estimate of the change is agreed between the Owner and the Contractor, at which time all payments made under this time and material method will be credited against the agreed total cost for the change.

5.4 Unit Price Method

- .1 Costing of changes by the Unit Price method:
 - .1 Costs for work identified by agreed unit costs shall be charged at those rates, unless the Owner agrees to other rates.

5.5 Proposed Changes; Other Change Instructions Method

- .1 For proposed changes to the Work or other similar instructions, submit a detailed quotation for approval.
- .2 The adjustment in the Contract Price for a change carried out by way of proposed change or other similar instruction shall be determined on the basis of the cost of the Contractor's actual expenditures and savings attributed to the Proposed Change. For clarity and by example, savings for deductions of similar materials, equipment, labour or services shall be valued at the same amount as for expenditures for additions of same.
- .3 Costs are to be approved by the Owner before the proposed change to the Work proceeds. The quotation for the change to the Work is to include a summary of charges made up of three components: labour charges, material costs and fees.
- .4 Labour Charges:
 - .1 The labour unit hour estimates are to be based on the current MCAA estimating manual unless otherwise agreed by the Consultant;
 - .2 The labour cost is to be determined using the agreed labour rates.
 - .3 Labour rates for Foreperson and Senior Foreperson shall be as per agreement, or in absence of such agreement shall be 1.15 times the journeyperson labour rate. The maximum allowable labour hours for supervision are not to exceed:
 - (a) for a Foreperson, a maximum of 10% of the total calculated journeyperson hours on a change, and
 - (b) for a Senior Foreperson of all levels, a maximum combined amount of 3% of the total calculated journeyperson hours on a change.
 - (c) no other supervisory hours will be permitted.
- .5 Material Charges:

- .1 Material costs for line materials and installed equipment are to be net of trade discounts. The discount to be applied to list prices for items included in Allpricer manual shall not be less than:
 - (a) 20% for line materials, and
 - (b) 10% for equipment that is not line material.

.6 Fees:

Refer to Division 01 regarding fees for overhead and profit on changes to the Work.

- .2 Unless otherwise stated in Division 01, the following applies:
 - (a) The Contractor and any sub-contractor is allowed a combined overhead and profit fee of 15% for work to be performed by their own forces,
 - (b) The Contractor and any sub-contractor is allowed a combined overhead and profit fee of 5% for work performed by a sub-contractor (in the case of the Contractor) or a sub-sub-contractor (in the case of work performed for a sub-contractor),
 - (c) For clarity, the allowable fees on direct work and on sub-contracted work apply to a sub-sub-contractor of any tier.

5.6 Cash Allowances; Contingency Allowances

- .1 Instructions for changes to the Work to be performed under a cash allowance or contingency allowance ("Allowance") included in the contract price shall be authorized by a Cash Allowance Disbursement instruction.
- .2 Except as described below, the determination of costs for Work performed under an Allowance shall be in accordance with the procedure for proposed changes unless otherwise instructed to proceed with the work, in which case the cost of such work shall be valued in accordance with the procedures for Change Directive.
- .3 The contract price, not the Allowance, includes the overhead and profit fee for the value of the Allowance.
- .4 Except where otherwise specified in the Construction Contract, where the cost of the Work performed under a Cash Allowance Authorization;
 - .1 is less than the Allowance value, the contract price includes the overhead and profit for the contractor and any sub-contractors. A change order will be issued for a credit for the balance of the Allowance, but shall not include the associated overhead and profit fee.
 - .2 exceeds the Allowance value, a Change Order will be issued for the amount in excess of the Allowance, and the excess amount is to include the agree fee for overhear and profit.

6 SUBMITTALS

Shop Drawings and Product Data Sheets

- .1 Submit shop drawings, manufacturers product data and samples in accordance with the requirements of Specification sections of Division 01, this Part, and as further required in other Specification sections of Division 20.
- .2 Submit shop drawings in the same unit of measure as are used on the drawings. Both metric and U.S. customary units may be included.
- .3 Submit shop drawings by email to: shopdrawings@hhangus.com, except where a project document management web-service is used.
- .4 Include a H.H. Angus shop drawing cover sheet form prepared for this project for each shop drawing submittal (refer to part "Attachments" for an example of this form) , or include the same information on the general or trade contractor's submittal cover sheet;

- .1 Information required on each submission:
 - (a) Client/Architect name,
 - (b) Project Name,
 - (c) H.H. Angus project number,
 - (d) Date,
 - (e) Contractor name,
 - (f) Contractor reference No.,
 - (g) Manufacturer name,
 - (h) Product type,
 - (i) Specification section number,
 - (j) Contractor trade category: architectural, structural, conveying equipment, user equipment, mechanical, electrical, telecommunications, civil or other.
 - (k) If a re-submission, the Consultant's previous submittal reference number.
- .5 Submit shop drawings in PDF format except as follows;
 - .1 if the Consultant agrees to a shop drawing to be submitted in hardcopy format, submit in 8.5 x 11 or 11 x 17 size, black and white originals of graphic quality suitable for photocopying and digital scanning. Allow one additional week for processing of shop drawings submitted in hardcopy format.
- .6 Manufacturer's letter sized product data sheets for standard items are acceptable in place of shop drawings provided that physical characteristics are identified and are related to specification references.
- .7 Submit with manufacturers data sheets, typed schedules listing manufacturer's and supplier's name and catalogue model number.
- .8 For plumbing fixtures and other permeant fixtures, submit fixture sheets with catalogue numbers. Identify and arrange fixture sheets in the same sequence and using the same identification number as shown in specification fixture lists.
- .9 Shop drawings and/or product data sheets to show;
 - (a) dimensioned outlines of equipment and construction details,
 - (b) equipment weights and center of gravity,
 - (c) performance ratings,
 - (d) dimensioned details showing service connection points,
 - (e) elevations illustrating locations of visible equipment such as gauges, pilot lights, breakers and their trip settings, windows, meters, and access doors,
 - (f) description of operation,
 - (g) single line diagrams,
 - (h) general routing of bus ducts and connecting services,
 - (i) mounting and fixing arrangements,
 - (j) operating and maintenance clearances,
 - (k) access door swing spaces, and
 - (l) where products are required to be certified to a published standard, the mark of the testing organization who certified the product and the standard reference number to which it is certified.
- .10 Shop drawings and product data to be accompanied by;
 - (a) detailed drawings of bases, supports and anchor bolts,
 - (b) sound power data, where applicable, and

(c) performance curve for each piece of equipment marked with point of operation.

- .11 Shop drawing and data sheet submission is taken as certification that the products are;
 - .1 from the manufacturer's current production, and
 - .2 in compliance with applicable codes, standards, and regulations.
- .12 For standard catalogued (non-custom) products, do not submit drawings showing internal construction details, component assemblies or interior piping and wiring diagrams. Such information may be necessary to understand correct functioning of equipment and are to be submitted with operating and maintenance data.
- .13 Check and stamp each shop drawing as being correct before submission. Shop drawings without such stamps will be rejected and returned.
- .14 Keep one copy of each reviewed shop drawing and product data sheet on site and have them available for reference purposes.
- .15 Where equipment is delivered without reviewed shop drawings, equipment will be condemned and is to be removed from site and replaced with new equipment after shop drawings have been submitted and reviewed.

6.2 Coordination, Fabrication, or Installation Drawings

- .1 Contractor coordination, fabrication, installation and/or sleeving drawings are to be provided in accordance with specification Section 20 01 03 *Mechanical Coordination and Installation Design Services*.
- .2 Contractor's coordination, fabrication, installation, and/or sleeving drawings will not be reviewed as shop drawings. If submitted as a shop drawing, a transmittal only will be returned identifying the submitted drawings have not been reviewed as a shop drawing.
- .3 Maintain a copy on site of such drawings for reference by the Consultant.
- .4 The Consultant reserves the right to request selected Contractor's coordination, fabrication, or installation drawings for review.

6.3 Effect of Consultants Review of Submittals

- .1 Consultant's review of shop drawings is performed on a sampling basis only, to confirm to Consultant's satisfaction that the Contractor understands the Work to be performed and is interpreting the design documents correctly, and such reviews are performed for the benefit of the Owner.
- .2 For greater certainty, the review of shop drawings by Consultant does not constitute a quality control function for the benefit of Contractor, nor does such a review relieve Contractor of their responsibility for complying with the Contract documents.

7 APPLICABLE CODES, STANDARDS AND REGULATIONS; PERMITS

7.1 Codes, Standards and Regulations

- .1 Where a published product standard or installation code is adopted by statute or regulation by an applicable AHJ, the applicable edition of the standard or code is the one that has been adopted
 - .1 at the time of obtaining a permit for the applicable portion of the Work, or
 - .2 in the absence of a requirement for a permit, the start date of construction.
- .2 Where a published product standard or installation code is not adopted by statute or regulation, then the most current edition of that standard or code at the start date of construction applies.

- .3 Install mechanical and electrical systems in accordance with the applicable requirements adopted by the AHJ in the jurisdiction of the Work.
- .4 Where requirements of the Specifications exceed those of applicable codes, standards, and regulations the requirements of the Specifications is to govern.
- .5 In the event of a conflict between codes, bulletins, regulations, or standards, or where work shown is in conflict with these documents, obtain interpretation before proceeding. Failure to clarify any ambiguity will result in an interpretation requiring application of the most demanding requirements.

7.2 Confined Spaces

- .1 Unless otherwise prescribed by the Constructor's / Owner's workplace safety program, treat spaces not designed and constructed for continuous human occupancy as confined spaces in accordance with applicable health and safety legislation, including but not limited to:
 - .1 horizontal and vertical service spaces, shafts, and tunnels,
 - .2 inside of equipment which permits entry of the head and/or whole body, and
 - .3 ceiling spaces which are identified as containing a hazardous substance.

7.3 Permits, Tests and Certificates

- .1 Arrange and pay for permits, tests, and Certificates of Inspection required by the AHJ applicable to the element of the Work.
- .2 Submit applications requiring Owner's signature before commencing work.
- .3 Obtain and submit applicable AHJ Inspection certificates or reports including but not limited to:
 - (a) Electrical inspection,
 - (b) Plumbing and drainage inspection,
 - (c) HVAC inspection,
 - (d) Pressure Vessel Inspection.
 - (e) Piping and Boiler Inspection.
 - (f) Fuel safety Inspection.
- .2 Renew certificates or reports so as to remain in force through the warranty period.
- .4 Co-ordinate and perform testing required by an AHJ in accordance with the Part on Testing in this Section.

8 COMMON PRODUCT REQUIREMENTS

Standard of Material and Equipment

- .1 Provide materials and equipment in accordance the requirements of Specification section of Division 01 and as follows.
- .2 Materials and equipment:
 - .1 new and of uniform pattern throughout work,
 - .2 of Canadian manufacture where obtainable,
 - .3 standard products of approved manufacture,
 - .4 labeled or listed (certified) to applicable standards in accordance with Specification sections of the Work and as required by authorities having jurisdiction,

- .5 registered in accordance with the requirements of the applicable provincial pressure vessels regulation and registered in accordance with CSA B51 for Canadian Registration Numbers, as applicable,
 - .6 in compliance with Standards and Regulations including but not limited to;
 - (a) chemical and physical properties of materials,
 - (b) design,
 - (c) performance characteristics, and
 - (d) methods of construction and installation.
 - .7 identical units of equipment to be by the same manufacturer. ,
 - .8 identical component parts of same manufacturer in similar units of equipment, but various component parts of each unit need not be from one manufacturer.
- .3 Materials and equipment are described to establish standards of construction and workmanship. Where manufacturers and/or products are listed under "Standard of Acceptance", select manufacturers and or products from these lists. Use of manufacturers or products other than as listed are subject to specification requirements concerning requests for substitution.
 - .4 Include items of material and equipment not specifically noted on Drawings or mentioned in Specifications but which are required to make a complete and operating system.
 - .5 Confirm capacity or ratings of equipment being provided, when based on ratings of equipment being provided under other trade Sections, before such items are purchased.
 - .6 Factory fabricated control panels and component assemblies are to be listed for electrical safety requirements.
 - .7 Select materials and equipment in accordance with manufacturer's recommendations and these Specifications, and install same in accordance with manufacturer's instructions and these Specifications.
 - .8 Materials and equipment not satisfying these selection criteria will be condemned. Remove condemned materials from job site and provide properly selected and approved materials.

8.2 Manufacturers Nameplates

- .1 Provide manufactured equipment with metal nameplate with raised or recessed lettering, mounted on each piece of equipment. On insulated equipment, mechanically fasten plates on metal stand-off bracket arranged to clear insulation.
- .2 Manufacturer's nameplate to indicate equipment size, capacity, model designation, manufacturer's name, serial number, voltage, cycle, phase and power rating of motors, and approval listings.
- .3 Certified products are to clearly show the mark of the certification agency when in the final installed state.

8.3 Factory Applied Painting

- .1 Protect factory finished equipment during construction, and clean at completion of work.
- .2 Touch-up factory painted prime and/or final coats damaged during construction, with colour matching paint recommended by the equipment manufacturer.
- .3 Use heat resistant paint where conditions require.

8.4 Factory Applied Prime Painting

- .1 Factory-prime paint other equipment fabricated from iron or steel, including equipment supports and hangers, access platforms, access doors, registers, grilles, diffusers, dampers, metal radiation

enclosures and fire hose cabinets where separate product specifications do not require a factory applied final coat.

8.5 Field Painting

- .1 After equipment has been installed and piping and insulation is completed, clean rust and oil from exposed iron and steel work provided under this Division, whether or not it has been factory prime painted.
- .2 In "occupied" areas of building touch up any damage to prime coat resulting from shipping or installation and leave ready for final decorative painting under Finishes, Division 9.
- .3 In addition, apply prime and/or final paint coats to equipment and materials where specifically detailed in other Sections of these Divisions.

8.6 Maintenance of Bearings

- .1 Turn-over rotating equipment at least once a month from delivery to site until start-up.
- .2 Run-in sleeve type bearings in accordance with manufacturer's written recommendation. After "run-in", drain, flush out and refill with new charge of oil or grease.
- .3 Protect bearings, shafts and sheaves against damage, corrosion and dust accumulation during building construction.

8.7 Pre-purchased Equipment; Damage and Ownership

- .1 At time of receipt of pre-purchased or pre-tendered equipment at the job site by the installing mechanical contractor, provide the services of the manufacturer/distributor/supplier's technical representative to:
 - .1 inspect the equipment prior to unloading,
 - .2 witness the unloading and advise the contractor on the appropriate method for handling the equipment in order to avoid damage during the unloading, moving and setting in place phase of the equipment, and
 - .3 report any damage to the Consultant.
- .2 In the event the equipment has been found to be damaged before unloading, it is to be returned immediately to the factory for repairs and/or replacement by the manufacturer/supplier.
- .3 In the event of damage occurring at any time during unloading and until the equipment is accepted by the Owner, the installing contractor is responsible for repairs and/or replacement of the damaged equipment to the satisfaction of the Owner.

9 OFFICE AND STORAGE; TOOLS

Office and Storage

- .1 Provide temporary office, washroom and lunchroom facilities, workshop, and tools and material storage space. Facilities may be site trailers or as otherwise approved by the General Contractor/Construction Manager.
- .2 Assume responsibility for security of these facilities.
- .3 Provide heat, light and telephone and Internet service
- .4 Owners cafeteria is off limits.

9.2 Tools, Temporary Equipment and Materials

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

COORDINATION; INSTALLATION DRAWINGS

10.1 Coordination

- .1 Consultant drawings are diagrammatic and illustrate the general location of equipment, and intended routing of ductwork, piping, etc. and do not show every structural detail. In congested areas drawings at greater scale may be provided to improve interpretation of the Work. Where equipment or systems are shown as "double line", they are done so either to improve understanding of the Work, or simply as a result of the use of a CAD drawing tool, and in either case such drawings are not represented as fabrication or installation drawings.
- .2 Lay out and coordinate Work to avoid conflict with work under other Divisions.
- .3 Make good damage to Owner's property or to other trade's work caused by inaccurate layout or careless performance of work of this Division.
- .4 When equipment provided under other Sections connects with material or equipment supplied under this Section, confirm capacity and ratings of equipment being provided.
- .5 Take information involving accurate measurements from dimensioned Architectural Drawings or at building.
- .6 Install services and equipment which are to be concealed, close to building structure so that furring is kept to minimum dimensions.
- .7 Location of pipes, ductwork, raceways and equipment may be altered without extra cost provided instruction is given or approval is obtained, in advance of installation of items involved. Changes will be authorized by site instructions and are to be shown on Record Drawings.
- .8 Location of floor drains, hub drains, combination drains, plumbing fixtures, convectors, unit heaters, diffuser, registers grilles and other similar items may be altered without extra cost provided instruction is given prior to roughing in. No claim will be paid for extra labour and materials for relocating items up to 3 m (10 ft) from original location nor will credits be anticipated where relocation up to 3 m (10 ft) reduces material and labour.
- .9 Include incidental material and equipment not specifically noted on Drawings or mentioned in Specifications but which is needed to complete the work as an operating installation.

10.2 Field, Fabrication, and Installation Drawings

- .1 Prepare field, fabrication, and/or installation drawings to show location of equipment and relative position of services, and to demonstrate coordination with the work of other trades;
 - .1 drawing scale: minimum 1:50 (1/4"=1'-0")
 - .2 use information from manufacturer's shop drawings for each trade and figured dimensions from latest Architectural and Structural Drawings,
 - .3 layout equipment and services to provide access for repair and maintenance,
- .2 Circulate drawings to other trades involved in each area, and conduct coordination meetings with those trades.

11 ANCHORS AND INSERTS

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

12 CUTTING, PATCHING AND REMEDIAL WORK

12.1 General

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

- .2 Neatly cut or drill holes required in existing building elements to accommodate building services including ductwork, piping, cable, raceways, bus duct or cable tray.
- .3 Arrange and pay for all cutting and patching as required for the Work. Before cutting, drilling, or sleeving structural load bearing elements, obtain the Consultant's approval of location and methods in writing. Employ original installer or expert in the finishing of material required to perform cutting or patching for weather-exposed, moisture-resistant elements or sight-exposed surfaces.

12.2 Structure Scanning and Cutting

- .1 Layout cutting of structural elements, such as floors slabs, walls, columns or beams and obtain approval before starting work. Conduct an initial electromagnetic scan of reinforcing rods and electrical conduit, and review with structural engineering Consultant.

Standard of Acceptance

- ° Hilti - fig. PS 300 Ferrosan

Based on the preceding results, arrange and pay for supplemental radiographic examination where necessary to improve on locating concrete reinforcement, conduits and other embedment's.

- .1 submit radiographic results to the structural engineer and obtain comments before starting work, the use of radiographic imaging methods is subject to approval by the Owner on a case by case basis.

As an alternative to radiographic examination for areas where the Owner does not permit radiographic examination, based on the preceding results, provide two-dimensional ground penetrating radar scans to locate concrete reinforcement, conduits and other embedment's. Scanners to be operated by personnel trained by the measurement device manufacturer.

Standard of Acceptance

- ° Hilti PS1000 X-SCAN

- .3 Relocate core drilling location if steel or conduit is found in the proposed location and repeat procedure. Reroute any circuits damaged by core drilling.
- .4 Scan for all shots and anchors in floors, walls, and ceilings.

13 PROTECTION OF PERSONNEL, WORK, AND PROPERTY

13.1 Personnel Protection

- .1 Without limiting the Contractor's responsibilities regarding occupational health and safety requirements at the construction site, provide specific personnel protection as follows:
 - .1 protect exposed live equipment during construction for personnel safety,
 - .2 shield and mark live parts "LIVE 120 VOLTS", or with appropriate voltage,
 - .3 arrange for installation of temporary doors for rooms containing electrical distribution equipment. Keep these doors locked except when under direct supervision of electrician,
 - .4 do not leave conduit, wires, cables, tools, equipment or materials in such a way that they constitute a hazard,

- .5 provide toe guards around openings in the roof or floor to prevent materials or debris from dropping down to a lower level,
- .6 remove loose equipment and tools from overhead areas before leaving each day,
- .7 cut off bolts at floor level to eliminate a possible tripping hazard.

13.2 Protection During Construction

- .1 Provide protection required to enable existing building and equipment to remain in continuous and normal operation.
- .2 Take the necessary precautions to protect equipment, existing building and service from damage during the Work. Accept responsibility for any damage and make good without cost to the Owner.
- .3 Protect existing surfaces and items so that they are not damaged in any way whatsoever by the work of all trades. Take precautions as necessary to prevent damage to walls, floors, ceilings, windows, doors, door frames, moldings, finishes, piping, ductwork, light fixtures, etc. Provide protection, hoarding, tarpaulins, dust sleeves etc., as required. Any damage caused because of lack of adequate protection to be made good at no cost to the Owner.
- .4 Take care when working above or around equipment that must remain in service.
- .5 Take care to eliminate dust in equipment areas.
- .6 Protect switchgear fronts from accidental breaker trips when working around or above them. Provide an extended shield constructed of 12 mm (½") fire retardant plywood a minimum of 450 mm (18") from board front to allow access to board.

13.3 Core Drilling

- .1 Wherever core drilling is required, provide temporary dust proof screens.
- .2 In areas where core drilling through a slab in an operating facility is necessary, clearly mark out the areas to be drilled on the underside of slab. Owner's representative to be notified at least 1 week prior to core drilling operation. Provide tarping of equipment supervised by the Owner.
- .3 During core drilling operations, station at least one person directly below the area of drilling with a large plastic container pressed to underside of slab to capture and hold core and water upon completion of operations.
- .4 Continuously use a wet/dry commercial quality vacuum at location of drilling operation to remove all excess water from the area.

13.4 Temporary Dust Proof Screens

Comply with Division 01 for temporary dust proof screens and infection control procedures.

13.5 Protection of Floors During Equipment Installation

- .1 Provide protection of floor finishes during installation or removal of equipment, and at any other time when moving or installing heavy equipment.
- .2 Install 19mm (¾") plywood over 6 mil plastic over finished floor areas when moving heavy equipment that could damage floor finish, or when installing equipment or line materials overhead.

- .3 Repaint or re-tile any floors or walls damaged or scratched during construction.

13.6 Housekeeping

Maintain a high level of cleanliness.

- .2 Remove scrap and refuse from the work area daily.
- .3 Whenever possible, clean up immediately following completion of work.
- .4 Deposit oily and waste solvent rags in approved containers to minimize the fire hazard.
- .5 Sweep and damp mop daily.

14 WORK IN EXISTING BUILDING

General

- .1 Comply with Specification section of Division 01 for restrictions on working in existing occupied buildings and as follows.
- .2 During the tender period, the Contractor shall perform a site inspection of the place of work and surroundings including the accessible ceiling spaces and other areas where access could be considered reasonable. Make a thorough investigation of as-built conditions to determine scope of renovation or demolition work required prior to submitting tender.
- .3 The Work includes changes to existing building and changes at junction of old and new construction. Route pipes, ducts, conduits and other services to avoid interference with existing installation.

Perform core drilling depending on the schedule of the impacted spaces. Coordinate with Owner for specific times.

- .5 Relocate existing pipes, ducts, conduits, bus ducts and any other equipment or services required for proper installation of new work, including as required for temporary removal and re-installation to suit new installation work.
- .6 Remove existing plumbing fixtures, lighting fixtures, piping, ductwork, wiring, and equipment to suit new construction. Cut back and cap drain, vent and water outlets, conduits and electrical outlets, not being used.
- .7 Unless noted otherwise removed materials and equipment become the property of the Contractor and are to be taken from the site and disposed of appropriately.
- .8 On completion of relocations, confirm relocated equipment are in proper working order.
- .9 Where Owner wishes to take over renovated areas ahead of project completion date and these areas are to be fed from new distribution systems, make temporary connections to existing services in these areas. Reconnect to permanent services, at later date, when new distribution systems are available.

14.2 Continuity of Services

- .1 Keep existing buildings in operation with minimum length of shutdown periods.
- .2 Make connections to existing systems at approved times.
- .3 Obtain written approval recording times when connections can be made.
- .4 Arrange work so that physical access to existing buildings is not unduly interrupted.
- .5 Be responsible for and make good any damages caused to existing systems when making connections.
- .6 Provide premium time labour to tie-in to services at night or on weekends.

- .7 For piping systems, make connections to existing piping by draining down the existing piping system. Use of hot-tapping or freezing of piping is only permitted where approved by the Owner and a specification section for such work has been included in the project specifications.
- .8 Provide temporary services to drain down existing piping systems which convey liquids or steam condensate, including provision of temporary hoses, etc., and provide services to perform the drain down of these systems, except where the Owner elects to perform such drain-downs.
- .9 For piping systems conveying liquids, after completion of new work to existing piping systems, refill the existing and new piping systems including provision of cleaning of new piping and addition of chemical treatments, as applicable, in accordance with the requirements of other sections of Division 20. Include for addition of replenishing chemical treatment for existing piping systems in accordance with the Owner's existing chemical treatment program, or in the absence of such, in accordance with the chemical water treatment requirements specified in other Sections of Division 20.

15 MOVING AND SETTING IN PLACE OF OWNER-SUPPLIED PRODUCTS

15.1 General

- .1 The requirements of this Part applies to;
 - .1 Division 20 equipment that has been directly purchased by the Owner, and
 - .2 other Owner-supplied products or equipment (i.e. process equipment) that has building services requirements.
- .2 Comply with the requirements of Division 01 and as specified herein.

15.2 Owner-Supplied Products (Supplied by Owner Equipment – “SBO”)

- .1 Items marked SBO on drawings are to be;
 - .1 purchased by the Owner,
 - .2 received, checked, and stored by the Contractor, and
 - .3 subsequently unpacked, uncrated, assembled and located in its final location by the Contractor, and installed in accordance with the manufacturer instructions,
 - .4 participate in the start-up and testing of the equipment and placing into service.
- .2 Provide mechanical and electrical services to SBO equipment in accordance with the SBO equipment manufacturer's instructions and as otherwise shown.

15.3 Existing Owners Equipment to be Relocated (E.R. or Ex. Rel.)

- .1 Applies to owners existing equipment which has mechanical and electrical services, and marked on the drawings as E.R. Ex.Rel. or otherwise so identified.
- .2 Items so marked on drawings are to be moved from their present location and reinstalled by the Contractor.
- .3 Disconnect and reconnect mechanical and electrical services to accommodate this equipment relocation.

16 TEMPORARY HEATING

During Construction

- .1 Temporary heating required while building is under construction will be provided under Division 01.

- .2 Permanent heating system may be used for temporary heating, when this equipment is installed in its permanent location and the building is closed-in and Contractor under Division 1 provides staff for operation and maintenance whenever permanent heating system is being used for temporary heating.
- .3 Hot water boilers may not be used unless heating units, radiation, pumps and piping are complete, the piping system has been pressure tested, cleaned, and final chemical water treatment is in operation.
- .4 Permanent heating equipment used for temporary heating to be thoroughly cleaned and put in first class operating condition and appearance at completion of the Work, as approved by the Owner.

17 FINAL CLEANING AND ADJUSTMENTS

Final Cleaning

- .1 Conduct final cleaning in accordance with Division 01 requirements and as specified herein.
- .2 Perform final cleaning after construction activities that create dust have been completed.
- .3 Thoroughly clean exterior surface of exposed piping, and vacuum external surfaces of exposed ducts and interior surfaces of air handling units. Clean strainers in piping systems and install clean filters in air handling systems immediately prior to handover of the building to the Owner.
- .4 HEPA vacuum the top and interiors of motor controllers, VFDs, control panels, and control cabinets followed by a thorough HEPA vacuuming of the service room floors. Thoroughly wash floors with wet mop and clean water. Control access to the room after cleaning. Provide temporary filter media on air supply ducts to these rooms to prevent re-contamination from other areas of construction.
- .5 Remove tools and waste materials on completion of work and leave work in clean and perfect condition.

17.2 Final Adjustments

- .1 Calibrate components and controls and check function and sequencing of systems under operating conditions.
- .2 Supply lubricating oils and greases for proper operation of equipment and systems until work has been accepted.

18 RECORD DRAWINGS

Record Drawings

Maintain record drawings in accordance with Division 01 during the course of the Work and as follows.

- .2 A set of design drawings in AutoCad or PDF format (as determined by the Consultant) will be provided by the Consultant. Record changes in actual installation as the Work progresses by the following method:
 - .1 make sets of white prints for each phase of Work and mark-up the print drawings, or
 - .2 revise the AutoCad file directly, and identify all changes made.
- .3 Mark-up these record drawings to provide dimensioned locations of drains, pipes, ductwork, conduit, manholes, foundations and similar buried items within the building, with respect to building column centres. Mark level with respect to an elevation which will be provided.
- .4 Retain on-site the survey information from excavation and backfill of site services, and after approval, transfer this information to the record documents.
- .5 Retain these drawings and make available to Consultant for periodic review.
- .6 At 50%, 75% and 90% project completion, scan marked-up drawings to PDF format and submit copy to the Consultant, or to the project on-line document management service if one is used.

18.2 As-Built Drawings

Prior to testing, balancing and adjusting, transfer site record drawing information to a copy of the computer aided drafting/design program ("CAD") files, in the same software format used for the Consultants design drawings, to record final as-built condition.

- .2 Obtain a current set of CAD files from the Consultant. The Consultant's CAD files may not reflect all or any construction changes.
- .3 Drawings are to remain set to and follow Consultants CAD Standards - do not alter drawing scales, reference files, colours, layers or text styles,
- .4 Where items have been deleted, moved, renumbered or otherwise changed from contract drawings, revise the CAD files to record these changes. "Bubble" these revisions, and place these annotations on a separate and easily identified drawing layer.
- .5 Show on mechanical as-built drawings final location of piping, ductwork, switches, starters, Motor Control Centres, thermostats, and equipment.
- .6 Show on site services as-built drawings survey information provided by an accredited land surveying service.
- .7 Identify each drawing in lower right hand corner in letters at least 12 mm (½ in) high with a note as follows:

AS-BUILT DRAWINGS. This drawing has been revised to show systems as installed (Signature of Contractor) (Date).
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- .8 The site services drawings are to include the signature and stamp of the accredited surveyor adjacent to the note.
- .9 Submit one (1) set of white prints of the draft as-built CAD files for Consultant's review.
- .10 Once "AS BUILT DRAWINGS" white prints are reviewed, transfer Consultant's comments to the CAD files. Return CAD files modified to "As Built" condition to Consultants electronically by electronic file transfer as designed by the Consultant.
- .11 Submit three (3) sets of white prints and one (1) electronic copy of CAD files with Operating and Maintenance Manuals to the Owner.

19 OPERATING AND MAINTENANCE INSTRUCTIONS

Operating and Maintenance Manuals

- .1 Provide operating and maintenance manuals in accordance with Division 01 and as follows.
- .2 Provide operation and maintenance data bound in vinyl covered, hard back, three-ring covers, nominally 50 mm (2 in) thick, suitable for paper size of 210 mm x 300 mm (8½ in x 11 in);
 - .1 organize material in volumes, generally grouped by Trade section;
 - (a) Table of Contents,
 - (b) General Information,
 - (c) Sub-contractors (list),
 - (d) Site services,
 - (e) Fire Protection,
 - (f) Plumbing,

- (g) Heating and Cooling Plant and Distribution,
 - (h) Air Handling Equipment and Distribution,
 - (i) Building automation, Controls and Instrumentation,
 - (j) Testing Reports,
 - (k) As-Built Drawings,
 - (l) Warranties.
- .2 Title sheet in each volume to be labeled "Operating and Maintenance Manual" and to bear;
 - (a) Project Name,
 - (b) Project Number,
 - (c) Date,
 - (d) Trade Section,
 - (e) List of Contents.
 - .3 Provide three hard-copies to Owner.
- .3 In addition, provide PDF files for each document, produced from original direct-to-digital file creations;
 - .1 organize documents into separate PDF files for each Trade Section identified above, and apply PDF Bookmarks to create a Table of Contents for each file.
- .4 Operating data to include;
 - .1 control schematics for each system,
 - .2 description of each system and associated control elements,
 - .3 control operating sequences at various load conditions, reset schedules and anticipated seasonal variances,
 - .4 operating instructions for each system and each component,
 - .5 description of actions to be taken in event of equipment failure,
 - .6 valve schedules and flow diagrams,
 - .7 service piping identification charts.
 - .5 Maintenance data to include;
 - .1 manufacturer's literature covering servicing, maintenance, operating and trouble-shooting instructions for each item of equipment,
 - .2 fault locating guide,
 - .3 manufacturer's parts list,
 - .4 reviewed shop drawings,
 - .5 equipment manufacturer's performance sheets,
 - .6 equipment performance verification test results,
 - .7 voltage and ampere rating for each item of electrical equipment,
 - .8 spare parts list and an itemized cost,
 - .9 name and telephone numbers of service organization and technical staff that will provide warranty service on the various items of equipment.
 - .6 Approval procedure;
 - .1 submit one set of first draft of Operating and Maintenance Manuals for approval at least one month prior to planned substantial performance date,

- .2 make corrections and resubmit for a final review,
- .3 review contents of Operating and Maintenance Manuals with Owner's operating staff or representative to ensure thorough understanding of each item of equipment and its operation.
- .4 hand-over two (2) hard-copies and one (1) PDF copy on removable storage device of the Operating and Maintenance Manuals to the Owner's operating staff and obtain written confirmation of delivery. Provide a copy of the delivery record to the Consultant.

19.2 Operating and Maintenance Training

Provide operating and maintenance training in accordance with Division 01 and as follows.

- .2 Provide training to Owners operations staff to thoroughly explain operation and maintenance of each system, incorporating specialized instruction by manufacturers as described under other Sections in these Divisions. Include classroom instruction and hands-on instruction, delivered by competent instructors.
- .3 Develop the proposed training plan, and submit an outline of the training program for review, adjustment and approval by the Owner.
- .4 Structure each session to start with the classroom instruction for the overall system, followed by hands-on instruction for each equipment, utilizing the services of the manufacturers' representative as required.
- .5 Organize and schedule each training session to deliver the required instruction in an efficient and effective manner on a schedule agreed upon with the Owner. Allow for two (2) training sessions for each training topic, separated by approximately one week each. Develop the proposed training plan and obtain approval from the Owner before commencing training.

All training to be scheduled and provided between the hours of 7 am to 5 pm, Monday to Friday. Where training is required to be performed outside of these hours due to availability of Owners operations personnel, if the trainers are paid for overtime outside of these hours, the overtime portion only is eligible to be paid by the Owner as an extra cost.

- .7 Complete the training as close to Substantial Performance as possible, so that the operations staff are prepared to operate the systems after Substantial Performance is certified.
- .8 Organize each training sessions as follows:
 - .1 Fire Protection - Division 21
 - .2 Plumbing – Division 22
 - .3 HVAC – Division 23
 - .4 Building Management System – Division 25
- .9 Keep records of date and duration of each instruction period together with names of persons attending. Submit signed records at completion of instruction.
- .10 For each training session, include the following topics;
 - .1 general purpose of system (design intent),
 - .2 use of O&M manuals,
 - .3 review of control drawings and schematics,
 - .4 start-up, normal operation, shutdown, unoccupied operation, seasonal changeover, manual operation, control set-up and programming troubleshooting, and alarms,
 - .5 interaction with other systems,
 - .6 adjustments and optimizing methods for energy conservation,

- .7 health and safety issues,
- .8 special maintenance and replacement sources,
- .9 occupancy interaction issues, and
- .10 system response to different operating conditions.
- .11 Develop and provide training material, including printed documents and electronic presentation aids (e.g. MS PowerPoint) for each session. Submit three (3) copies of materials in both hardcopy and PDF format, in accordance with article on Operating and Maintenance Manuals.
- .12 Sessions may be video recorded by the Owner as an aid to ongoing training of Owners staff.

20 CARE, OPERATION AND START-UP

- .1 Provide all labour and materials as necessary to perform start-up and testing of equipment and systems.
- .2 Arrange and pay for services of manufacturer's factory service technician to supervise start-up of the installation, check, adjust, balance and calibrate components and equipment as specified in the specification sections of Division 20.
- .3 Provide these services for such period, and for as many visits as necessary to put equipment in operation, and ensure that operating personnel are conversant with every aspect of the operation, care and maintenance thereof.
- .4 Arrange and pay for services of applicable manufacturer's factory service engineer or certified independent testing organization to supervise initial start-up of specialized portions of installation and to check, adjust, balance and calibrate components including related wiring and controls. Provide these services for such periods, and for as many visits as may be necessary to put applicable portion of the installation in complete working order. Provide a certificate indicating that the equipment is free and clear of deficiencies.

21 TESTING

21.1 General

- .1 The following describes the general requirements for testing of mechanical systems; refer to additional testing requirements in applicable sections of Division 20 of the Work.
- .2 Conduct tests during progress of Work and at its completion to verify equipment and systems meet the contract documents. Submit details of test methods in writing and obtain approval before commencing work.
- .3 Supply test equipment, apparatus, gauges, meters and data recorders, together with skilled personnel to perform tests and log results.
- .4 Submit written notice 24 hours in advance of each test series, setting out the time, place and nature of the tests, to the Inspection Authority and personnel witnessing tests.
- .5 The Owner reserves the right to witness any test; any such witnessing activity shall not be construed as acceptance of the system or equipment by the Owner.
- .6 Conduct tests before application of external insulation and before any portion of pipes, ducts or equipment is concealed.
- .7 Do not subject expansion joints, flexible pipe connections, meters, control valves, heat exchangers, terminal heating and cooling equipment, and fixtures, to test pressures greater than the stated working pressure of equipment. Isolate or remove equipment or devices during tests when prescribed test pressure is greater than working pressure of any piece of equipment or device.

- .8 Should section of pipe, duct, or electrical cable fail under test, replace faulty piping, duct, or cable with new fittings, pipe, duct or cable and then retest. Do not repair threaded pipe joints by caulking nor welded joints by peening. Repeat tests until results are satisfactory.
- .9 Where it is necessary to test portions of piping, ductwork or electrical cable system before system is complete, overlap successive tests so that no joint or section of duct or pipe is missed in testing.
- .10 Upon completion of work and testing of same, submit logs to demonstrate that tests have been carried out satisfactorily. Repeat any tests if requested.

21.2 Testing - Potable Water Piping

- .1 Except where otherwise specified in other sections of Division 22, test potable water systems with water or air as required by the plumbing code in effect at the location of the Work.
- .2 For water service pipes 100 mm (4") and larger, disinfect the pipe with chlorine ("hyper-chlorinate") from the street valve to the first shut-off valve inside the building. At completion of disinfection, take water samples just before the utility meter and pay for the samples to be tested by an accredited testing laboratory. Test the water samples for contaminants and to measure the residual chlorine concentration and provide test certificate confirming water contaminates are below the threshold values proscribed by applicable legislation.
- .3 Where stainless steel piping is used in the domestic water system, between the entry point in the building and the utility water meter, after taking the water sample for laboratory testing, immediately drain down the incoming service piping up to the utility meter and then flush with clean city water until a site test of the drain water shows a residual chlorine level not greater than the incoming city water supply.
- .4 Where stainless steel piping is used in potable water piping inside the building (i.e. downstream of the utility meter), do not allow any hyper-chlorinated water used for disinfection of piping to come into contact with the stainless steel piping.

21.3 Testing - Other Piping

- .1 Except where otherwise specified in other sections of Divisions 21, 22 or 23, hydraulically pressure test other water piping systems at 1½ times system design pressure (relief valve setting) or 1000 kPa (150 psi), whichever is greater, for 10 minutes then reduce the test pressure and hold for 24 hours. Pressure must remain essentially constant throughout test period without pumping. Make allowance for correction of pressure readings for variations in ambient temperature between start and finish of test.
 - .1 Alternatively, hold the pressure at the design pressure and testing all joints with a soap test.
- .2 Test drainage, waste and vent piping for tightness and grade as required by the plumbing code in effect at the location of the Work.
- .3 Test special service piping as detailed in other sections of Divisions 21, 22 and 23.

21.4 Testing - Ventilation

- .1 Pressure test ductwork in accordance with section 23 31 13 *Ductwork*, or other applicable sections of Division 23.

21.5 Testing - Electrical

- .1 Make tests of equipment and wiring. Test wiring systems in accordance with section 20 05 12 *Wiring Requirements for Mechanical*.
- .2 Replace defective equipment and wiring with new material.

COMMISSIONING

- .1 Participate in commissioning of equipment and systems in accordance with Section 20 08 15 *Mechanical Commissioning*.
- .2 Equipment supplied on this project will be subject to detailed factory inspection and/or on-site testing and commissioning prior to being placed in service. The electrical contractor, their major system and equipment suppliers, and the Independent Testing Agent (ITA) will be required to participate in special commissioning meetings to review progress and status of the commissioning program.
- .3 Include in Bid amount for licensed electricians to participate in the commissioning program, to undertake temporary power connections, operation of equipment, opening and closing of panel boards and switchboards, testing of power and control wiring, and assisting the ITA and the equipment suppliers' field personnel in the startup and testing of the equipment.
- .4 The contractor and equipment suppliers to include in the Bid amount the costs to accommodate and undertake factory and site testing.

23 TEMPORARY AND TRIAL USAGE

- .1 Temporary and trial usage by Owner of any mechanical or electrical device, machinery, apparatus, equipment or any other work or materials before final completion and written acceptance is not to be construed as evidence of acceptance by Owner.
- .2 Owner to have privilege of such temporary and trial usage, as soon as that said work is claimed to be completed and in accordance with Contract Documents, for such reasonable length of time as is sufficient for making complete and thorough test of same.
- .3 No claims will be considered for damage to or failure of any parts of such work so used which may be discovered during temporary and trial usage, whether caused by weakness or inaccuracy of structural parts or by defective materials or workmanship of any kind whatsoever.
- .4 Defects in workmanship and materials identified during temporary and trial usage are to be rectified under warranty.

24 SPECIAL TOOLS AND SPARE PARTS

24.1 Spare Parts

- .1 Prior to application for Substantial Performance, furnish spare parts as follows;
 - .1 one glass for each gauge glass,
 - .2 one set of V-belts for each drive of the same model size,
 - .3 one set of filter cartridges for each filter or filter bank installed.
- .2 Maintain an inventory record and delivery receipt record of spare parts delivered to the Owner, and include them in the Operating and Maintenance manuals.

25 CONSULTANT REVIEWS

25.1 General

- .1 Consultant's attendance at site including but not limited to site meetings, demonstrations, site reviews and any resulting reports are for the sole benefit of the Owner and as required by the local authority have jurisdiction. It is the Contractor's responsibility to ensure that the Work is complete and constructed in accordance with the design documents.

25.2 Site Reviews

- .1 General reviews and progress reviews do not record deficiencies during the course of the Work until such time as a portion or all of the work is declared complete. In some instances, before the work is Issued For Tender

completed, readily noticeable deficiencies may be recorded by the Consultant where the deficient item is indicative of issues such as poor workmanship, incorrect materials or installation methods, or may be difficult to correct at a later date. Any such reported items, or lack thereof, shall not be relied on in any way as part of the Contractors quality assurance program nor relieve the Contractor in the performance of the Work, specifically in identification and rectification of deficiencies or incomplete Work.

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

25.3 Milestone Reviews

- .1 Specific milestone reviews may be conducted at key stages by the Consultant, including;
 - .1 before backfilling of buried drainage,
 - .2 before closing of shafts,
 - .3 before closing of ceilings,
 - .4 before closing of walls,
 - .5 equipment demonstration,
 - .6 Substantial Performance deficiency review,
 - .7 Total Performance deficiency review.
- .2 Coordinate with the Consultant the type and quantity of milestone reviews required by the Consultant and incorporate these requirements in the construction schedule.
- .3 Notify the Consultant in writing seven (7) calendar days in advance of work to be concealed to arrange a site review prior to the Work being concealed where required by the Consultant. Any noted deficiencies are to be corrected before being concealed. Failure to provide notification can result in the Work being exposed for review at the Contractor's cost.

25.4 Partial Occupancy Reviews

- .1 Where the Work is planned to include occupancy by the Owner of a part of the Work but not the entire Work ("partial occupancy"), the procedures specified for Substantial Performance Review will apply to the portion of the Work being considered for partial occupancy.

25.5 Substantial Performance Review

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

25.6 Final Review

- .1 At project completion submit written request for final review of mechanical and electrical systems. Refer to section 20 08 19 *Project Close-Out*.
- .2 Include with the request a written certification that:
 - .1 reported deficiencies have been completed,
 - .2 systems have been balanced and tested and are ready for operation,
 - .3 completed maintenance and operating data have been submitted and approved,
 - .4 equipment/line material tags are in place and equipment identification is completed,
 - .5 cleaning is finished in every respect,

- .6 all mechanical equipment surfaces have been touched up with matching paint, or re-finished as required,
- .7 spare parts and replacement parts specified have been provided and receipt acknowledged,
- .8 As-built and Record drawings are completed and approved,
- .9 Owner's operating personnel have been instructed in operation and maintenance of systems,
- .10 fire protection verification is 100% completed and Verification Certificates have been submitted and accepted.

26 CONTRACTOR INSPECTIONS

26.1 General

- .1 The Division 20 contractor shall assign one person responsible for ensuring that Work from all mechanical trades is complete prior to;
 - .1 closing in wall, ceilings or burying of services,
 - .2 partial-occupancy reviews, and
 - .3 substantial performance reviews.
- .2 In conjunction with the Contractor's Mechanical and Electrical sub-contractors, the Contractor shall walk the site and thoroughly inspect that the work is complete, in good workmanship and installed according to the contract documents and derived documents therefrom. The Contractor shall then submit a report attesting to the completed state of the Work (the "Statement of Completion" report, as detailed later in this part).
- .3 In the case of Contractor inspections for partial-occupancy or substantial performance, submit the Statement of Completion report at least 24 hours prior to the scheduled review by the Consultant.

26.2 Contractor Inspections for Partial Occupancy and Substantial Performance

- .1 In preparation for the Consultants general review for partial-occupancy and/or substantial performance of the Work, the Contractor shall perform a comprehensive inspection of the Work to ensure that their contractual obligations are met before requesting a Consultant's review of the Work. In performing this inspection, the Contractor shall create a Statement of Completion report which is to include;
 - .1 date and time of the Contractor's inspection, signed by the person who conducted the inspection,
 - .2 names of the mechanical contractor's personnel who participated in the inspection,
 - .3 confirmation that previously noted deficiencies have been completed,
 - .4 confirmation that the work is 100% complete, tested, balanced and free of deficiencies, or include a list of outstanding deficiencies and incomplete Work with;
 - (a) a reason why the Work has not been completed (i.e. another trade has to complete their work)
 - (b) a plan of action to complete the Work, and
 - (c) a commitment date for completion of the Work including rectification of all deficiencies.
- .2 The format of the Statement of Completion shall be approved by the Consultant.
- .3 The Consultant shall review and sign-off the Statement of Completion Report and return a copy to the Contractor. The Contractor shall retain on-site a log of all signed off Statement of Completion reports.
- .4 If a required Statement of Completion report is not received, the Consultant reserves the right to withhold conducting a review for partial-occupancy or substantial performance.
- .5 After receipt of the Contractor's Statement of Completion report, if upon entering an area of the work covered by the Statement of Completion report the Consultant determines, in its sole opinion, that the

applicable Work is not ready for review, the Consultant may elect to cancel the review of the Work or the affected portion of the Work, and shall assume no responsibility for any damages or losses as a result of cancellation of the review. The Contractor shall remedy the incomplete work and request another review with 72 hours prior written notice, and shall resubmit the revised Statement of Completion at least 24 hours prior to the new review.

27 CORRECTION AFTER COMPLETION

- .1 At completion, submit a written warranty undertaking to remedy defects in work for a period of one year from date of substantial performance of the Work. This warranty is not to supplant other warranties of longer period called for on certain equipment or materials.
- .2 Warranties are to encompass replacement of defective parts, materials or equipment, and to include incidental fluids, gaskets, lubricants, supplies, and labour for removal and reinstallation of the corrected Work.
- .3 Submit similar warranties for one year from date of acceptance for any part of work accepted by Owner, before completion of the whole Work.

28 ATTACHMENTS

28.1 Schedule of Values Form

- .1 Attached sample of the Schedule of Values form layout.

28.2 Shop Drawing Submittal Form

- .1 Attached sample of shop drawings submittal form.

SCHEDULE OF VALUES

Project Name: <<name of project>>
Owner Name: <<owner name>>
Contractor Name: <<name of trade contractor: mechanical, electrical, etc>>
Division(s) of the Work: <<i.e. 20, 21, 22...>>
For the billing period ending: dd-mmm-yyy

This sheet is an example of a required schedule of values to be developed by the Contractor, to be submitted with each progress payment request.
Specific level of detail for each work element to be approved by the Consultant.

Item	Base Contract Element	Contract Value		Complete to Date		Previously Billed		This Billing		Balance to Complete	
		\$	%	\$	%	\$	%	\$	%	\$	%
1.1	<<work element>>	1,000,000.00	65.9%	400,000.00	40.0%	225,000.00	22.5%	175,000.00	17.5%	600,000.00	60.0%
1.2	<<work element>>	250,000.00	16.5%	30,000.00	12.0%	5,000.00	2.0%	25,000.00	10.0%	220,000.00	88.0%
1.3	<<work element>>	125,000.00	8.2%	50,000.00	40.0%	22,000.00	17.6%	28,000.00	22.4%	75,000.00	60.0%
X.X	Itemized Price No. 1	25,000.00	1.6%	0.00	0.0%	0.00	0.0%	0.00	0.0%	25,000.00	100.0%
X.X	Separate Price No. 1	12,500.00	0.8%	5,000.00	40.0%	0.00	0.0%	5,000.00	40.0%	7,500.00	60.0%
CCA.1	Cash Allowance Disbursements Summary	75,000.00	4.9%	34,000.00	0.0%	8,000.00	0.0%	26,000.00	0.0%	41,000.00	0.0%
X.X	Coordination drawings	15,000.00	1.0%								
X.X	As-built documents and operating manuals	15,000.00	1.0%								
Original Contract Values		1,517,500.00	100.0%	519,000.00	34.2%	260,000.00	17.1%	259,000.00	17.1%	968,500.00	63.8%
CO.1	Approved Changes Summary	13,400.00		5,200.00	38.8%	2,000.00	14.9%	3,200.00	23.9%	8,200.00	61.2%
Total Current Contract Values		1,530,900.00		524,200.00	34.2%	262,000.00	17.1%	262,200.00	17.1%	976,700.00	63.8%

Reference	Cash Allowance Disbursement	CA Value		Complete to Date		Previously Billed		This Billing		Balance to Complete	
		\$	%	\$	%	\$	%	\$	%	\$	%
CAA_1	<<description of cash allowance>>	20,000.00		20,000.00	100.0%	8,000.00	40.0%	12,000.00	60.0%	0.00	0.0%
CAA_2	<<description of cash allowance>>	55,000.00		14,000.00	25.5%	-	0.0%	14,000.00	25.5%	41,000.00	74.5%
					0.0%		0.0%	0.00	0.0%	0.00	0.0%
Total		75,000.00		34,000.00	45.3%	8,000.00	10.7%	26,000.00	34.7%	41,000.00	54.7%

Reference	Approved Changes	Change Value		Complete to Date		Previously Billed		This Billing		Balance to Complete	
		\$	%	\$	%	\$	%	\$	%	\$	%
CO_01	<<description of change of work>>	5,800.00		-	0.0%	-	0.0%	0.00	0.0%	5,800.00	100.0%
CD-01	<<description of change of work>>	7,600.00		5,200.00	68.4%	2,000.00	26.3%	3,200.00	42.1%	2,400.00	31.6%
					0.0%		0.0%	0.00	0.0%	0.00	0.0%
Total		13,400.00		5,200.00	38.8%	2,000.00	14.9%	3,200.00	23.9%	8,200.00	61.2%

Reference	Unquoted/Unapproved Changes	Status	Quotation	
			\$	%
CCN-01	<<description of change of work>>	Waiting for approval	12,000.00	
CCN-02	<<description of change of work>>	Unquoted		
Total			12,000.00	



Toronto Montreal Vancouver Dallas Chicago

SHOP DRAWING SUBMITTAL

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

Client/Architect: Click or tap here to enter text.

Project Name: Click or tap here to enter text.

HHA Project No: Click or tap here to enter text.

Contractor to complete the following for each submission.

Date: _____

Contractor Name: _____ Ref. No: _____

Manufacturer Name: _____

Product Type/Description: _____

Specification section number: _____

Contractor Trade Category:

- | | | | |
|--|-------------------------------------|--|---|
| ☐ Architectural | ☐ Structural | ☐ Conveying Equipment | ☐ User Equipment |
| ☐ Mechanical | ☐ Electrical | ☐ Telecommunications | ☐ Civil |
| ☐ Other | | | |

If this is a resubmission, check here: ☐

Previous submission HHA reference no.: _____

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END OF SECTION

QUALIFICATIONS AND AUTHORITIES - ONTARIO

20 01 02

1 GENERAL

1.1 Scope

- .1 This specification section:
 - .1 describes the qualification requirements for tradesmen in the province of Ontario;
 - .2 defines the applicable authorities having jurisdiction related to construction in Ontario; and
 - .3 describes the responsibilities of the contractor and/or Owner for registration and inspection of systems and application for construction or installation permits.

1.2 Definitions

- .1 **TSSA:** Technical Standards and Safety Authority
- .2 **ESA:** Electrical Safety Authority

2 QUALIFICATIONS

2.1 Trades Qualification and Apprenticeship

- .1 Tradesmen to hold a a certificate of qualification or be an apprentice in accordance with the *Building Opportunities in the Skilled Trade Act*, 2021, S.O. 2021, c. 28, including but not limited to the following prescribed trades in accordance with the *Prescribed Trades and Related Matters* regulation O.Reg. 876/21:
 - .1 Construction Millwright,
 - .2 Electrician – construction and maintenance,
 - .3 Fuel and electrical systems technician,
 - .4 Heat and frost insulator,
 - .5 Information technology – hardware technician,
 - .6 Information technology – network technician,
 - .7 Network cabling specialist,
 - .8 Instrumentation and control technician,
 - .9 Plumber,
 - .10 Refrigeration and air-conditioning systems mechanic,
 - .11 Sheet metal worker,
 - .12 Sprinkler and fire protection installer,
 - .13 Steamfitter,

2.2 Work-Specific Qualification Licenses

- .1 Fabricators and installers of pressure piping and equipment which are subject to O.Reg. 220/01 *Boilers and Pressure Vessels* regulation shall hold the required license for performing such work, unless otherwise exempt by the regulation.

3 AUTHOURITIES

3.1 Authorities having Jurisdiction

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

Work Element	Authority	AHJ Abbreviation
Fire Protection	Municipal Building Department or Fire Department	None
Plumbing	Municipal Building Department	None
HVAC	Municipal Building Department	None
Flammable and Combustible Liquids	Fire Department	None
Liquid fuels (for vehicle refueling)	Technical Standards and Safety Authority	TSSA
Heating Oil and Diesel Fuel	Technical Standards and Safety Authority	TSSA
Propane	Technical Standards and Safety Authority	TSSA
Pressure Piping	Technical Standards and Safety Authority	TSSA
Refrigeration	Technical Standards and Safety Authority	TSSA
Licensed Plant Operators	Technical Standards and Safety Authority	TSSA
Electrical	Electrical Safety Authority	ESA

4 PERMITS, REGISTRATION AND INSPECTION

4.1 Building Code Permits

- .1 Application for Building Permit including plumbing and HVAC has been made by the Owner. Arrange and coordinate for municipal inspections as required under the Ontario Building Code.

4.2 Other Work Permits, Registration and Inspection

- .1 Arrange, provide documentation, and pay for permits, registration, and inspection of the following work elements:
- .1 Boilers, pressure vessel and pressure piping,
 - .2 Buried liquid fuel tanks and underground piping,
 - .3 Electrical work performed under Division 20 to 25, and
 - .4 Where described elsewhere in Division 20 to 25.
- .2 Arrange, provide documentation, and pay for variance approvals and field inspections where specified elsewhere in Division 20 to 25.

END OF SECTION

MECHANICAL COORDINATION AND INSTALLATION DESIGN SERVICES 20 01 03

1 GENERAL

1.1 Scope

- .1 Provide detailed coordination, fabrication, and installation design drawings for the services provided under Division 20. Integrate the coordination drawings provided under Division 26 into the design drawings provided under Division 20.
- .2 Provide the services of an experienced mechanical and electrical coordination supervisor to manage these contractors' design services. The supervisor is responsible for leading a multi-trade coordination effort including but not limited to: detailed inspection of existing conditions, layout and finalize routing of services, setting sleeves for structural openings and sequencing of service installation.

1.2 Document Ownership

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

1.3 Consultant Drawings

- .1 Consultant drawings are diagrammatic and illustrate the general location of equipment, and intended routing of ductwork, piping, bus duct, etc., and do not show every structural detail. In congested areas drawings at greater scale may be provided to improve interpretation of the Work. Where equipment or systems are shown as "double line", they are done so either to improve understanding of the Work, or simply as a result of the use of a CAD drawing tool, and in either case such drawings are not represented as fabrication or installation drawings.
- .2 The use of Consultant's drawings directly for construction, without preparation of Contractor detailed coordination, fabrication, and installation design drawings, is at the Contractors risk.

1.4 Requests for Information

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

2 WORK RESTRICTIONS

- .1 The following commentary describes work restrictions that may affect the Contractors construction schedule and/or means and methods of construction, and are to be taken into consideration by the Contractor when estimating the cost and duration of the Work. This commentary does not limit the scope of work nor does it address all potential risk factors associated with the Work.
 - .1 restricted access to ceiling spaces for coordination with existing services
 - .2 restricted access to confined spaces
 - .3 unknown structural conditions
 - .4 hidden conduit in slabs and walls
 - .5 availability of existing documentation

3 INTERFERENCE CO-ORDINATION DRAWINGS

3.1 General

- .1 Refer to Section 20 05 02 Mechanical Work in Hospital Construction for additional requirements.
- .2 Take information involving accurate measurements from dimensioned Architectural Drawings or at building.
- .3 Install services and equipment which are to be concealed, close to building structure so that furring is kept to minimum dimensions.
- .4 Location of equipment and associated service connections are diagrammatic and based on manufacturer information available at the time of design. Include suitable allowances for and make adjustments to installation of actual equipment, including but not limited to size of housekeeping pads, methods of support, routing of pipe, duct, conduit and other services around and to the equipment, and location of services connection points to the equipment, at no change to the Construction Price.
- .5 Location of pipes, ductwork, raceways and equipment may be altered without extra cost provided instruction is given or approval is obtained, in advance of installation of items involved. Changes will be authorized by site instructions and are to be shown on Record Drawings.
- .6 Location of floor drains, hub drains, combination drains, plumbing fixtures, convectors, unit heaters, diffuser, registers grilles and other similar items may be altered without extra cost provided instruction is given prior to roughing in. No claim will be paid for extra labour and materials for relocating items up to 3 m (10 ft) from original location nor will credits be anticipated where relocation up to 3 m (10 ft) reduces material and labour.
- .7 Include incidental material and equipment not specifically shown but which is needed to complete the work as an operating installation.
- .8 Make good damage to Owner's property or to other trade's work caused by inaccurate layout or careless performance of work of this Division.

3.2 Interference Coordination Drawings

- .1 Prepare interference coordination drawings to show location of equipment and relative position of services, and to demonstrate coordination with works of other trades. Drawings shall be prepared by a specialist firm experienced in CAD mechanical and electrical interference drawing production. Interference drawings are to include coordination with all mechanical and electrical services.
- .2 Mechanical contractor is to consult and co-operate with electrical contractor to identify electrical services which are to be incorporated into interference drawings. Contractor shall perform site survey work to document all existing mechanical and electrical services that are to remain and are to be included in the interference drawings.
- .3 Conduct weekly meetings to discuss and resolve interference issues discovered during interference drawing production.
- .4 Submit drawings to other trades involved in each area and include a note in the drawing title block as follows;
 - .1 "This drawing was prepared and circulated for review and mark-up to related subcontractors as noted and initialed in the table below. Corrections and concerns identified through this coordination process have been addressed on this drawing. Areas that incorporate significant changes from layouts shown on Contract Documents have been circled for Consultants' general review"
 - .2 Drawing scale to be minimum 1:50 (1/4"=1'-0").

- .3 Produce coordination drawings in 3D using AutoCAD MEP, Revit, or an equivalent software. Generate interference drawings in PDF and submit these to the Consultants. Keep a printed or digital set of 2D drawings on site.
- .4 Obtain Consultant's drawing files for background information, pending completion and return of any electronic file waiver forms.

3.3 Coordination with Other Trades

- .1 Lay out and coordinate Work to avoid conflict with work under other sections of this Division and other Divisions.
- .2 When equipment provided under other Sections or Divisions connects with material or equipment supplied under this Section, confirm capacity and ratings of equipment being provided.

3.4 Interconnecting Control and Power Wiring

- .1 Provide wiring block diagrams and detailed termination drawings for controls wiring connections to equipment and instrumentation, for both Building Automation System control and hard-wired interlock wiring. Provide wiring terminal numbers specific for each equipment connection.
- .2 Maintain these interconnection drawings through the course of the Work and include a final updated version with the Operating and Maintenance instructions.

3.5 Fire Alarm and Building Automation System

- .1 Provide a wiring coordination interface drawing for termination of fire alarm annunciation circuits to Building Automation System I/O equipment and/or motor starters, adjustable frequency drives, dampers, and motorized fire dampers.
- .2 Drawings to include wiring terminal numbers and description label for FAS annunciation zone.
- .3 Submit interface drawings as a shop drawing for Consultants review.
- .4 Maintain these interconnection drawings through the course of the Work and include a final updated version with the Operating and Maintenance instructions.

4 OWNERS EQUIPMENT AND RELOCATED EQUIPMENT

- .1 The service provisions shown for Owner's supplied equipment and/or relocated equipment is based on the available information at the time of design. Examine the actual service requirements for this equipment and make adjustments as necessary to connection sizes of service drops to suit. A change (increase or decrease) in one trade size for piping, tubing, electrical conductors and conduit, and a change of up to 25% in duct cross-sectional area will be provided at no change to the construction cost.
- .2 Where actual service requirements (except as described above for size) are different between the Consultant's drawings and Owner's equipment requirements, submit proposal for new or deleted services or capacities to the Consultant for review.

5 FABRICATION AND INSTALLATION DRAWINGS

- .1 On an as-needed basis, prepare fabrication, spooling, and/or installation drawings based on the completed interference coordination drawings. Such drawings are to be in accordance with Contractor's company standards.
- .2 Drawing scale: same as the interference coordination drawings or at larger scale as needed.
- .3 Use information from manufacturer's shop drawings for each trade and figured dimensions from latest Architectural and Structural Drawings.
- .4 Layout equipment and services to provide access for repair and maintenance.

END OF SECTION

DEFINITIONS AND ABBREVIATIONS - MECHANICAL

20 01 13

1 GENERAL

1.1 Scope

- .1 This specification provides definitions and abbreviations of terms which may apply to one or more specification sections under Division 20, 21, 22, 23 and 25.
- .2 Additional definitions and/or abbreviations may also be included in other specification sections where they apply only to one specification section.

1.2 Definitions

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

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

Building Automation System ("BAS"): the building control systems as specified in Division 25.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

1.3 Abbreviations

AMCA	Air Movement and Control Association International
ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
ASHRAE	American Society of Heating, Refrigeration and Air-Conditioning Engineers
ASPE	American Society of Plumbing Engineers
ASSE	American Society of Sanitary Engineers
ASTM	ASTM International (formerly American Society for Testing and Materials)
CSA	Canadian Standards Association
FM	Factory Mutual Approvals
MCAA	Mechanical Contractors Association of America
MCAC	Mechanical Contractors Association of Canada
MSS	Manufacturers Standardization Society
NECA	National Electrical Contractors Association
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
NSF	NSF International (formerly National Sanitary Foundation)

SMACNA	Sheetmetal and Air Conditioning Contractors' National Association
UL	Underwriters Laboratory (USA)
ULC	Underwriters Laboratory Canada

End of Section

BASIC MATERIALS AND METHODS

20 05 01

1 GENERAL

1.1 Scope

- .1 Articles that are of a general nature, and applicable to each Section of Division 20 to 25.

2 ACCESSIBILITY FOR BUILDING CONTROL DEVICES

- .1 Mount control devices, intended to be adjusted or to otherwise be operated by the occupant for the operation of building services or safety devices, as follows:
 - .1 room environmental controls, including thermostats/adjustable room temperature sensors: at 1200 (47 in) above the finished floor,
 - .2 all other controls: between 900 and 1100 mm (36 in. and 43 in.) above the finished floor.
 - .3 be positioned to have a clear space in front of and centered on the control device, of 810 x 375 mm (32 x 15 in).
 - .4 be operable using a closed fist and with a force not exceeding 22.2 N (5 lbf).
- .2 The above requirements do not apply to control devices that are solely located and used by the building operations staff.

3 ACCESS PANELS / DOORS

3.1 General

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

Standard of Acceptance

- Williams Brothers – fig. GP
- Elmdor/Acorn - fig. DW
- Mifab - fig. UA

3.2 Applicable Product Standards

- .1 CAN/ULC-S104 Standard Method for Fire Testing of Door Assemblies

3.3 Construction:

- .1 Standard access door:
 - .1 1.6 mm (16 ga) carbon steel door and door-frame with white satin coat prime coat finish, with door edges turned back to frame for rigidity,
 - .2 flush mounted with 180° opening door, round safety corners, concealed hinges, plaster lock and anchor straps,
 - .3 latch: screw driver operated,
 - .4 access doors in ceilings, where acoustic tile is applied to plaster or gypsum board, to be dish type designed to receive tile insert.
 - .5 size:
 - (a) 600 mm x 600 mm (24 in x 24 in) for personnel entry,
 - (b) 300 mm x 450 mm (12 in x 18 in) for hand entry,

.2 Variations:

- .1 stainless steel variant:
 - (a) Type 304 stainless steel with No. 4 brush satin finish.
- .2 waterproof variant:
 - (a) Type 304 stainless steel with No. 4 brush satin finish, with neoprene gasketed door.
- .3 security access variant:
 - (a) keyed cylinder, with all cylinders keyed alike,
- .4 fire rated variant:
 - (a) where access door is located in a horizontal or vertical fire separation that has a fire resistance rating of 2 hours or less,
 - (b) insulated door with 50 mm (2 in) fire retardant mineral wool insulation, and 0.95 mm (20 ga.) back liner,
 - (c) heavy duty spring for self-closing door action,
 - (d) rated for installation in masonry walls and fire rated shaft wall construction, or fire rated ceiling construction as applicable to the installation,
 - (e) listed to CAN/ULC-S104 for minimum 1.5 hour closure ratings.
- .5 Submit shop drawings showing access door size, type and location.

3.4 Installation:

- .1 Access doors are required at;
 - .1 expansion joints,
 - .2 dampers,
 - .3 fire dampers,
 - .4 air valves,
 - .5 air terminal units,
 - .6 isolation and control valves ,
 - .7 pressure reducing valves,
 - .8 heating or cooling coils,
 - .9 control wiring junction boxes.
- .2 Supply access doors and make arrangements and pay for installation by Division in whose work they occur.
- .3 Supply access doors with the required variations in accordance with the following table:

Space Type	Wall or Ceiling Finish	Variants		
		Stainless Steel	Water-proof	Key lock
Service rooms, Service corridors,	Drywall	---	---	---

Space Type	Wall or Ceiling Finish	Variants		
		Stainless Steel	Water-proof	Key lock
Public spaces and corridors - more than 2.4 m (8 ft) above the floor, Private spaces, washrooms	Tile or other hard finished surfaces	Yes	---	---
Public spaces and corridors - 2.4 m (8 ft) or less above the floor, Mental health patient areas, Public washrooms	Drywall	---	---	Yes
	Tile or other Hard Surfaces	Yes	---	Yes
Shower rooms, bathtub rooms, Pools, saunas, Kitchens, laundries, Other damp, washdown or high humidity spaces Decontamination Rooms	All	Yes	Yes	Yes

- .4 Provide fire rated variant in addition to the above table variants, as applicable to the wall or ceiling construction.
- .5 Size and locate access doors in applied tile, block or in glazed or unglazed structural tile to suit joint patterns.
- .6 Access doors are not required in removable ceilings. Provide coloured marking devices after completion of ceilings, at four corners of each panel below point requiring access. Colour code markers to show service or device above.
- .7 At time of instruction of owners operating staff, hand-over and obtain signed receipt for 4 sets of each type of key used for access doors with key-lock cylinders.

4 DRAIN VALVES

- .1 Provide drain points with drain valves at low points of piping systems and at section isolating valves.
- .2 Drain valves:
 - .1 NPS ¾ drain and valve for service pipes NPS 2-1/2 and smaller, complete with hose end male thread, cap and chain,
 - .2 NPS 2 drain and valve for services pipes NPS 3 and larger, complete with female Camlock coupling and dustcap.
- .3 Where mechanical-compression fittings are used in the piping system, use only threaded fittings for the construction of the drain piping.

5 V-BELT DRIVES

5.1 Products

- .1 Provide V-belt drive for each motor driven device which is not directly connected to the motor. Keep overhung loads on prime mover shafts within manufacturer's design guidelines.

- .2 Sheaves for motors 7.5 kW (10 hp) and less, with not more than two belts:
 - .1 cast iron or steel secured to shafts with removable keys.
 - .2 adjustable pitch on motor, fixed pitch on driven device, giving plus or minus 10% speed range,
 - .3 selected to meet specified operating condition at mid position in pitch adjustment.
- .3 Belts:
 - .1 matched sets of 'B' section, selected for service factor of 2.0 times installed motor horsepower.
 - .2 capable of carrying load with one belt broken.
- .4 Motor slide rails:
 - .1 adjustment plates for centre line alignment
 - .2 belt tension adjusting screws.

5.2 Installation

- .1 Tension belts to manufacturer's recommendations before start-up and after first 100 hr of operation using calibrated belt tensioning gauge.
- .2 Provide replacement pulleys and belts during start-up and balancing to suit field operating conditions.

6 DRIVE AND COUPLING GUARDS

6.1 Products

- .1 Provide guards to protect belt drives, flywheels, rotating couplings on equipment and fan inlet and outlets.
- .2 Guards:
 - .1 removable for servicing,
 - .2 arranged to permit lubrication with guards in place.
- .3 Guards for belt drives:
 - .1 expanded metal screen welded to steel bar stock or angle frame,
 - .2 minimum 1.2 mm (18 ga) thick galvanized sheet metal tops and bottoms,
 - .3 40 mm (1½") diameter holes at both shaft centres for insertion of tachometer.
- .4 Flexible coupling and flywheel guards:
 - .1 Removable "U" shaped, minimum 1.6 mm (16 ga) thick galvanized mild steel or expanded metal mesh on substantial welded angle iron or round barstock frame.
- .5 Guards on unprotected fan inlets and outlets:
 - .1 Minimum 20 mm (¾ in) galvanized wire mesh or expanded metal screen with net free area of guard not less than 80% of fan opening.

6.2 Installation

- .1 Belt guards to accommodate movement of motors for belt tension adjustment.
- .2 Where equipment is installed on resiliently mounted base frame or pad, attach belt guard to this base
- .3 Belt guards and fan inlet guards may be omitted where fan and motor is installed in plenum less than 1.4 m (4 ft) high and disconnect for fan motor is mounted adjacent to and outside access door to plenum.

- .4 Fan inlet guards may be omitted where fan is fitted with inlet guide vanes.

7 SLEEVES

7.1 General

- .1 Provided sleeves for pipes, ducts and conduits passing through walls, floors and roofs.
- .2 Maintain fire-resistance integrity where pipes and ducts pass through walls, floors and partitions which are or form part of a fire separation.
- .3 Manufactured sleeves and integral sleeves with firestopping may be used provided they meet the same performance requirements as specified for fabricated sleeves.

Standard of Acceptance

- Hilti
- 3M
- Marfab Metal Products

7.2 Floor and Wall Sleeves – Dry Locations (“Standard Sleeves”)

- .1 Sleeve dimensions in floor and wall fire separations having a fire-resistance rating:
 - .1 For piping, insulated piping, and conduit:
 - (a) opening sized to suit fire stopping methods employed but in no case having an inside dimension more than 50 mm (2 in.) larger than the outside dimension of the service.
 - (b) sleeves may be permanent or only provided as formwork in concrete and masonry construction,
 - .2 For ductwork:
 - (a) opening sized to suit duct fire damper and/or smoke damper with clearance required for thermal expansion between the wall/floor opening and the fire/smoke damper sleeve in accordance with the fire/smoke damper manufacturer installation instructions.
 - (b) opening sleeves may be permanent or only provided as formwork in concrete and masonry construction,
 - (c) in gypsum-board construction provide permanent opening sleeves or ensure that steel-stud framing is provided to line the opening in the construction.
 - .3 Sleeve length – permanent type:
 - (a) piping: extend 25 mm (1 in.) past each face of fire separation.
 - (b) ductwork fire damper sleeve: as required to allow for installation of retaining angles and installation of required access door.
- .2 Sleeve dimensions for all other wall and floor types (except waterproof floors):
 - .1 For all services:
 - (a) opening sized to suit the outside dimension of the service, but in no case having an inside dimension of not less than 12 mm (1/2 in.) and not more than 50 mm (2 in.) larger than the outside dimension of the service.
 - (b) for clarity, for insulated pipes and insulated ducts the outside dimension of the service includes the insulation thickness.
 - .2 Sleeve length:
 - (a) flush to wall/floor construction or not to extend more than 25 mm (1 in.) past each face of wall or floor construction.
 - .3 Sleeve construction for pipes and conduits:

- .1 for all types of floor and wall construction:
 - (a) minimum schedule 10 steel pipe,
 - (b) fabricated carbon steel sheet of same thickness as schedule 10 pipe, rolled to dimension, lapped and spot welded, or
 - (c) as required by specific firestop system listing requirements.
- .4 Sleeve construction for ducts smaller than 0.4 m² (4 sq ft) cross sectional area including insulation:
 - .1 for wall construction other than as fire separations having a fire-resistance rating:
 - (a) 1 mm (20 ga) minimum sheet metal, lapped and spot welded with 20 mm (¾ in) lip flange at one, or
 - (b) sleeves are not required where wall openings are coordinated wall construction trades which includes any duct insulation.
 - .2 for floors and walls that are fire separations with required fire-resistance rating:
 - (a) as required by fire and/or smoke damper listing.
- .5 Sleeve construction for ducts of 0.4 m² (4 sq ft) and larger cross sectional area including insulation through walls and floors:
 - .1 for wall construction other than fire separations having a fire-resistance rating:
 - (a) 1.6 mm (16 ga) minimum sheet metal, lapped and spot welded with 20 mm (¾ in) lip flange at one end.
 - .2 for floors and walls that are fire separations with required fire-resistance rating:
 - (a) as required by fire and/or smoke damper listing.
- .6 Manufactured floor sleeves with integral fire stopping:
 - .1 floor sleeve with integrated firestopping, for insulated and non-insulated metal pipes, and plastic pipes,
 - .2 for installation in concrete floors and metal deck/concrete floors,
 - .3 adaptors for support or pipe riser clamps,
 - .4 listed to CAN/ULC-S115.

Standard of Acceptance

- ° Hilti - fig. CP 680 series

7.3 Slot Sleeves

- .1 Application:
 - .1 where multiple pipes or conduits are grouped together in a linear arrangement to pass through a concrete floor or wall, or masonry wall, a common slot sleeve may be used,
 - .2 where slot openings are not shown on structural drawings, Contractor may propose location and sizes of slot openings for approval by the structural engineer. Where such approval is denied, use individual sleeves for each pipe or conduit.
- .2 Formwork:
 - .1 provide removable formwork or instruct the contractor under Division 03 of the Work to set formwork for the required slot dimensions prior to pouring concrete or setting of masonry units.
- .3 Slot dimensions:

- .1 slot sleeve dimensions, pipe and conduit sizes, and location of services within the slot are subject to firestopping listing requirements.

7.4 Waterproof Floor Sleeves - Indoors

- .1 Applications:
 - .1 where pipes, conduits and ducts pass through floors in areas subject to water, in building service rooms, in kitchens, in washing areas and in slabs over electric and telephone rooms.
- .2 Fabricated waterproof sleeves for pipes and conduits, :
 - .1 minimum schedule 10 carbon steel pipe with either:
 - (a) hot dip galvanized to ASTM A123 after fabrication, or
 - (b) internally and externally painted with industrial anti-corrosion paint in accordance with Specification section 20 05 02 *Painting for Mechanical Services*, or
 - .2 schedule 10 stainless steel pipe,
 - .3 provided with water bars: 75 mm (3 in.) wide annular water bar flange continuously welded to sleeve.
- .3 Fabricated waterproof sleeves for ducts:
 - .1 fabricated carbon steel sheet sleeve, continuously welded seams and joints, with angle-channel water bar welded to side of sleeve,
 - (a) 1 mm (20 ga) thick for ducts of less than 0.4 m² (4 sq ft) cross-section area including insulation,
 - (b) 1.6 mm (16 ga) thick for ducts 0.4 m² (4 sq ft) and larger cross-section area including insulation, and for openings with multiple ducts:
 - .2 sleeves internally and externally painted with industrial anti-corrosion paint in accordance with Specification section 20 05 02 *Painting for Mechanical Services*,
 - .3 water bars:
 - (a) new construction, embedded into floor concrete: 75 x 75 mm (3 x 3 in.) galvanized-steel angle channel continuously welded to sleeve,
 - (b) existing or new construction, surface mounted: 75 x 50 mm (3 x 2 in.) carbon steel angle channel, surface mounted to top of concrete housekeeping curb.
- .4 Location of water bars:
 - .1 placed at mid-height of floor construction thickness in new floor construction,
 - .2 surface mounted on and fastened to top of concrete housekeeping curb in existing buildings or in new floor construction.

7.5 Foundation Wall Sleeves

- .1 For installation in poured concrete foundation walls.
- .2 Manufactured foundation wall sleeves:
 - .1 PVC wall sleeve with 50 mm (2 in) wide water bar,
 - .2 sized to suit pipe OD and pipe link-seal.

Standard of Acceptance

- Metraflex

- .3 Fabricated wall sleeve:

- .1 Method 1:
 - (a) schedule 10 Type 304 stainless steel pipe with 75 mm (3 in) wide water bar welded to mid-point of sleeve,
- .2 Method 2:
 - (a) schedule 40 carbon steel pipe with 75 mm (3 in) wide water bar welded to mid-point of sleeve,
 - (b) sleeves internally and externally painted with industrial anti-corrosion paint
- .3 sized to suit pipe OD and pipe link-seal.

7.6 Installation

- .1 Provide sleeves for the passage of services through walls, floors and roofs in accordance with the following table:

Construction Element	Fire Resistance Rating	Element Construction	Mechanical Service	Opening Sleeve Required
Roof	Any or none	All	All	Yes
Walls	>0 hrs	Concrete, Masonry Units	Pipe and Conduit	As required for formwork
			Ductwork	As required for formwork
		Gypsum Board	Pipe and Conduit	Yes
			Ductwork	As required by fire or smoke damper listing
Wall (smoke barrier)	0 hrs	All	All	Yes, or wall tightly finished to sides of service
Acoustic Isolation Walls	None [1]	All	All	Yes
All other walls	None [1]	All	All	None unless otherwise shown
Floors	>0 hrs	Concrete	Pipe and Conduit	As required for formwork
			Ductwork	As required by fire or smoke damper listing
Waterproof Floors	Any or none	Concrete	Pipe and Conduit	Yes
			Ductwork	Yes or Curb

Notes:

[1] Walls are not fire separations of any type.

- .2 Place and secure sleeves in concrete form work for floors, walls and roofs.
- .3 Supply sleeves to be set in masonry walls with installation detail drawings setting out locations of sleeves.

- .4 Standard sleeves:
 - .1 terminate flush with surfaces of concrete and masonry walls.
 - .2 standard sleeves may be omitted where the services pass through walls which are not fire-separations and are concealed above opaque ceilings.
- .5 Waterproof sleeves in new construction:
 - .1 extend sleeves 50 mm (2 in.) above top of housekeeping curbs,
 - .2 extend sleeves 150 mm (6 in.) above finished floors where housekeeping curbs are not used,
 - .3 install sleeves with water bar embedded within the concrete floor or with water bar sitting on top of concrete housekeeping curb. Where mounted on top of housekeeping pad, mechanically fasten sleeve and water bar to concrete housekeeping curb.
 - .4 where water bars are exposed, grind smooth any edges to allow application and adhesion of floor/curb paint finishes.
- .6 Waterproof sleeves in existing concrete buildings:
 - .1 install sleeves in neatly cut or drilled holes in existing construction,
 - .2 carry out cutting and drilling of structural elements, such as floors, slabs, and walls in accordance with procedure set out in Article "Cutting and Patching".
 - .3 provide 150 wide x 150 high mm (6 x 6 in.) housekeeping curb for each penetration.
 - .4 extend sleeves 50 mm (2 in.) above top of housekeeping curbs, with water bar mechanically fastened to curb,
- .7 Seal the void between sleeve and service:
 - .1 except for sleeves for fire dampers and smoke dampers, fill void between sleeve and pipe, conduit or duct in accordance with Article "Fire Stopping and Smoke Seals" in this Section for sleeves located in fire separations,
 - (a) for waterproof sleeves, use firestopping material which is also suitable for exposure to water under normal operating conditions.
 - .2 at other locations, pack the void between sleeve and pipe, conduit or duct for full depth of sleeve, with mineral wool insulation and seal both ends with silicone-free caulking compound.
- .8 Where shown, provide floor, wall or roof sleeves for future use. Coordinate with trade contractor under Division 03 of the Work to have such sleeves filled with light weight concrete.

8 LINK SEALS

8.1 General

- .1 Fit each pipe passing through floor slab in contact with ground or basement walls below grade with link seal between sleeve and bare pipe.
- .2 Submit manufacturer's literature and schedule showing location, service, inside diameter of wall opening, sleeve length and pipe outside diameter.
- .3 Link seal:
 - .1 Manufactured from modular synthetic rubber links with stainless steel hardware.
 - .2 Loosely assembled with bolts to form continuous rubber belt around pipe, with pressure plate under each bolt head and nut.
 - .3 Constructed to provide electrical insulation between pipe and sleeve.

Standard of Acceptance

- Power Plant Supply – fig. Thunderline Linkseal
- Advance Products & Systems – fig. Innerlynx
- Metraflex - fig. MetraSeal

8.2 Installation

- .1 Determine inside diameter of each wall opening or sleeve before ordering seal.
- .2 Position seal in sleeve around pipe and tighten bolts to expand rubber links until watertight seal is obtained.

9 FIRE STOPPING AND SMOKE SEALS

9.1 General

- .1 Provide fire stopping and smoke seals where ducts, pipes or conduits penetrate fire separations.
- .2 Fire stop materials to be impervious to water when installed in a horizontal separation, including waterproof service sleeves.
- .3 Firestop material manufacturer or their designated service representative to provide the following services:
 - .1 selection of listed fire stopping assemblies for each applicable service penetration and fire separation assembly/rating,
 - .2 provide training of contractor's staff for proper installation of fire stopping assembly; create and maintain a log of those personnel who obtain training,
 - .3 inspect the completed installation of all penetrations and submit a written report to the Consultant, including photo record of randomly selected instances of each fire stopping method. Where deficiencies are discovered, note the deficiencies in the report and provide remedial instructions to the contractor to correct the deficiency. After deficiencies are corrected, re-inspect the deficiencies to conform their correction, update and resubmit the report to the Consultant.
- .4 Submit a complete fire stopping and smoke seal shop drawing schedule to the Consultant for review. Include details, cut sheets, system description and location for each proposed fire stopping and smoke sealing application.

9.2 Products

- .1 Materials and firestopping system to be listed for conformance with CAN/ULC-S115 "*Standard Method of Fire Tests of Firestop Systems*".
- .2 Firestop systems to have F duration rating equal to the fire resistance rating of the applicable fire separation. In addition, where required by the applicable building code for the specific service penetration, the fire stop assembly shall:
 - .1 have a F rating equal to the fire resistance rating of the applicable fire separation with a pressure differential of 50 Pa (0.2 in.w.c.) between exposed and unexposed side with the highest pressure on the exposed side, and
 - .2 have an FT rating equal to the fire resistance rating of the applicable fire separation,

Standard of Acceptance

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

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

9.3 Installation

- .1 Install firestopping and smoke seals in accordance with the manufacturer's recommendations and in accordance with its listing.
- .2 Firestopping and smoke seals to be installed only by personnel trained by the manufacturer on the installation of such systems.
- .3 Seal space between penetrating service and sleeve or opening in in fire rated floors and walls with a firestop and smoke sealing system.
- .4 Select thickness and arrangement of back-up materials to suit size of service, length of sleeve and anticipated movement.
- .5 At time of application of materials, surfaces to be clean, dry and free from dust, oil, grease, loose or flaking paint and foreign materials.
- .6 Select firestopping system to allow insulation and vapour barrier to pass un-broken through assembly.
- .7 Do not apply fire stopping materials to fire or smoke dampers.

10 WALL AND FLOOR PLATES

10.1 General

- .1 Provide finishing plates fitted to ducts, pipes, and electrical services provided under Division 20 of the Work which pass through walls, floors and ceilings in finished areas.

10.2 Products

- .1 Escutcheons for small diameter piping and small diameter electrical conduit:
 - .1 manufactured chrome plated two-piece split type with hinge and set-screw.
- .2 Finishing plates for ducts, larger pipes, larger electrical conduits and electrical cables:
 - .1 finishing plate (ring) fabricated from minimum 0.9 mm (20 ga) thick T304 stainless steel with No. 4 brushed finish, with minimum 25 mm (1 in) high collar ring,
 - .2 mounting holes drilled at not less than three (3) symmetrically location positions around the ring to allow mechanical fastening,
 - .3 plate diameter to be sufficiently sized to overlap the wall, floor or ceiling opening by not less than 25 mm (1 in) all around the opening.

10.3 Installation

- .1 Escutcheons;
 - .1 secure escutcheons to pipe and electrical conduit with mechanical fastener.
- .2 Finishing plates:
 - .1 set finishing plates flat against the finished surfaces, and secure to the surface with stainless steel pan-head mechanical fasteners. Provide insert anchor plugs in the finished surface as necessary to secure the fasteners.

PIPE SUPPORTS, EQUIPMENT SUPPORTS, AND TRENCH COVERS

11.1 General

- .1 Design and fabricate supplementary supporting steel for piping, ductwork and equipment supports, and trench and pit covers, from steel plate and sections. For clarity, the contractor under these Division 20 to 25 of the Work is responsible for design, fabrication and installation of such materials.
- .2 Concrete housekeeping bases for mechanical and electrical equipment which are in direct contact with floor slab, are to be provided by this Division 20.
- .3 Concrete for equipment supported on vibration isolated inertia bases is to be provided by this Division 20.
- .4 Work to be done by firms specializing in these fields.
- .5 Submit shop drawings for steel and concrete work, prepared by Professional Engineers licensed in the jurisdiction of the Work

11.2 Applicable Codes and Standards

- .1 Legislation:

Ontario Building Code,

- .2 R.R.O. 1990, Reg. 851 Industrial Establishments

- .2 Installation codes and standards:

- .1 CAN/CSA-S16.1 Limit States Design of Steel Structures.
- .2 CSA W59 Welded Steel Construction (Metal Arc Welding).

- .3 Product standards:

- .1 ASTM A36 Standard Specification for Carbon Structural Steel
- .2 ASTM A53/A53M Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
- .3 ASTM A123 Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
- .4 ASTM A 307 Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
- .5 CAN/CSA G40.20/G40.21 General Requirements for Rolled or Welded Structural Quality Steel.

11.3 Supplementary Supports and Support Brackets

- .1 Provide supplement supports and brackets for the support of equipment, piping and ductwork.
- .2 Fabricate supports from structural grade steel with anchor bolts and fastenings, so that horizontal supporting beam deflections do not exceed 1/360 for the span, and not exceed an absolute deflection of 5 mm (0.20 in), with a safety factor of 1:4 to the ultimate strength of the material
- .3 Design the supports in consultation with the building structural Consultant, to transfer live loads and dead loads to the building structural elements,
- .4 Construct the supports as frames bracketed from walls, and/or supported from building structure above, and/or floor below.

11.4 Trench Covers, and Pit Covers

- .1 Fabricated with:
 - .1 75 mm x 75 mm x 9.5 mm (3 in x 3 in x $\frac{3}{8}$ in) welded angle frame with anchor bars,
 - .2 25 mm x 9.5 mm (1 in x $\frac{3}{8}$ in) trim bar to fit concrete pit, and with matching checker-plate cover,
 - .3 hot dip galvanized after fabrication

11.5 Installation - General

- .1 Locate supporting steel to permit removal of parts for service or repair, and to allow clear access to valves, fittings, and equipment,
- .2 Set equipment on supporting frames and brackets and install hangers, anchor bolts, vibration mountings and snubbers.
- .3 Set equipment base plates on housekeeping pads on minimum 13 mm ($\frac{1}{2}$ in) epoxy grout and fill hollow portion of base with concrete.
- .4 Install anchor bolts, vibration mountings and snubbers between equipment and housekeeping pad, or inertia pad and housekeeping pad.
- .5 Provide anchorage, dowels, anchor clips, bar anchors, expansion bolts and shields, and toggles.
- .6 Make field connections with bolts to CAN/CSA-S16.1, or by welding.
- .7 Supply items for casting into concrete or building into masonry to appropriate trades together with setting templates.
- .8 Touch-up field welds, bolts and burnt or scratched surfaces after completion of erection with primer.
- .9 Where trench covers are cut in field or damaged, touch up with zinc rich paint.

END OF SECTION

MECHANICAL RENOVATIONS IN EXISTING FACILITIES

20 05 02

1 GENERAL

1.1 Scope

- .1 Contractor is responsible to review all documents for all divisions to coordinate phasing and services required at end of each phase.
- .2 Work in existing areas where new construction connects to existing will be heavily phased. Rework of services will impact on the existing facility. Notify the Owner and the Architect, in writing, at least one week in advance of the work where work requires shut-down or isolation of existing services.
 - .1 Note a portion of the renovation requires re-routing of existing piping. ***All new piping is to be in place prior to removal/disconnection of existing*** to minimize downtime.
- .3 Except as identified, shut downs of existing services will be restricted from 11PM to 5AM and on weekends.
- .4 All work outside area of renovation and/or outside of IPAC hoarding to be done after hours and/or on weekends. Work to be done in accordance with Owner's IPAC procedures.
- .5 When directed by the Engineer, where specific sizes are listed in sections below, components or services may be provided in sizes equal to or smaller than the sizes listed.
- .6 The Contractor shall include all provisions below in the contract. The Contractor shall not be required to credit or provide spare parts for any unused provisions.

2 CONNECTIONS TO EXISTING

2.1 Hydronic Piping Connections

- .1 Provide connections to existing heating water systems by freezing. Coordinate with Owner freezing of lines to make required connections. Cost of freezing to be Contractor's cost and does not include the additional freezing carried as required below.

2.2 Medical Gas Connections

- .1 Make connections to the existing medical gas systems, on a gas by gas basis, within one overnight shut-down. Provide additional valves where new connections are to be made to limit shutdown to one night.
- .2 Complete all piping installation and inspection, and arrange for certification by facility's designated inspection agency, prior to connection to the existing facility's piping.
- .3 Arrange for the inspection of the connections to the existing facility's piping to be made immediately after the completion of the work.

3 PROVISIONS FOR SPARE SERVICES AND COMPONENTS

3.1 Sleeving, Core Drilling, and Scanning

- .1 All services penetrating concrete walls and floors to be sleeved prior to pouring. Submit sleeving drawings indicating service size and sleeve size, superimposed over structural drawings and submit for approval. Relocate sleeves as directed by Engineer.
- .2 Include in contract for additional cores and scanning for the following for missed sleeves and/or changes.
 - .1 4@ 4" cores
 - .2 2@ 6" cores

3.2 Spare Components

- .1 Provide the following components in addition to those required in contract.
- .2 Provide spare access doors for unexpected situations where access to installed devices in hard ceilings is required:
 - .1 6 @ 24" x 24" keyed access doors,
- .3 Provide spare valves including installation on existing or new piping, modifications to insulation as required:
 - .1 Domestic Water service – 4@ 3/4", 2@ 1 1/2", 4@ 2", 2@ 3", 2@ 4".
 - .2 Heating and Cooling service – 4@ 3/4", 4@ 1".
 - .3 Medical service – 8@ 1".
- .4 Provide the following spare fire dampers complete with duct access door and installation in new or existing ductwork:
 - .1 4@ 24" x 24"
- .5 Provide **2** type spare **A1 diffusers** complete with installation, 10 feet of 12"x12" duct, and insulation on supply duct.
- .6 Provide **2** type spare **C1 grilles** complete with installation and 10 feet of 12"x12" duct.
- .7 Provide **5 spare BAS control points** complete with device, wiring and conduit (assume 200 ft per point), programming, etc. in contract to be used by discretion of Engineer.

3.3 Sprinkler Heads

- .1 In situations where architect re-positioning of a sprinkler head in the reflect ceiling plan results in additional heads for coverage, provide **2 additional concealed sprinkler heads** with associated piping.
- .2 In addition to the above, provide **2 additional concealed sprinkler heads** with associated piping for sprinkler protection under large ducts, under obstructions, and in blind spaces.
- .3 Identify additional sprinkler heads on shop drawings with a capital letter "A" and resubmit drawings to permit inclusion of these sprinkler heads in hydraulic calculations.
- .4 The sprinkler heads above shall be dry concealed heads where required in preaction systems.

3.4 Freezing of Live Water Services

- .1 Include in contract an allowance for the following connections where existing valves do not hold or do not exist:
 - .1 Freezing of two (2) 4" sprinkler lines
 - .2 Freezing of four (4) 4" water lines
 - .3 Freezing of one (1) 8" water line

4 PHASING

4.1 Phasing – General

- .1 Comply with all Division 01 Specifications regarding Work Restrictions, Phasing, and Staging.
- .2 Carefully examine the phasing plan from the Architectural drawings and Division 01 Specifications to develop a mechanical construction plan in conjunction with the General Contractor to ensure that areas can be constructed mechanically for each phase/stage with all active services. All services will be complete and available for occupancy of the phased spaces, unless noted otherwise.
- .3 The drawings show service configuration for final construction layout and do not include scope required for each individual phase of construction. Prior to construction, the Mechanical Contractor shall review each phase, review existing services and formulate a plan on how to construct the area with all services without interruption to other occupied areas.
- .4 The mechanical work necessary to maintain services will not be restricted to the architectural phased areas of work. This division will have to work in the existing occupied building during off hours; obtaining and modifying services for new phased areas.
- .5 The Contractor shall maintain existing systems until the new services are ready for use. New equipment, ductwork, piping is to be installed prior to demolition of existing services, where possible to minimize shut down period.

4.2 Air and Water Balancing

- .1 Air and water balancing is to be carried by the mechanical contractor (see Specification Sections 22 05 93 *Testing Adjusting and Balancing for Plumbing*, 23 05 93.13 *Testing Adjusting and Balancing for HVAC*, and 23 05 93.23 *Testing, Adjusting & Balancing Supplement for Healthcare*).
- .2 Provide air/water balancing at the end of **each** phase.

4.3 Work in Occupied Areas

- .1 Work in Owner occupied areas to be scheduled with the Owner.
- .2 Access to these areas will be at the discretion of the Owner and strictly after hours unless otherwise noted on the drawings.

4.4 Phased Occupancy

- .1 Provide relevant reports at each phase of construction. All items listed in the Occupancy Permit Checklist are required per phase to obtain Partial Occupancy.
- .2 This is one project and substantial performance will be granted at the end of the project. There will be no phased substantial performance or phased release of holdback.

- .3 The Mechanical Contractor to ensure all mechanical equipment is complete and functioning before testing and commissioning is done.

4.5 Equipment Maintenance Equipment Operation

- .1 The Mechanical Contractor will be responsible to maintain and operate new equipment and systems supplied under this project until the project is formally handed over to the Owner. Maintenance shall include all manufacturers' recommended maintenance, filter changes, bearing lubrication, fan belt adjustment, chemical treatment, cleaning of coils. Maintenance and system downtime to be minimized and scheduled to suit the Owner.
- .2 The Mechanical Contractor shall operate the systems to the Owner's benefit to ensure that the occupied phases are fully serviced to the Owner's schedule.
- .3 The Mechanical Contractor to provide a list of emergency contacts so they can respond 24/7 to issues with their system. Repairs to be made quickly to minimize disruption to the users and Owner.

4.6 Training

- .1 Training of Owner's maintenance personnel to be done at end of project prior to formal turnover to Owner. Training will not be required at the end of each phase as the Contractor will be maintaining and operating the equipment/systems installed under this project.

4.7 Warranty

- .1 Equipment and system warranties to start after Substantial Performance even though equipment may be installed and operating early in the construction. Notify equipment supplier of this situation during bidding and include any additional costs related to operating the equipment during the construction period or include extended equipment warranty to cover contract duration plus the standard warranty period starting after Substantial Performance.

5 INTERFERENCE RESOLUTION PROCESS

5.1 General

- .1 Comply with all requirements in Section 20 01 03 Mechanical Coordination and Installation Design Services.
- .2 Provide necessary offsets in ducts, piping etc. to change elevation and direction as required to coordinate services in the ceiling space.
- .3 These requirements apply to the ceiling space of all rooms and to the whole room for Service Rooms that do not contain ceilings.
- .4 Mechanical contractor shall make arrangements with Owner to access the site and ceiling spaces immediately after award of contract, or where existing ceilings are congested, immediately after demolition of the majority of the services to be demolished, to start survey and preparation of coordination drawings so drawings are coordinated before services are installed.
- .5 If the Interference Resolution Process is not completed, all interferences will be resolved at the contractor's own expense.

5.2 Minimum Size of Services to Coordinate

- .1 Superimpose all services, including piping and conduits larger than 2" diameter, on one drawing.

5.3 Interference Resolution Process

- .1 The Interference Resolution Process shall proceed as follows:
 - .1 Demolition of existing, including where applicable:
 - (a) ceilings, and
 - (b) large existing services (ducts, pipes, etc.) within the ceiling which slated to be demolished, where survey work cannot be reasonably completed before demolition due to lack of visibility above the services.
 - .2 Mechanical Contractor shall survey the site and document all existing conditions which deviate from the drawings provided, either by 3D Scan (preferred) or by sketch. Existing conditions may include but are not limited to:
 - (a) Slab to underside-of-slab ceiling height does not match Architectural Drawings
 - (b) Structural elements (beams, joists, etc.) which are not indicated on the structural drawings
 - (c) Existing ducts, piping, conduits, and cable trays
 - .3 (where applicable) Mechanical Contractor to flag any existing conditions to the Consultants which will require major redesign of the Mechanical or Electrical services.
 - .4 (where applicable) Consultants to redesign around major deviations and issue formal documentation of the new design to the Contractor.
 - .5 Mechanical contractor to lay out services and produce interference drawings:
 - (a) (where applicable) Receive preliminary layout from ceiling support supplier ("Unistrut" or similar).
 - (b) Plan the mechanical service layout in 3D.
 - (c) Send mechanical layout to other trades including but not limited to Electrical and Fire Protection.
 - (d) Receive other trades layouts.
 - (e) Incorporate other trades' layouts into the Mechanical 3D software.
 - (f) Review for interferences
 - (g) Coordinate with other trades to resolve minor interferences.
 - (h) Iterate steps (a) through (g) until all minor interferences are resolved.
 - .6 Mechanical Contractor to send the Consultants completed Interference Drawings, in PDF, with all trades shown on one floor plan, and sections through important areas. Mechanical contractor shall indicate any outstanding interferences that could not be resolved by the trades alone, and therefore require Consultant input. For each outstanding item, all restrictions shall be clear such that the Consultant can understand the limitations and advise on a solution.
 - .7 Mechanical Contractor to organize a meeting with all relevant trades, the General Contractor, the Owner, and all relevant Consultants to
 - (a) This may occur during a regularly scheduled Construction Meeting, or may require a dedicated meeting.
 - .8 Iterate Steps #4-7 until all interferences are resolved.
 - .9 Mechanical Contractor may begin fabrication and construction.

5.4 Schedule

- .1 Reasonable time for survey and generation of first draft of interference drawings (Step 5.3.1.2 above) shall be included in the schedule. This encompasses 5.3.1, Steps 2 through 6, above.
- .2 Allow for a minimum two (2) week period to resolve coordination issues that arise during the survey and coordination drawing process. This period begins *after* the first iteration of interference drawings is provided, i.e. Step 5.3.1.6 above.

END OF SECTION

COMMON ELECTRICAL REQUIREMENTS FOR MECHANICAL SERVICES

20 05 12

1 GENERAL

1.1 Scope

- .1 Provide wiring, conduit, fittings, supports, disconnect switches, service lights, and related devices and equipment for mechanical trades work, at voltages of 600V and less and to the extent specified herein.
- .2 Pre-installation survey of SCCR values for equipment supplied under Divisions 20 to 25 which requires power wiring supply, to verify nameplate SCCR is equal to or greater than the minimum specified SCCR values.

1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
 - .1 20 05 29 Hangers and Supports
 - .2 20 05 49 Seismic Restraint
 - .3 20 05 14.13 Motor Controllers
 - .4 20 05 14.16 Variable- Frequency Drives

1.3 Definitions and Abbreviations

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

- .12 **Receptacle panel (RP)** - a 120/208 V panelboard with branch circuit breakers, provided by Division 26.
- .13 **SCCR**: the RMS symmetrical short-circuit current rating of the equipment or motor controller, measured at the input to the motor or controlled equipment (short-circuit withstand rating has the same meaning).
- .14 **VFD**: variable frequency drives in accordance with specification section 20 05 14.16.
- .15 **Wiring** means conductors, cable, conduit, fittings, supports and accessories.
- .2 With respect to these definitions, for equipment provided by Division 26 the actual terminology used in the Division 26 drawings and specification may differ but the intent remains the same.
- .3 For clarity, any reference herein to Division 20 means Divisions 20 to 25 inclusive.

1.4 Applicable Codes and Standards

- .1 Legislation:
 - .1 Electrical safety legislation in the jurisdiction of the Work.
 - .2 For clarity, on Federal Government projects, comply with the provincial or territorial legislation at the place of the Work which adopts the applicable edition of CSA 22.1 with any amendments
- .2 Installation standards and codes:
 - .1 CSA C22.1 Canadian Electrical Code Part 1, as amended and adopted by the AHJ for electrical safety in the province or territory at the place of the Work.
- .3 Product standards:
 - .1 CSA C22.2 No. 4 Enclosed and Dead-Front Switches
 - .2 CSA C22.2 No. 38 Thermoset-Insulated Wires and Cables
 - .3 CSA C22.2 No. 39 Fuseholder Assemblies
 - .4 CSA C22.2 No.94.1 Enclosures for Electrical Equipment, Non-Environmental Considerations
 - .5 CSA C22.2 No.94.2 Enclosures for Electrical Equipment, Environmental Considerations
 - .6 CSA C22.2 No. 106 HRC – Miscellaneous Fuses
 - .7 CSA C22.2 No. 124 Mineral Insulated Cable
 - .8 CSA C22.2 No. 131 Type TECK 90 Cable
 - .9 CSA C22.2 No. 208 Fire Alarm and Signal Cable
 - .10 CSA C22.2 No. 230 Tray Cable
 - .11 CSA C22.2 No. 239 Control and Instrumentation Cables

1.5 Quality Control

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

1.6 Short Circuit Current Ratings (SCCR) and Markings

Except where another Specification section requires a SCCR of a different value, equipment provided under Division 20 to 25 which is supplied electrical power in accordance with CSA C22.1 shall have a short circuit capacity rating (SCCR) of not less than 10 kAIC RMS symmetrical.

- .2 The SCCR value is to be marked on all equipment provide with power wiring in accordance with CSA C22.1. Where the SCCR nameplate rating references an instruction manual, provide a separate label that states the SCCR value.

1.7 Permits, Fees and Inspections

- .1 Arrange and pay for electrical permits and any required inspections for electrical work for mechanical equipment and systems.
- .2 Submit to the electrical safety authority the required number of drawings and specifications for examination and approval prior to commencement of work.
- .3 Notify Consultant of changes required by the electrical safety authority prior to making changes.
- .4 On completion of the Work, furnish certificates of acceptance (or similar report) from the electrical safety authority to the Consultant.

1.8 Standard Details

- .1 Device legend with list of abbreviations and schematic wiring diagrams are included at the end of this section that delineate the scope of work between Division 20 and Division 26 and as further specified herein.
- .2 This material is to be used in the interpretation of specification requirements for power wiring and control wiring of Division 20 to 25 equipment.

1.9 Submittals

- .1 Submit manufacturer catalogue cut-sheets for the following materials;
 - .1 VFD Inverter Duty cable,
 - .2 service lights.

1.10 Storage of Materials

- .1 Store wire and cable in a clean, dry, well-ventilated area.
- .2 Protect white insulated wire from exposure to NOx gas (e.g.: exhaust from propane fueled equipment) by wrapping with shrink wrap, by locating away from sources of NOx and by maintaining adequate ventilation to minimize NOx levels.
- .3 Where white insulated wire has discoloured:
 - .1 do not install,
 - .2 dispose of the wire,
 - .3 remove and replace wire that has been installed.

2 PRODUCTS

2.1 Motor Feeder and Control Wiring ("Building Wires")

- .1 Application:
 - .1 motor and equipment power feeders controlled by constant speed motor controllers;
 - (a) do not use for motors controlled by variable frequency drives,
 - .2 control wiring including control valves and damper actuators, panel control wiring, motor controller interlock wiring, BAS control wiring, and switch-type instrumentation,
 - .3 convenience power outlets and service lights.
- .2 Conductors:

- .1 solid copper for No. 12 and 14 AWG,
- .2 stranded conductors for 10 AWG and larger.
- .3 Minimum wire size:
 - .1 No. 12 AWG for equipment power,
 - .2 No. 14 AWG, for control wiring at 120 VAC or lower.
- .4 Insulation:
 - .1 chemically cross-linked thermosetting polyethylene (XLPE) material, RW90 or RWU90,
 - .2 1000 V insulation for 600 V systems,
 - .3 600 V insulation for 100 VAC to 480 VAC systems.
 - .4 300 V insulation for systems less than 100 VAC, and for systems 24 VDC and less.
- .5 Colour coded conductors:
 - .1 colour impregnated into insulation at time of manufacture,
 - .2 phase conductors No. 8 AWG and larger with black insulation, may be colour coded with adhesive colour coding tape.
- .6 Listed to CSA C22.2 No. 38.
 - Standard of Acceptance*
 - Aetna Insulated Wire
 - General Cable
 - Nexans Canada Inc.
 - Prysmian Cables & Systems Ltd.
 - Southwire

2.2 VFD Inverter Duty Cable

- .1 Application:
 - .1 for motor power feeders between a VFD and its driven motor,
 - .2 specifically manufactured to reduce high frequency noise and grounding of common mode currents.
- .2 Cable:
 - .1 symmetrical conductor, low-capacitance design with three ground wires and shield,
 - .2 conductors: braided copper wire with RW90 XLPE insulation.
 - .3 voltage rating: 1000 VAC, with resistance to voltage spikes of not less than 2 kV.
 - .4 bonding conductors: three (3) bare copper conductors,
 - .5 shielding:
 - (a) designed for EMC/RFI reduction and as a low-impedance path for high-frequency common mode currents,
 - (b) 100% coverage by two-layers of copper-wrap tape shield, or
 - (c) shielding provided by continuous corrugated and welded aluminium armoured sheath.
 - .6 sheath:
 - (a) method 1: continuous corrugated and welded aluminum armour sheath (armour and shield),

- (b) method 2: interlocked aluminium sheath for armour, separate copper wrap shields as specified above,
- (c) method 3: no armour sheath required when cable has the specified copper tape shielding and is installed in conduit,
- .7 outer jacket: TPE or PVC liquid-tight with FT4 and AG14 rating, and UV resistant.
- .8 listed to CSA C22.2 No. 38, and CSA C22.2 No. 230.

Standard of Acceptance

- NEXANS - fig. DriveRx (armoured)
- ShawCor - fig. CSA Armoured AIA VFD (armoured)
- ShawCor - fig. CSA Unarmored Tray VFD (unarmoured)
- Belden - fig. Symmetrical 2kV (unarmoured)
- Belden - fig. Symmetrical 2kV (armoured)

.3 Cable shield termination fittings:

- .1 High-frequency/low impedance shield termination kit to provide 360° connection to the cable shield, with flexible tinned copper braid bonding strap with attached lug, and constant force spring collar.

Standard of Acceptance

- Southwire – fig. 85451

- .2 High-frequency/low impedance cable gland, with integral 360° copper alloy shield contact spring.

Standard of Acceptance

- Southwire - fig. 85452

2.3 Extra-Low Voltage Power Wiring – 24 VAC, 24 VDC

- .1 Application: power wiring to 24 VAC or 24 VDC electrically commutated motors.
- .2 Type: ACIC,
- .3 Cable:
 - .1 insulated solid or stranded copper conductors,
 - .2 insulation: XLPE, colour coded or numbered wires,
 - .3 minimum wire size: 16 AWG,
 - .4 voltage rating: 600 V.
- .4 Armour:
 - .1 aluminium interlocked armour.
- .5 Jacket:
 - .1 FT4 flame retardant,
 - .2 FT6 when installed in raised floors, or in ceiling spaces that are used as return air plenums.
- .6 Listed to CSA C22.2 N0. 239,

Standard of Acceptance

- General Cable (Carol)
- Belden
- Nexans Canada Inc.

2.4 Instrumentation Cabling

- .1 Application: instrumentation and control wire suitable for analogue 4-20 mA and 0-10 VDC signaling.
- .2 Cable:
 - .1 insulated solid-copper twisted-multipair conductors, shielded cables with individually shielded pairs, 100% coverage overall shield, drain wires and overall rated jacket,
 - .2 insulation: XLPE, colour coded or numbered wires,
 - .3 minimum wire size: as specified by equipment manufacturer or controls vendor, but not less than 18 AWG,
- .3 Armour:
 - .1 corrugated steel, or
 - .2 none required if installed in conduit or approved wireway.
- .4 Jacket:
 - .1 FT4 flame retardant,
 - .2 FT6 when installed in open style cable trays in ceiling spaces that are used as return air plenums.
- .5 Listed to CSA C22.2 No. 239,

Standard of Acceptance

- General Cable (Carol)
- Belden
- Nexans Canada Inc.

2.5 Conduits and Fittings

- .1 Conduits:
 - .1 rigid hot dipped galvanized steel threaded conduit,
 - .2 electrical metallic tubing (EMT), hot dipped galvanized with couplings,
 - .3 PVC coated hot dipped galvanized rigid steel conduit: with 40 mil PVC exterior coating, 2 mil urethane interior and thread coating,
 - .4 flexible metal conduit and liquid-tight flexible metal conduit.
- .2 Conduit fastenings:
 - .1 single hole steel straps to secure surface conduits 50 mm (2") and smaller,
 - .2 two hole steel straps for conduits larger than 50 mm (2"),
 - .3 beam clamps to secure conduits to exposed steel work,
 - .4 channel type supports for two or more conduits,
 - .5 Ø6 mm threaded rods to support suspended channels.
- .3 Conduit fittings:
 - .1 manufactured for use with conduit specified including coatings,
 - .2 factory "ells" where 90° bends are required for 25 mm (1in.) and larger conduits,
 - .3 insulated throat steel set screw or raintight insulated throat steel compression connectors and couplings for EMT,

- .4 threaded or compression type raintight/concrete tight insulated throat zinc plated steel connectors and couplings for rigid steel conduit,
- .5 raintight insulated throat steel connectors at all surface equipment enclosures and other electrical equipment in sprinklered areas for all conduit terminations.

2.6 Outlet Boxes

- .1 Construction:
 - .1 hot dipped galvanized steel single and multi-gang flush device boxes for flush installation,
- .2 Size:
 - .1 76 mm x 50 mm x 38 mm (3" x 2" x 1½") or as indicated,
 - .2 102 mm (4") square outlet boxes when more than one conduit enters one side with extension and plaster rings as required.

2.7 Disconnect Switches

- .1 Construction:
 - .1 listed to CSA C22.2 No. 4,
 - .2 enclosure type:
 - (a) painted metal with hinged door,
 - (b) indoors: type 1, 3R, 4 or 12, unless otherwise specifically shown,
 - (c) outdoors: type 3R.
 - .3 fuseholder assemblies listed to CSA C22.2 No. 39,
 - .4 include fuses unless shown as unfused,
 - .5 fuseholders suitable for Class J fuses, sized to suit the fuse sizes without the use of adaptors,
 - .6 horsepower rated,
 - .7 one, two or three pole as required for single phase or polyphase circuits,
 - .8 two pole with solid neutral or three pole with solid neutral for three wire and four wire circuits with neutral,
 - .9 six pole for two speed motor applications,
 - .10 provision for padlocking in the Off switch position,
 - .11 mechanically interlocked door to prevent opening when handle is in the ON position,
 - .12 heavy duty, quick-make, quick-break action,
 - .13 ON-OFF switch position indication on switch enclosure cover.
- .2 Fuses:
 - .1 HRCI-J time delay up to 600A,
 - .2 HRCI-L for ratings above 600A,
 - .3 minimum interrupting capacity: 200 kAIC
 - .4 product of one manufacturer,
 - .5 ampere rating as indicated, where not indicated, the maximum rating permitted by the electrical code.
- .3 Special requirements for disconnect switch located upstream of harmonic filters:

- .1 double break contacts per pole, to isolate fuses on both the line and load side,
- .2 14 AWG power taps on both line and load sides for control power transformers.
- .4 Special requirements for disconnect switch located between a VFD and the controlled equipment:
 - .1 auxiliary switch position status switch;
 - (a) rating: 10 A at 120 VAC,
 - (b) switch contacts open when disconnect switch is Not-Closed.
- .5 Ratings:
 - .1 IEC 90 rotary switch for motors up to 18.6 kW (25 HP),
 - .2 NEMA flange mount switch-handle for all ratings.

Standard of Acceptance

- Square "D"/Schneider Electric Company (Canada) Ltd.
- Eaton
- Siemens Canada Ltd.
- Klockner Moeller/Eaton

2.8 Switches

- .1 Toggle switch, with neon pilot light – light is On when switch is Off.
- .2 Rating: 20 A at 120 Vac.
- .3 Switch cover: weatherproof with silicone rubber gasket, and clear bubble over toggle.

Standard of Acceptance

- Hubbell - HBL1795

2.9 Receptacles

- .1 Class A GFCI type, 15 A at 120 VAC indoors, and 20 A T-slot for outdoors.
- .2 Receptacle outlet hood:
 - .1 in-use weatherproof, for both indoor and outdoor locations,
 - .2 die cast aluminum base and cover with gasket,
 - .3 vertical mount.
 - .4 self-closing lift cover.
 - .5 CSA 3R rated.

Standard of Acceptance

- Bryant Electric – WPB26EH

2.10 Conduit and Equipment Supports

- .1 General:
 - .1 supports for conduit may conform to Specification section 20 05 29 except/and as specified herein.
 - .2 Materials: carbon steel supports, hot dipped galvanized after fabrication.
 - .3 manufacturer standard products suitable for support load rating of conduit and conductors:

Standard of Acceptance

- Burndy Canada Ltd.
- Canstrut
- Electrovert Ltd.
- E. Myatt & Co. Ltd
- Steel City Electric Ltd.
- Pilgrim Technical Products Ltd.

.2 Upper attachment – concrete inserts

- .1 galvanized wedge inserts to MSS SP-58 type 18.
- .2 maximum tension load rating: 4.4 kN (1000 lbs),

Standard of Acceptance

- Anvil - fig. 281
- Unistrut - fig. P-3245

.3 Upper attachment – existing concrete:

- .1 conform to Specification section 20 05 29.

.4 Upper attachment – steel beams:

- .1 carbon steel beam clamp (top flange), hook rod with locking jaw, fasteners and lockwashers, to MSS SP-58, type 25,

Standard of Acceptance

- Anvil - fig. 227
- Myatt - fig. 504, 505

.5 Upper attachment - steel joists:

- .1 for installation of support rod in the interstice space of double-ell steel joists and open-web steel joints for support on the lower chord,
- .2 carbon steel washer plate with double locking nuts on top-side of washer,
- .3 second steel washer plate on underside of joist with nut where supported equipment is subject to vibration.

Standard of Acceptance

- Anvil - fig. 60
- Myatt - fig. 545

.6 Hanger rods:

- .1 continuous threaded rod, carbon steel, USS national course thread,
- .2 minimum rod size: Ø6 mm (1/4 in. dia.),
- .3 tension load ratings to MSS SP-58,

Standard of Acceptance

- Anvil - fig. 146
- Myatt - fig. 434

.7 Horizontal Pipe Support – Swivel Ring Hanger

- .1 swivel ring hangers, carbon steel ring strap, zinc plated, adjustable knurled swivel nut, to MSS SP-58 Type 10,
- .2 nominal conduit size: 12mmC to 100 mmC.

Standard of Acceptance

- Anvil - fig. 69, CT-69
- Myatt - fig. 41, 42, 43
- Unistrut

- .8 Support channels:
 - .1 U shape, minimum size 41 mm x 41 mm x 2.5 mm (1-1/2" x 1-1/2" x 1/10") thick, surface mounted, suspended or set in poured concrete walls and ceilings.
 - .2 channel size selected for total supported loads,
 - .3 conduit attachments: one-piece or two piece conduit clamps suitable for suspended loads and bottom supported conduit loads.
- .9 J Hooks:
 - .1 galvanized steel open-style J hooks with rolled edges for fastening direct to building structure or hanger rods.
- .10 Rooftop conduit supports:
 - .1 conform to specification section 20 05 29.

2.11 Wire Markers

- .1 Printed, self-laminating vinyl wire and cable labels and sleeve-labels.

Standard of Acceptance

- Brady BMP21 Plus series

3 EXECUTION

3.1 Pre-Installation Survey for Short Circuit Current Ratings

- .1 Prior to installation of power wiring to mechanical equipment provided under Division 20 to 25, conduct a survey of such mechanical equipment's SCCR values. Verify that the equipment nameplate SCCR rating is equal to or greater than:
 - .1 the general value specified in this section, or
 - .2 the specific value specified in the relevant Specification section for the equipment.
- .2 Where the nameplate SCCR is less than the specified minimum SCCR required value, provide a fused disconnect switch as specified herein ahead of the equipment, even if the equipment already has an integral disconnect switch. The cost for the provision of such disconnect switches shall be borne by the trade contractor supplying the mechanical equipment, at no cost to the Owner.
- .3 For clarity, this survey also applies to existing mechanical equipment where the Work includes replacement of the power wiring supplying the equipment.

3.2 General Installation Requirements

- .1 Install electrical wiring work under this specification section in accordance with the applicable electrical safety code and regulations applicable at the location of the Work.

- .2 In other than service rooms, run conduit and cable concealed within walls or above ceilings.
 - .1 for open-cell concrete block walls, install conduit during wall construction with openings for outlet boxes,
 - .2 for solid concrete walls, rough-in conduit and outlet boxes supported from structural reinforcing bars prior to pouring of concrete,
 - .3 where walls or ceiling structures are exposed, such as steel or finished concrete, arrange conduit neatly on the supporting surface, avoid the use of elbows to the greatest extent possible, and locate conduit as close as possible to the building structure.
- .3 In service rooms, run conduit and cables exposed.

3.3 Conduit Support and Hanger Installation

- .1 As an alternative to the materials specified herein, specification section 20 05 29 may also be used for support of conduits.
- .2 Support conduit from building structure in accordance with specification section 20 05 29.
- .3 Support conduit directly from or on structural building elements. Do not support conduit directly from other services.
- .4 Provide all miscellaneous materials including nuts, washers, and backing plates to make a complete support installation.
- .5 Where wall brackets are used, select brackets and size mounting bolts and backing plates to suit the supported load, allowing for a safety factor by not loading the bracket more than 80% of its published load rating.
- .6 In steel framed construction, support conduit from structural members. Where structural members are not suitably located for upper hanger attachment locations, and where inserts of adequate capacity cannot be installed in concrete slabs, provide supplementary steel framing members;
 - .1 fabricate supplementary steel from standard HSS sections, single EL section, double C "strongback" sections, or pipe rolls,
 - .2 size supporting steel to limit span deflection to 1/250 (0.4%) between support points,
- .7 Support horizontal conduit at intervals not exceeding 3 m (6 ft).
- .8 Support vertical conduit at intervals not exceeding 3 m (6 ft).
- .9 Where trapeze hangers are used, secure conduit to trapeze with U-bolts or conduit clamps.
- .10 Mechanically fasten supplementary steel to structural steel.

3.4 Armoured Cable Support

- .1 Support armoured cable VFD cables on 300 mm (12 in.) centres on channel supports and secured with conduit clamps. Do not use nylon or wire lashing or perforated strap to support or secure cables.
- .2 Support instrumentation armoured cables horizontally in cable trays or with J-hooks on 300 mm (12 in.) centres.
- .3 Support instrumentation armoured cables vertically by securing to building structure or secondary framing with perforated straps with 3 mm (1/8 in.) thick EPDM protective strip between the strap and cable.

3.5 Plenum-Rated Control and Instrumentation Cables Support

- .1 Support plenum-rated instrumentation and control cables in cable trays or with J-hooks on 300 mm (12 in.) centres. Support vertical cable drops to controls instrumentation, controlled devices or related equipment by use of vinyl tie-wraps fastened to building structure, supplementary steel, or equipment hanger rods. Do not support cables on piping or ductwork.

3.6 Installation of Power and Control Wiring – General Requirements

Wiring methods and standards to conform with those specified in Electrical Division 26 for the area of building in which installation is to be made, except as otherwise specified in this section.

- .2 Except where fire rated cables or VFD Inverter duty cables are required, use building wire for:
 - .1 power wiring for motors and packaged equipment,
 - .2 power wiring to control panels, heat tracing and other non-motorized packaged equipment, and
 - .3 non-analog control wiring at 120 VAC or less, and 24 VDC or less.
- .3 Provided polyphase motor and equipment power conductors with the following colour coding:
 - .1 Phase A – Red,
 - .2 Phase B – Black,
 - .3 Phase C – Blue ,
 - .4 Neutral - White,
 - .5 Ground - Green,
 - .6 Control - Orange.
 - .7 Where colour coded tape is utilized, apply at least 50 mm (2") at terminations, junction boxes and pull boxes. Do not paint conductors.
- .4 Provide single-phase motor and control wiring conductors with the following colour coding:
 - .1 Line – Red,
 - .2 Neutral – White,
 - .3 Ground – Green.
- .5 Install all wiring in conduit or approved raceway.
- .6 Use conduit type as follows:
 - .1 EMT: use thin wall conduit up to and including 32 mm (1 ¼ in) size for wiring in ceilings, furred spaces, in hollow walls and partitions and where not exposed to mechanical injury, and as otherwise shown.
 - .2 Rigid : use rigid galvanized steel conduit for wiring in poured concrete, where exposed, and for conduit 40 mm (1½ in) size and larger.
 - .3 Liquid-tight flexible: use only for the last 1000 mm (3 ft) of motor feeder at connection to motor, and for instrumentation wiring to equipment subject to vibration.
 - .4 select conduit size to be of sufficient size to allow easy removal of conductors at any time. Conduit sizes, where shown, are minimum and shall not be reduced.
- .7 Provide separate conduit for power wiring for each motor or starter. Except for motor temperature transducer wiring, do not install control wiring in the same conduit as power wiring.
 - .1 exception: motor temperature transducer wiring between motor and associated motor controller may be run in the same conduit as the associated motor feeder provided the conduit is sized for the additional wire pair.

3.7 Installation of Power Wiring for VFDs and Associated Motors

- .1 Use VFD inverter duty cables for motor feeders between VFDs and associated motor.
- .2 Run VFD inverter duty cables in rigid conduit or EMT between the VFD and the motor, with liquid-tight flexible conduit used at the motor connection;

- .1 use only site-formed bent elbows for changes of direction; do not use ells,
- .2 make an elbow radius so that the bend radius of the cable is not less than the minimum bending radius specified by the cable manufacturer,
- .3 do not combine wiring from any other source or purpose within VFD feeder conduit.
- .3 VFD inverter duty cables may be run in free- air (without conduit) where all the following conditions are met;
 - .1 the VFD cable is of the armoured type,
 - .2 the armoured cable is located in the same room as the VFD and the motor,
 - .3 the armoured cable length does not exceed a total length of 10 m (33 ft);
 - (a) for longer cables, the 10 m (33 ft) free-air length is to be located at the motor end,
 - .4 where the cable passes through the wall of air handling units,
 - (a) provide a 100 mm (4 in) long section of rigid conduit (sleeve) through the wall,
 - (b) the sleeve is provided with escutcheons to seal the wall opening,
 - (c) the ends of the conduit are reamed and cleaned of burrs and sharp edges, and
 - (d) the cable/sleeve is sealed with a non-hardening mastic (i.e. firestop compound) at one end.
- .4 Terminate the shield on VFD inverter duty cables as follows:
 - .1 terminate at both ends of the cable at the motor enclosure box ground screw and at the VFD cabinet entrance potential bond screw,
 - .2 connect the shield to the ground screw of any intervening devices between the VFD and the motor where the cable is interrupted, including disconnect switches, output load-filters,
 - .3 connect the ends of the shield with a low-impedance 360° contact termination kit, either by use of a special-purpose gland or by a special-purpose bonding strap.
- .5 Terminate the three ground conductors at each end. A pigtail may be used for final termination to the motor ground lug or the VFD ground lug provided the pig-tail size is not less than the size of the individual cable ground wire.
- .6 Where the VFD cable must be interrupted at an equipment disconnect switch or otherwise spliced, terminate the ends of the shield using low-impedance termination kits at the common ground lug in the disconnect switch or junction box. Bond the six (6) ground conductors with a common pigtail to a ground lug.

3.8 Harmonic Filter Control Power

- .1 Provide 120 VAC control power supply to operate contactors in the passive harmonic filters from a 24 VDC control signal from the VFD.
- .2 Power and control system to include:
 - .1 120 VAC power supply (one branch circuit may serve multiple harmonic filters),
 - .2 double voltage relay, 24 VDC coil voltage, 120 VAC output contacts,
 - .3 Type 1 metal enclosure to CSA C22.2 No. 94.1.
- .3 Where the VFD output relay contacts are rated to power the harmonic filter contactor directly, 120 VAC power supply and double-voltage relay is not required.
- .4 Provide control wiring between the VFD and the passive harmonic filter.
- .5 Program the VFD to open the harmonic filter contactor (to disconnect the filter capacitors) when the VFD output is below 70% of motor rated speed.

3.9 Installation of Instrumentation, Communications and Control Cabling

- .1 Install wiring in conduit.
- .2 Neatly train circuit wiring in cabinets, panels, pullboxes and junction boxes and hold with nylon cable ties.
- .3 Run instrumentation, communication and control cabling point to point and terminate on terminal strips. Do not splice communication or control cabling. Where long runs make a continuous point to point installation impractical, make splices on labelled terminal blocks in an accessible labelled terminal cabinet, installed at 1200 mm (48") above floor, and indicate cabinet location, terminal and wire numbers on the As-built drawings.
- .4 Terminate control cables in equipment with suitable connectors.
- .5 Clearly identify cables/conductors at both ends, with permanent wire markers, indicating device/panel identification and terminal numbers on the device/panel (refer to standard detail 20 15 12-021 at the end of this specification section):
 - .1 Use applicable reference name or ID tag for the device or control panel.
 - .2 Print the labels such that the applicable panel/device identification is closest to the end of the cable.
 - .3 Where individual wires are run in conduit, collect wires associated to the same control panel/device and apply a label to the group of wires inside each control panel/device. Where there is insufficient space inside a device (such as a transmitter), the label may be applied to the conduit at the point of connection to the device.
 - .4 Where there are multiple conductors, individually identify each wire by its termination reference on the panel or device to which it connects.
 - .5 Where there are only two wires and it is readily understood where each wire is to be terminated (i.e. white neutral, green ground), individually marking of the wires is not required.

3.10 Grounding

- .1 Ground electrical equipment and wiring in accordance with the applicable electrical safety code and regulations applicable at the location of the Work except where greater requirements are specified herein.
- .2 Provide insulated green bonding conductor in each power and control conduit sized per Table 16 of the Electrical Safety Code. Minimum bonding conductor size #12AWG copper.
- .3 Install grounding conductors, outside electrical rooms and electrical closets, in conduit.
- .4 Make connections to neutral and equipment with brass, copper or bronze bolts, star-washers, and connectors.
- .5 Except for VFD Inverter Duty cables, ground all motors with separate green insulated copper ground conductor installed in power feeder conduit, wired from ground terminal in the motor controller to a ground lug bolted directly to the motor frame, located inside the motor terminal box. Size the ground conductor per Table 16 of the electrical safety code except that the smallest conductor size to be #12 AWG.
- .6 Ground VFD inverter duty cables using all three integral ground conductors, from the ground terminal in the VFD enclosure to the ground lug bolted directly to motor frame inside the motor terminal box.
- .7 For VFDs, bond both ends of the VFD inverter duty cable as previously specified herein.

3.11 Disconnect Switches

- .1 Provide a disconnect switch for each piece of mechanical equipment provided under Division 20 to 25 which requires a power supply. This requirement is to be met by the following methods as applicable to each piece of equipment:
 - .1 as an integral factory-installed component of the equipment, or
 - .2 as a field-installed switch where;
 - (a) the equipment does not have an integral disconnect switch, or
 - (b) the equipment includes a factory installed disconnect switch but the equipment as a whole does not have a SCCR rating which meets or exceeds the required minimum SCCR rating specified herein or as specified in the applicable equipment Specification section.
- .2 For clarity, provide a disconnect switch upstream of harmonic filters provided for VFDs.
- .3 Locate the disconnect switches as follows;
 - .1 within 9 m (29 ft) and in the line-of-site of motors serving non-refrigeration motorized equipment, and within 9 m (29 ft) of the motor controller or VFD controlling the equipment,
 - .2 within 3 m (9.5 ft) and in the line-of-site of equipment containing refrigeration compressors and related motorized equipment that forms part of a refrigerant circuit,
 - .3 at cooling towers and other outdoor equipment where the motor controller is located indoors, and
 - .4 within 1 m (3 ft) of non-motorized equipment,
 - .5 within 1 m (3 ft) of harmonic filters for VFDs.
- .4 Disconnect switch types for motorized equipment:
 - .1 fused type for motor controllers and VFD's, including harmonic filters.
 - .2 fused type for motorized packaged equipment,
 - .3 unfused for non-motorized equipment,
 - .4 unfused type at the controlled equipment for:
 - (a) cooling towers and other outdoor equipment where the motor controller is located indoors, or
 - (b) where the motor controller is in excess of the distance specified above or is not in line of site of the controlled equipment.
- .5 Disconnect switches on load side of VFD:
 - .1 where a disconnect switch is required between a VFD and the driven motor due to excess distance or lack of line-of-site requirements, provide an unfused disconnect switch with integral disconnect status position switch, as close as possible to the motor,
 - .2 wire the status switch back to the VFD input for drive output protection.
- .6 Disconnect switches for non-motorized equipment:
 - .1 provide unfused disconnect switch for non-motorized mechanical equipment.
- .7 Where the nameplate SCCR value of a mechanical equipment is less than the specified minimum SCCR value required, provide a fused disconnect switch to isolate the mechanical equipment, even if the equipment has an integral disconnect switch.
- .8 Where fuse protection is specified, install fuses of the correct overcurrent rating as specified by the mechanical equipment installation instructions.
- .9 Where fuse protection is specified, provide a set of six spare fuses of each size used in the disconnect switches. Turn spare fuses over to the Owner and submit a copy of the receipt signed by the Owner.

- .10 Provide power wiring between the field-installed disconnect switch and the associated equipment, with the conductors of the same wire gauge as the branch circuit conductors.

3.12 Outlet Boxes

- .1 Size boxes in accordance with CSA C22.1. Use 102 mm (4") square or larger outlet boxes as required for special devices.
- .2 Gang boxes where wiring devices are grouped. Use combination boxes with barriers where outlets for more than one system are grouped.
- .3 Provide blank cover plates for boxes without wiring devices.

Seismic Restraint

- .1 Provide seismic restraints for electrical conduit in accordance with specification section 20 05 49.

Coordination and Division of Responsibility – Division 20 and Division 26

- .1 Schedule A at the end of this Specification section specifies the division of responsibility between Division 20 and Division 26 for provision of electrical work for mechanical equipment, including termination of conductors.
- .2 For clarity;
 - .1 the Division 20 electrical Work may be performed by the Division 26 contractor, but the work is managed and paid for by the Division 20 contractor.
 - .2 related work performed under Division 26 is listed in Schedule A for reference.
- .3 Coordinate power requirements for mechanical trades equipment with the contractor under Division 26 of the work, including;
 - .1 provide a list of all planned and ordered mechanical trades equipment with motor horsepower ratings and electrical power requirements, prior to the Division 26 contractor procuring their power distribution equipment,
 - .2 periodically update this power requirements list as mechanical trades equipment is ordered, and review with the Division 26 contractor to allow them to revise breaker ratings in a timely manner,
- .4 Where the branch circuit breaker rating requirements change as a result of the actual ordered mechanical trades equipment, coordinate and pay for any breaker and feeder changes required whether the affected work is in Division 20 or Division 26 scope of work.

Wiring Diagrams

- .1 The following wiring diagrams are included at the end of this section:
 - .1 20 05 12 - 001 Mechanical – Electrical Coordination (Sheet 1 of 3)
 - .2 20 05 12 - 002 Mechanical – Electrical Coordination (Sheet 2 of 3)
 - .3 20 05 12 - 003 Mechanical – Electrical Coordination (Sheet 3 of 3)
 - .4 20 05 12 - 005 Rooftop Custom A.H.U. – Maintenance Receptacles
 - .5 20 05 12 - 006 Rooftop HVAC Equipment – Maintenance Receptacles

Schedule A – Coordination of Division 20 and 26 Scope of Work			
Reference	Work Element	Div. 20	Div. 26
All	Motor Control Centers, motor controller racks, motor controllers, VFDs, Mechanical Breaker Panels (MBP), and disconnect switches	●	
Mechanical Equipment at 1000 VAC and higher	Power wiring from Division 26 switchgear to: - motor controller, - between motor controller and the mechanical equipment (where motor controller is free-standing separate from the mechanical equipment) - field-installed disconnect switches, and wiring between the disconnect switch and the mechanical equipment		●
	Field-installed disconnect switches.		●
General Mechanical Equipment fed from Dedicated Power Panels for Mechanical Equipment (Note 1)	Mechanical Service Panels (MSP), including branch overcurrent protection devices.		●
	Power wiring from MSPs and/or MCCs to: - motors, including between motors and motor controllers, VFDs and/or disconnect switches as applicable, - packaged equipment, including disconnect switches as applicable, - equipment not requiring motor controllers or disconnect switches (control panels, heat tracing, etc.)	●	
	Power wiring from RP and/or MBP to: - motors, including between motors and motor controllers, - packaged equipment, including disconnect switches as applicable, - equipment not requiring motor controllers or disconnect switches (control panels, heat tracing, etc.)	●	
General Mechanical Equipment fed from Non-dedicated Power Panels (Note 2)	Non-dedicated Power Panels (PP) and receptacle panels (RP), including branch overcurrent protection devices.		●
	Distribution splitters		●
	Power wiring from PPs and/or distribution splitters to: - motor controller, - disconnect switch ahead of VFD, - disconnect switch for package equipment, - packaged equipment (with integral disconnect switch) - equipment not requiring motor controllers or disconnect switches (control panels, heat tracing, etc.)		●
	Power wiring from RP to: - motor controller or disconnect switch, - disconnect switch for package equipment, - packaged equipment (with integral disconnect switch), - equipment not requiring motor controllers or disconnect switches (control panels, heat tracing, etc.)		●

Schedule A – Coordination of Division 20 and 26 Scope of Work			
Reference	Work Element	Div. 20	Div. 26
	Power wiring from: - disconnect switch to a VFD, - motor controller or VFD to the motor, - disconnect switch to packaged equipment	●	
Terminal Units BAS Controllers	Power wiring for controllers at 120 V, single phase terminating at each terminal box controller		●
	Power wiring for controllers at 120 or 24 VAC, from junction box provided by Division 26 to each terminal unit controller.	●	
	Power wiring for controllers at 24 VAC/DC, from building automation system control panels to terminal unit box controller.	●	
	3 phase, 208 V and higher voltage wiring direct to terminal unit box.		●
BAS Controls and OEM Controls	In service rooms: provision of 120/208 VAC mechanical service panels (MSP) complete with 15 A breakers in service rooms for use by Division 20 to 25.		●
	In service rooms: where MCC's are used, dedicated 120 VAC mechanical breaker panels (BP) complete with 15 A breakers for use by Division 20 to 25.	●	
	Power wiring for controls in service rooms: wiring from MSP or BP to the BAS and OEM control equipment.	●	
	Other than service rooms: Dedicated 120V 15A normal and emergency branch circuit breakers as indicated on the receptacle panel schedules.		●
	Power wiring for controls other than in service rooms: wiring from dedicated circuits in receptacle panels to control equipment.	●	
	120 V, single phase power supply with a junction box at specific control devices as shown.		●
	Breaker tamper-protection locks.	●	
	Instrumentation and actuator power and control wiring, for both BAS controls and OEM controls.	●	
	Control wiring to interlock motor controllers and to connect safety and operating controls.	●	
Plumbing Fixtures	120 V, single phase power supply with a junction box with sufficient wiring to terminate at plumbing fixtures requiring control power		●
	Conduit from adjacent junction box or pull box to plumbing fixtures requiring control power, pulling of wiring to the plumbing fixture and termination of wiring to the fixture or primary side of control transformer.	●	
	Control transformers and extra-low voltage wiring	●	

Schedule A – Coordination of Division 20 and 26 Scope of Work			
Reference	Work Element	Div. 20	Div. 26
Medical Gas Equipment	Dedicated emergency power circuits 120 VAC, single phase for central and distributed medical gas alarm panels, terminated in the control panels.		●
	Control wiring between field installed instrumentation and medical gas alarm panels.	●	
Equipment Service Lights	120 VAC, 15A power circuits for equipment service lights, terminated in the equipment service light.		●
	120 VAC, 15A power circuits for equipment convenience receptacles, terminated in the receptacle.		●
	Power wiring from adjacent junction boxes to light switches/service convenience receptacles and fixtures	●	
	Equipment service lights, switches and convenience receptacles.	●	
Fire and Smoke Dampers	Power wiring to damper interlock control panels for smoke dampers, motorized fire dampers, and combination smoke/fire dampers.		●
	Wiring between damper interlock control panels (for smoke dampers, motorized fire dampers, and combination smoke/fire dampers), to their associated dampers.	●	
Life Safety Interface	[Fire Alarm System ("FAS") control and monitoring modules located at BAS control interface panel.][Fire Alarm System ("FAS") control and monitoring modules located at/near fan starter or damper actuator, and wiring between control module and damper motor and fan starter.]		●
	FAS control and monitoring modules located at/near sprinkler and standpipe supervised valves and flow switches including wiring between each module and the respective valve/flow switch.		●
	Wiring between FAS control and monitoring modules, and smoke control and smoke venting fans and dampers.		●
	Termination of FAS control and monitoring wiring in BAS panels	●	

Notes:

[1] MPP and MBP will be located in mechanical services rooms.

[2] PP and RP are not dedicated for mechanical equipment and may be located in any type of service room or space.

LEGEND

CONSTANT SPEED MOTOR
CONTROLLER

VARIABLE FREQUENCY DRIVE

UNFUSED SERVICE DISCONNECT
SWITCH

FUSED SERVICE DISCONNECT
SWITCH

TRANSFORMER

120 VAC/ XX VDC POWER SUPPLY,
CLASS AS SHOWN

120/208 VAC MECHANICAL BREAKER
PANEL

MECHANICAL SERVICE PANEL (DIV 26)

POWER PANEL (DIV 26)

JUNCTION BOX

MOTOR

ELECTRIC HEAT TRACING

PACKAGED EQUIPEMENT WITH
MOTORS AND INTEGRAL MOTOR
CONTROLLERS

CONTROL PANELS, TERMINAL UNIT
CONTROLLERS, AND OTHER NON-
MOTORIZED EQUIPMENT

FUSE

LIGHT SWITCH (FOR SERVICE LIGHTS)
- FLOOR PLAN

POWER SWITCH (SINGLE-LINE)

SERVICE LIGHT

ALARM BEACON

SCOPE OF WORK:
DIVISION "A" / DIVISION "B"
BOUNDARY

WIRING AND/OR EQUIPMENT BY
DIVISIONS 20-25

WIRING AND/OR EQUIPMENT BY
DIVISION 26

General Notes

1. This drawing indicates general coordination of mechanical and electrical work. Refer to plan and riser drawings and specifications for project specific requirements, which take precedence over this drawing.

 **HHA Angus**

Sheet Title
**MECHANICAL – ELECTRICAL
COORDINATION BLOCK DIAGRAM
(SHEET 1 OF 3)**

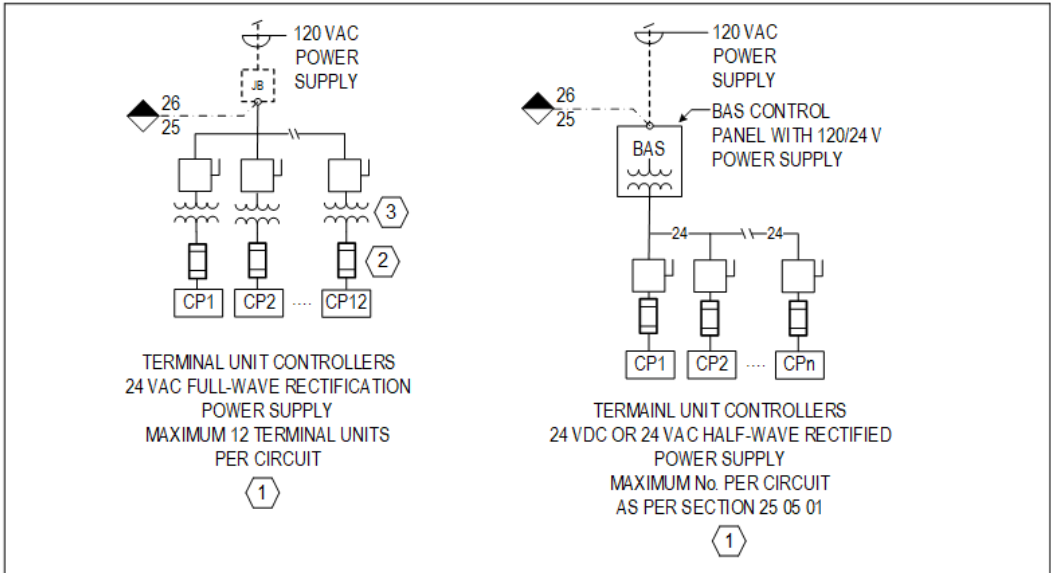
Date
21 JUNE 2023

Rev. No.:
03

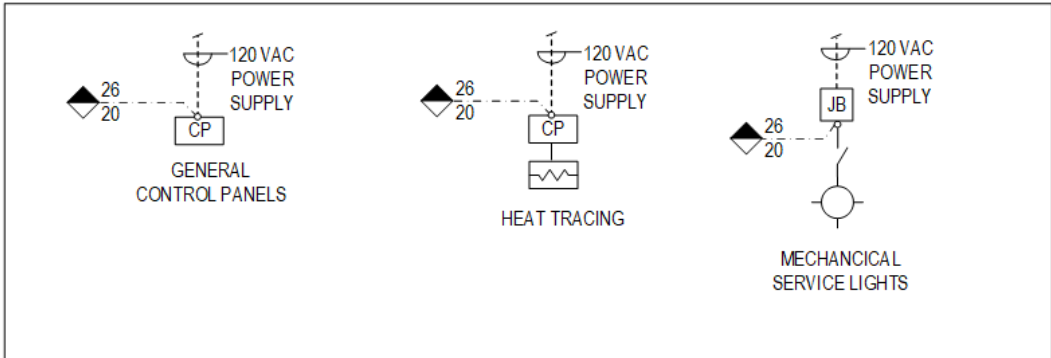
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Standard Detail No.

20 05 12 - 001



TERMINAL UNITS



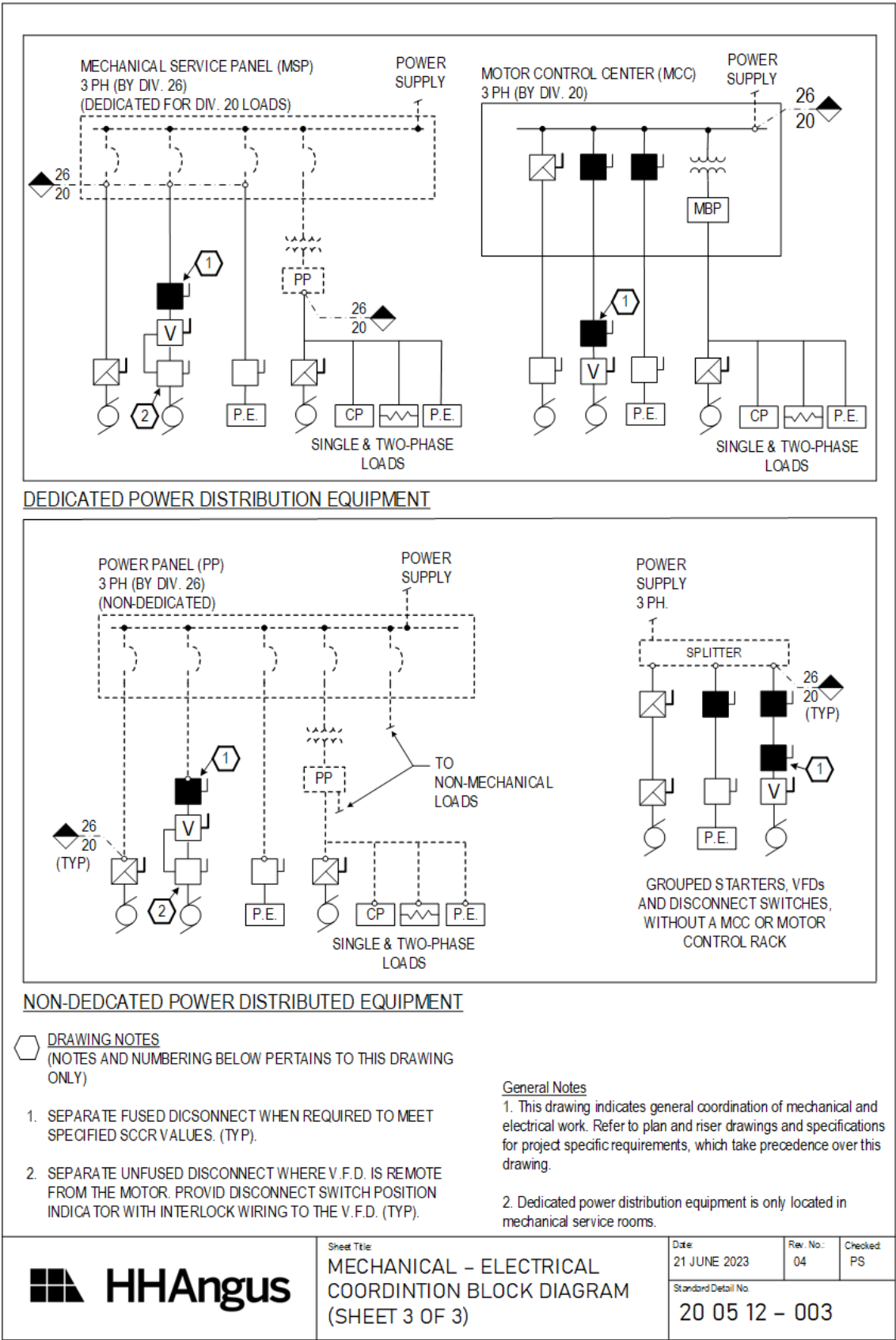
MISCELLANEOUS EQUIPMENT

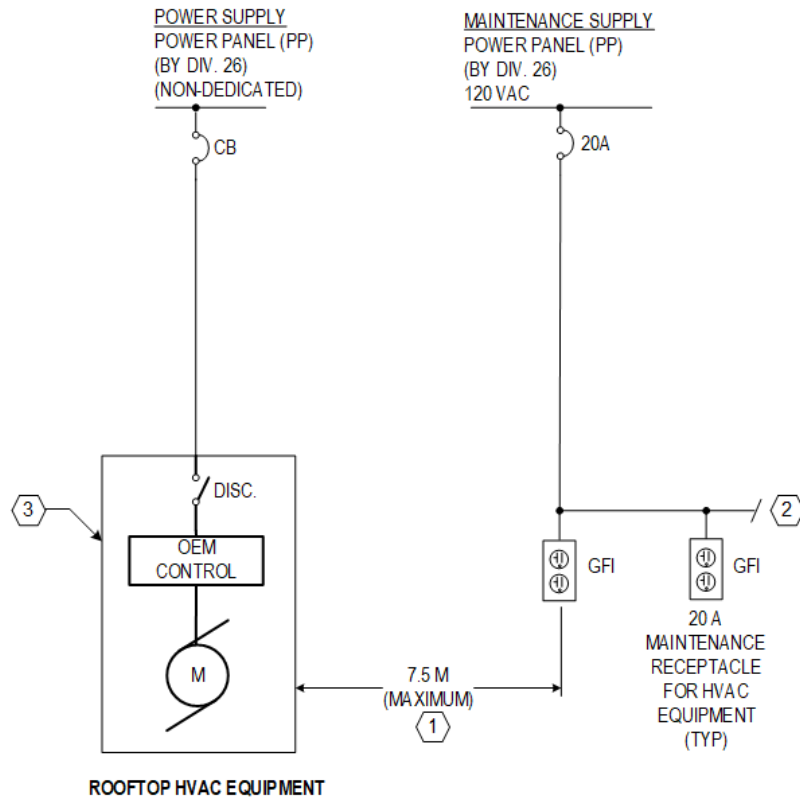
- DRAWING NOTES
(NOTES AND NUMBERING BELOW PERTAINS TO THIS DRAWING ONLY)
1. REFET TO SPECIFICATION SECTION 25 05 01 FOR APPLICABLE WIRING METHODS.
 2. PROVIDE FUSE PROTECTION IF TRANSFORMER DOES NOT HAVE INTEGRAL CIRCUIT BREAKER.
 3. PROVIDE DEDICATED TRANSFORMER FOR FULL-WAVE RECTIFIED 24 VAC CONTROL DEVICES.



Sheet Title:
MECHANICAL – ELECTRICAL
COORDINATION BLOCK DIAGRAM
(SHEET 2 OF 3)

Date: 21 JUNE 2023	Rev. No.: 03	Checked: PS
Standard Detail No. 20 05 12-002		





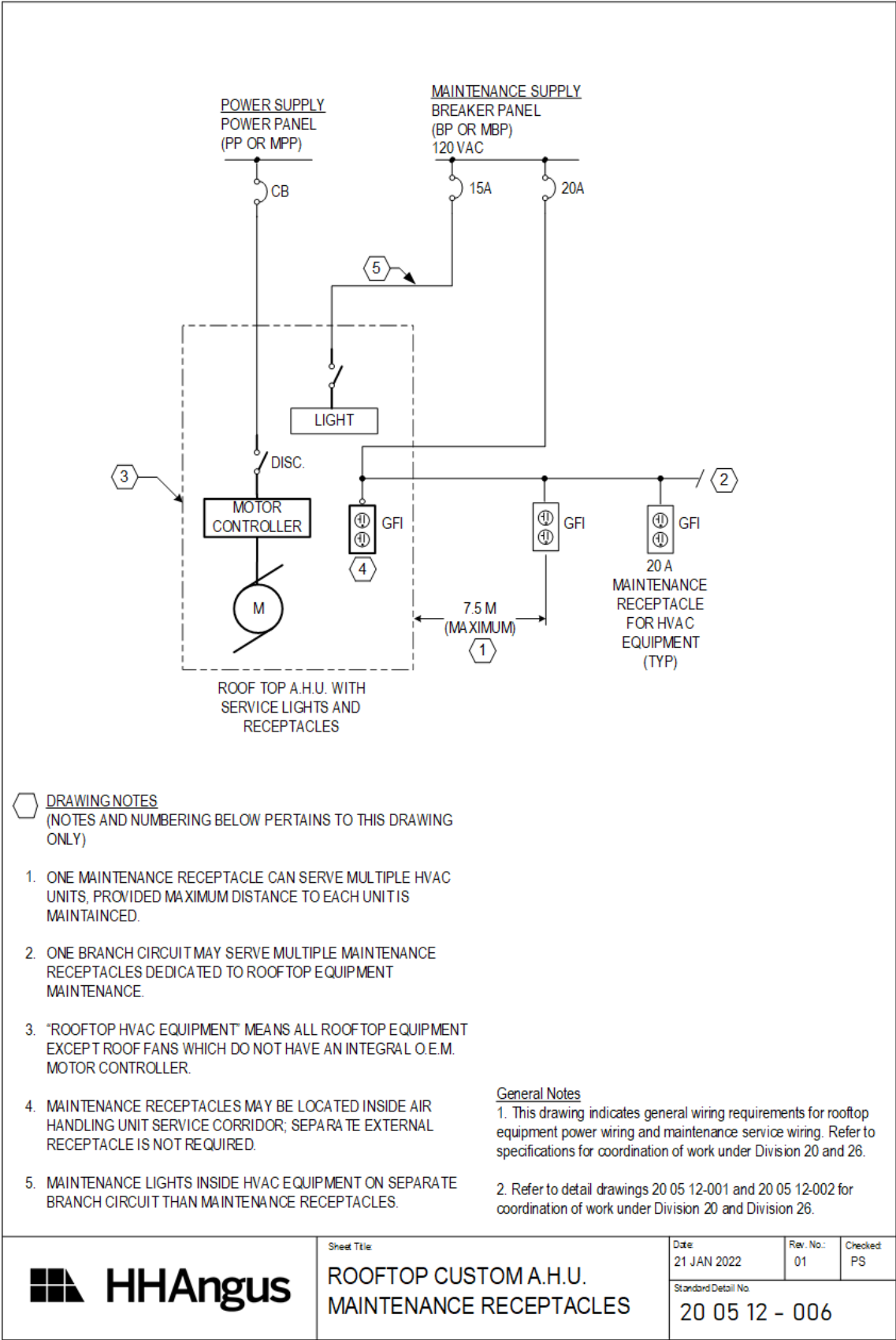
DRAWING NOTES
(NOTES AND NUMBERING BELOW PERTAINS TO THIS DRAWING ONLY)

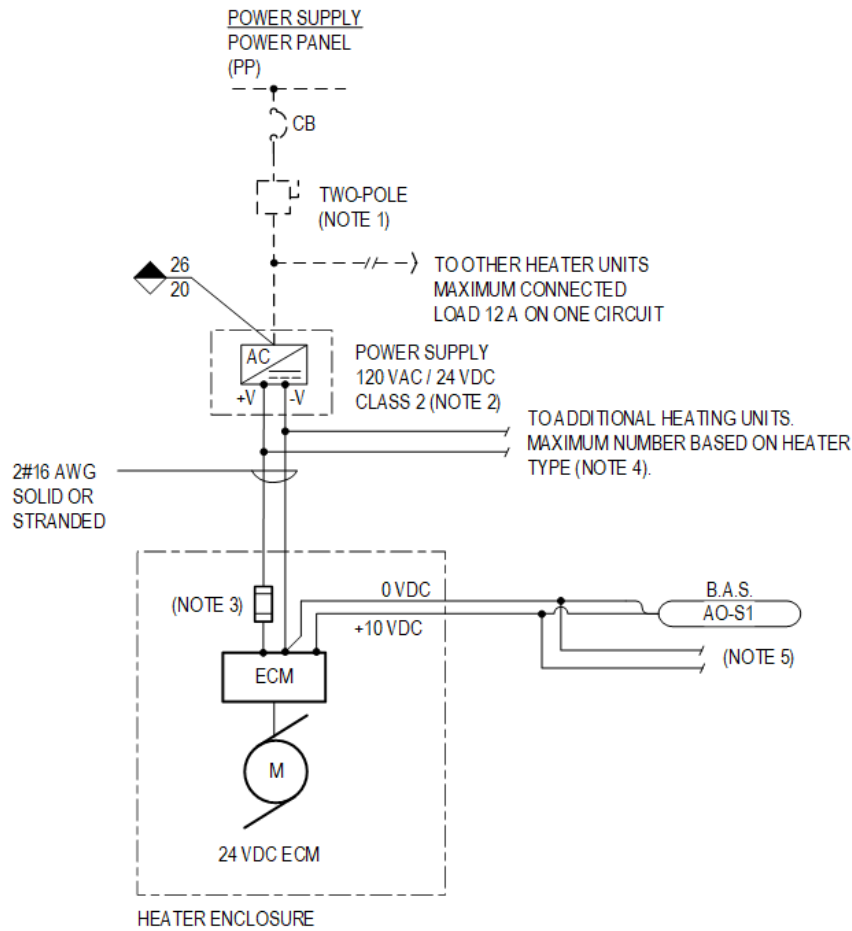
1. ONE MAINTENANCE RECEPTACLE CAN SERVE MULTIPLE HVAC UNITS, PROVIDED MAXIMUM DISTANCE TO EACH UNIT IS MAINTAINED.
2. ONE BRANCH CIRCUIT MAY SERVE MULTIPLE MAINTENANCE RECEPTACLES DEDICATED TO HVAC EQUIPMENT.
3. "ROOFTOP HVAC EQUIPMENT" MEANS ALL ROOFTOP EQUIPMENT EXCEPT ROOF FANS WHICH DO NOT HAVE AN INTEGRAL O.E.M. MOTOR CONTROLLER.

General Notes

1. This drawing indicates general wiring requirements for rooftop equipment power wiring and maintenance service wiring. Refer to specifications for coordination of work under Division 20 and 26.
2. Refer to detail drawings 20 05 12-001 and 20 05 12-002 for coordination of work under Division 20 and Division 26.

	Sheet Title ROOFTOP HVAC EQUIPMENT MAINTENANCE RECEPTACLES	Date: 21 JAN 2022	Rev. No.: 01	Checked: PS
		Standard Detail No. 20 05 12 - 005		





REFERENCE NOTES

1. DISCONNECT BOTH LINE AND NEUTRAL
2. POWER SUPPLY MOUNTED IN TYPE 1 ELECTRICAL ENCLOSURE AND MOUNTED WITHIN 10 M (30 FT) OF FIRST HEATER SERVED AS SHOWN..
3. PROVIDE FUSE OF AMPERE RATING AS SPECIFIED BY HEATING EQUIPMENT MANUFACTURER
4. REFER TO PLAN DRAWINGS FOR NUMBER OF INDIVIDUAL HEATER UNITS SERVED BY THE SAME 24 VDC POWER SUPPLY.
5. THE SAME B.A.S. OUTPUT MAY CONTROL MULTIPLE HEATER UNITS IN THE SAME ZONE.

GENERAL NOTES

1. THIS DRAWING INDICATES GENERAL WIRING REQUIREMENTS FOR 24 VDC FAN-COIL HEATING UNITS. REFER TO EQUIPMENT MANUFACTURER INSTALLATION INSTRUCTIONS FOR SPECIFIC WIRING REQUIREMENTS.
2. REFER TO DETAIL DRAWINGS 20 05 12-001 AND 20 05 12-002 FOR GENERAL COORDINATION OF WORK UNDER DIVISIONS 20 AND 26.



Sheet Title

**FORCED-AIR CONVECTORS
24 VDC & CONTROL WIRING**

Date
08 DEC 2022

Rev. No.:
00

Checked:
PS

Standard Detail No.

20 05 12 - 007

END OF SECTION

COMMON MOTOR REQUIREMENTS FOR MECHANICAL EQUIPMENT 20 05 13

1 GENERAL

1.1 Scope

- .1 Provide single phase and three-phase low-voltage AC induction motors from fractional horsepower to 200 horsepower, and brushless DC ECM motors.
- .2 This specification section applies to general purpose motors and inverter duty motors, except where otherwise specified by other specification sections of Divisions 20 to 25.

1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
 - .1 20 05 14.13 Motor Controllers
 - .2 20 05 14.16 Variable- Frequency Drives

1.3 Definitions

- .1 The following definitions apply to this section and referenced sections:
 - .1 **ECM**: electrically commutated motor (AC supply, brushless DC motor).
 - .2 **ODP**: open drip proof (motor enclosure).
 - .3 **Soft-start motor controller**: a solid-state electronic motor controller that regulates output current and voltage during motor starting.
 - .4 **FEFC**: totally enclosed non-ventilated (motor enclosure without motor driven cooling fan).
 - .5 **TEFC**: totally enclosed fan cooled (motor enclosure with motor driven cooling fan).

1.4 Applicable Codes and Standards

- .1 Legislation:

O.Reg. 509/18 Energy and Water Efficiency – Appliances and Products

- .2 U.S. DOE 10 CFR 431 Code of Federal Regulations Part 431 (to the extent adopted in O.Reg. 509/18)

- .2 Product standards:

- .1 CSA C22.2 No. 100 Motors and Generators
- .2 CSA C390-10 Test Methods, Marking Requirements, and Energy Efficiency Levels for Three-phase Induction Motors
- .3 CSA C747-09 Energy Efficiency Test Method for Small Motors
- .4 IEEE 85-1973 Test Procedure for Airborne Sound Measurements on Rotating Electric Machinery
- .5 IEEE 112-2004 Standard Test Procedure for Polyphase Induction Motors and Generators
- .6 IEEE 114-2010 Standard Test Procedure for Single-Phase Induction Motors
- .7 NEMA MG1-2016 Motors and Generators

1.5 Submittals

- .1 Submit manufacturer data sheets with the following information for motors 50 HP and smaller:
 - .1 motor model/catalogue numbers,
 - .2 motor full load ratings: current, speed, voltage, horsepower, efficiency, and KVAR.
- .2 Submit manufacturer data sheets with the following information for motors greater than 50 HP:
 - .1 associated driven equipment identification tag,
 - .2 motor model/catalogue numbers,
 - .3 motor full load ratings: current, speed, voltage, horsepower, efficiency, and KVAR,
 - .4 bearing data,
 - .5 acceleration time at maximum inertia,
 - .6 guaranteed efficiency and power factor at full load, 75% load, 50% load, and 25% load,
 - .7 dBA scale sound power levels.

1.6 Shipping and Storage

- .1 Ship motors from factory;
 - .1 packed in impact-absorbing material, or fastened to hardwood skid or pallet for fork truck handling. Do not use Styrofoam or similar plastic-based materials,
 - .2 protected against dirt and moisture during transit and outdoor storage,
 - .3 clearly identified with permanent ink marking on packing,
- .2 Protect motors attached to equipment against dirt and moisture during transit and outdoor storage.

1.7 Operating and Maintenance Manuals

- .1 Include in the operating and maintenance manuals the following data for all motors supplied to the project:
 - .1 shop drawing data as specified herein,
 - .2 motor weight,
 - .3 sliding base dimensioned drawings,
 - .4 internal winding connection diagram,
 - .5 speed torque performance data for across line start, from stand-still to synchronous speed,
 - .6 installation and maintenance instructions.

2 PRODUCTS

2.1 Motors - General Requirements

- .1 Listed to CSA C22.2 No.100.
- .2 Listed to CSA C390 for NEMA MG-1 Premium efficiency ratings (three phase, 1 – 200 HP)
- .3 Motors selected and marked with a power rating that is the greater of:
 - .1 not less than the input brake horsepower of driven equipment at both the specified operating condition and at maximum run-out conditions at design driven equipment operating speed, without operation in the motor service factor, and

- .2 not less than the minimum horsepower rating as shown.
- .4 Common motor characteristics:
 - .1 frequency: [60][50] Hz.
 - .2 voltage:
 - (a) 115 and 220 volt, for single phase motors as shown,
 - (b) [575 and 208][460 or 208] volt, for three phase motors, as shown.
 - .3 nominal rated-load speed: 1750 RPM unless otherwise shown,
 - .4 minimum ambient operating temperature at nameplate power rating: 40°C (104°F),
 - .5 vibration velocity: not to exceed 2.0 mm/s (0.08 inches/second) measured at bearing housing,
 - .6 motor generated noise, 10 HP and larger: not to exceed 85 dBA, measured at 3 m (10 ft) in accordance with IEEE 85.
- .5 Permanently lubricated ball bearing rotor supports.
- .6 Motor enclosure:
 - .1 cast iron, aluminum, or rolled steel construction,
 - .2 drain openings,
 - .3 shouldered lifting eye bolts (three phase TEFC motors),
 - .4 bi-directional, spark-proof, abrasion and corrosive resistant cooling fan keyed to shaft (three phase TEFC motors),
 - .5 compression type grounding lug or double ended cap screw of silicon bronze, mounted in conduit box by drilling and tapping into motor frame.
- .7 Motor nameplate:
 - .1 stainless steel plate mounted on enclosure with stainless steel fastening pins,
 - .2 information as described in NEMA MG-1 including motor efficiency rating,
 - .3 motor bearing part numbers and motor wiring diagram instructions,
- .8 Protective coating, TEFC motors:
 - .1 primer and 4 to 5 mils epoxy overcoat on external surfaces, and corrosion resistant coating of epoxy paint on internal surfaces, shaft, rotor, stator iron, and end bells,
 - .2 shaft extension protected with rust preventive strippable coating capable of being peeled off or unwrapped.
- .9 Motor termination junction boxes and motor leads:
 - .1 cast iron or sheet steel diagonally split, tapped for conduit, and attached to motor frame with cadmium plated hex head cap screws,
 - .2 arranged for conduit entry from either side or bottom,
 - .3 gaskets between box and motor frame and between halves of box, with cover secured with cadmium plated hex head cap screws,
 - .4 motor leads in conduit box;
 - (a) identified in accordance with ANSI C6.1,
 - (b) with the same insulation class as windings,
 - (c) sized in accordance with EASA recommended minimum ampacity values,

- .5 motor leads between motor frame and termination box to pass through tight fitting neoprene rubber seals.

2.2 Motor Efficiency

- .1 Motor efficiency test method:
 - .1 CSA C747 or IEEE 114 for single phase ECM and AC motors,
 - .2 CSA C747 or IEEE 112 for polyphaser motors up to 3 HP, and.
 - .3 CSA C390 or IEEE 112 for three-phase motors 1 to 200 HP.
- .2 Motor efficiency ratings:
 - .1 Minimum motor efficiency to be not less than the greater of the following:
 - (a) applicable legislation for energy efficiency,
 - (b) NEMA Premium® for three-phase integral horsepower motors, and
 - (c) as specified in the Schedules appended at the end of this specification section.
- .3 These motor efficiency ratings do not apply to electric motor-driven fire pumps.

2.3 Single Phase Motors

- .1 Single phase motor rating less than 375 W (1/2 hp):
- .2 Types:
 - .1 PSC motor:
 - (a) permanent split capacitor type for AC power supply,
 - (b) suitable for variable speed applications.
- .3 ECM motor:
 - .1 brushless DC electrically commutated motor with integral microprocessor based inverter and controller, for AC power supply,
 - .2 factory programmed or field programmable for specific application,
 - .3 capable of accepting an external 0-20 mA or 0-10 V signal for remote variable speed operation including fan On/Off control.
- .4 Winding insulation: Class B.
- .5 Suitable for mounting in the horizontal or vertical orientation.
- .6 Continuous duty rating with 1.35 service factor.
- .7 ODP or TEFC enclosure, resilient mounts.
- .8 Built-in overload protection.
- .9 Motor over-temperature protection as specified herein.

2.4 Three Phase Motors, Fractional Horsepower

- .1 Motors of 375 W (½ HP) and 560 W (¾ HP).
- .2 For use with magnetic motor controllers.
- .3 Three phase squirrel cage induction type, NEMA T frame, general purpose type, to NEMA MG-1.
- .4 NEMA B design.

- .5 Winding insulation: Class F, with a rated motor winding temperature rise of not more than 90°C above an ambient temperature of 40°C at full motor load,
- .6 Continuous duty rating with minimum 1.15 service factor.
- .7 ODP or TENV enclosure.
- .8 Motor over-temperature protection as specified herein.

2.5 Three Phase Motors, Integral Horsepower

- .1 Motors 745 W (1 hp) to 150 kW (200 hp).
- .2 For use with constant speed magnetic motor controllers.
- .3 Three phase squirrel cage induction type, NEMA T frame, general purpose type.
- .4 NEMA design:
 - .1 Type B for centrifugal fans and pumps,
 - .2 Type C for positive displacement pumps and compressors.
- .5 Winding insulation: Class F, with a rated motor winding temperature rise of not more than 90°C above an ambient temperature of 40°C at full motor load,
- .6 Continuous duty rating with minimum 1.15 service factor.
- .7 TEFC enclosure.
- .8 Suitable for horizontal, vertical or belt-driven mounting.
- .9 Motor over-temperature protection as specified herein.
- .10 Motor winding leads:
 - .1 three (3) leads for single speed operation,
 - .2 six (6) leads for two-speed operation (five lead two-speed motors are not acceptable).

2.6 Three Phase Motors – Inverter Duty

- .1 Application: motors 745 W (1 hp) to 150 kW (200 hp) operating on power supply controlled by a variable frequency drive (inverter) motor controllers and soft-start constant speed motor controllers.
- .2 General requirements:
 - .1 three phase squirrel cage induction type, NEMA T frame, general purpose type, suitable for pulse width modulated wave form,
 - .2 winding insulation: Class F insulation, with a rated motor winding temperature rise of not more than 90°C above an ambient temperature of 40°C at full motor load (i.e. Class B temperature rise),
 - .3 continuous duty rating and rated for 200% of full load starting torque,
 - .4 service factor: 1.15 on Sine Wave and 1.0 on pulse-width modulated power supply,
 - .5 TEFC enclosure,
 - .6 suitable for horizontal, vertical or belt-driven mounting,
 - .7 motor over-temperature protection as specified herein,
 - .8 motor winding leads: three (3) leads,
 - .9 motor over-temperature protection as specified herein except where the protection function is provided by the variable frequency drive.
- .3 Special requirements:

- .1 motors rated for inverter duty in accordance with NEMA MG-1 Part 31,
 - (a) stator winding insulation ratings:
 - i) peak voltage and partial discharge-free voltages:

Rated Voltage V RMS	Withstand Voltage Zero-to-Peak (Line-to-Line) V	Partial Discharge-Free Zero-to-Peak (Line-to-Line) V
208, 3 phase	645	513
575, 3 phase	1782	1281

- ii) for operation on a VFD with a carrier frequency of between 2 and 12 kHz.
 - iii) with a VFD switching voltage rise time of 0.1 μ s and higher.
- .2 speed range: minimum 10:1 (6 to 60 Hz) for variable torque applications,
- .3 provided with stray rotor current grounding system consisting of;
 - (a) 3 HP and smaller: electrically conductive bearing grease for motors,
 - (b) all HP ratings: rotor shaft grounding system at the drive-end bearing, either integral to the bearing construction or externally mounted to the motor frame.

Standard of Acceptance

- AEGIS - fig. SGR series
- .4 for motors 100 HP and larger, provide insulated bearings on the non-drive end.
- .5 motor to be compatible with type of soft-start motor controller or variable frequency drive supplied under other specification sections, and that the starter/motor system will be capable of providing rated torque over a frequency range from 15 to 60 hz while operating within motor temperature rise specification,
- .6 motor to be capable of operating between 60 Hz and 90 Hz with torque reducing at drive frequency above 60 Hz,
- .7 ball bearing rotor supports suitable for continuous low speed operation at minimum motor speed.
- .8 drive end face drilled and tapped (4 places) for mounting of auxiliary devices.
- .4 Motor stator winding:
 - .1 made up with copper magnet wire coated with moisture resistant triple-build Class F insulation, non-hygroscopic varnish, phase paper insulation, and with thermal rating of not less than 150°C for 30,000 hours life when tested in accordance with IEEE No. 57,
 - .2 insulation resistance greater than 100 megohms when measured at 25°C with 1000-volt direct current mega-ohm bridge,
 - .3 slot-wound installation, held in stator slots that have had sharp edges and burs removed prior to winding insertion,
 - .4 connection leads mechanically secured and silver soldered,
 - .5 designed for operation in either direction of rotation.
- .5 Motor bearings:
 - .1 anti-friction single shield, vacuum-degassed steel ball bearings,

- .2 lubricated bearings; extended pipe zerk fitting, and ½-lb relief fitting for external lubrication while machine is in operation, bearing seal, lubricated at factory after assembly,
- .3 bearing shield on motor winding side of bearing,
- .4 rated fatigue life of L'-10 (B-10) 150,000 hours for direct coupled applications and 50,000 hours for belted applications,
- .5 belt drive-set rating based on radial loads and pulley sizes from NEMA MG1-14.43.
- .6 Motor junction box sized and provided with at least two (2) conduit connection points, one for motor feeder cable and one for motor thermal sensor control wiring.

2.7 Motor Over-Temperature Protection

Motor thermal protection for single phase motors mounted in air ducts, plenum chambers or in air stream inside air handling equipment:

- .1 motor winding thermostats, normally closed contact, phenolic snap-acting disc thermal switch, temperature calibrated,
- .2 automatic reset type.

Standard of Acceptance

- Texas Instruments - Klixon Phenolic Motor Protectors

- .2 Motor thermal protection for three phase motors less than 37 kW (50 HP) that are mounted in air ducts, plenum chambers or in air stream inside air handling equipment:
 - .1 Winding sensors;
 - (a) three (3) Positive Temperature Coefficient (PTC) temperature sensors, one in each motor winding, wired in series, and compatible with Texas Instruments - Klixon model 42AA100E control unit,
 - (b) control unit provided under section 20 05 14.13 or 20 05 14.16.
- .3 Motor thermal protection for three phase motors 37 kW (50 HP) and larger:
 - .1 Winding sensors;
 - (a) three (3) Positive Temperature Coefficient (PTC) temperature sensors, one in each motor winding, wired in series, and compatible with Siemens model 3RN10 12 control unit,
 - (b) control unit provided under section 20 05 14.13 or 20 05 14.16.

2.8 Field Applied Rotor Grounding System for Operation with Variable Frequency Drives

- .1 Shaft-grounding ring system with contact brushes providing 360 degree coverage of drive shaft, to provide grounding of rotor to motor frame.

Standard of Acceptance

- AEGIS - fig. SGR series

2.9 Sliding Base for Motors with V-belt Drives

- .1 Construction:
 - .1 fabricated from steel as a single unit with double supported slide and two adjusting bolts,
 - .2 finished with coating as specified above for motor exterior.

3 EXECUTION

3.1 Application

- .1 Refer to other specification sections for motor style requirements for single phase motors and fractional horsepower polyphase phase motors (ODP, TENV or TEFC).
- .2 Where motors are provided with internal thermistors for motor overtemperature protection, run thermistor control wiring:
 - .1 in the same conduit as the motor power conductors for constant speed motor controllers,
 - .2 in a separate conduit from the motor power conductors for variable frequency drive motor controllers.

3.2 Field Applied Rotor Grounding System

- .1 Install shaft-grounding system on motors operating on variable speed drives and not provided with OEM rotor grounding systems.

3.3 Maintenance During Construction

- .1 Rotate motors by hand at one month intervals while at the project site.

3.4 Schedules

- .1 The following schedules of motor minimum electrical efficiency ratings apply:
 - .1 Schedule A – Single Phase Electric Motor Efficiency, 0.25 to 0.5 HP,
 - .2 Schedule B – Two-phase Electric Motor Efficiency 0.25 to 3 HP, and Three-phase Electric motor Efficiency 0.25 to 0.75 HP,
 - .3 Schedule C – Three Phase Electric Motor Efficiency, 1 to 200 HP.

Schedule A - Single Phase Electric Motor Efficiency, 0.25 to 0.5 HP

Motor HP (kW)	Single Phase, Permanent-Split Capacitor 0.25 to 0.5 HP Nominal Full-Load Efficiency (%) [Note 1]		
	Open Motors		
	6 Pole 1200 RPM	4 Pole 1800 RPM	2 Pole 3600 RPM
0.25 (0.18)	62.2	68.5	66.6
0.33 (0.25)	66.6	72.4	70.5
0.5 (0.37)	76.2	76.2	72.4

Notes:

[1] From U.S. DOE 10 CFR Part 431, SubPart X, §431.446(a)

Schedule B – Polyphase Electric Motor Efficiency, 0.25 to 3 HP

Motor HP (kW)	Polyphase Induction Motors 0.25 to 3 HP Nominal Full-Load Efficiency (%) [Note 2]			Remarks
	Open Motors			
	6 Pole	4 Pole	2 Pole	
0.25 (0.18)	67.5	69.5	65.6	2 Phase & 3 Phase
0.33 (0.25)	71.4	73.4	69.5	2 Phase & 3 Phase
0.5 (0.37)	75.3	78.2	73.4	2 Phase & 3 Phase
0.75 (0.55)	81.7	81.1	76.8	2 Phase & 3 Phase
1 (0.75)	82.5	83.5	77.0	2 Phase only
1.5 (1.1)	83.8	86.5	84.0	2 Phase only
2 (1.5)	---	86.5	85.5	2 Phase only
3(2.2)	---	86.9	85.5	2 Phase only

Notes:

[2] From U.S. DOE 10 CFR Part 431, SubPart X, §431.446(a)

Schedule C – Three-Phase Electric Motor Efficiency, NEMA Premium, 1 to 200 HP

Motor HP (kW)	Three-Phase Induction Motors 1 to 200 HP Nominal Full-Load NEMA Premium Efficiency (%) [Note 3]							
	2 Pole 3600 RPM		4 Pole 1800 RPM		6 Pole 1200 RPM		8 Pole 900 RPM	
	Encl.	Open	Encl.	Open	Encl.	Open	Encl.	Open
1 (0.75)	77.0	77.0	85.5	85.5	82.5	82.5	75.5	75.5
1.5 (1.1)	84.0	84.0	86.5	86.5	87.5	86.5	78.5	77.0
2 (1.5)	85.5	85.5	86.5	86.5	88.5	87.5	84.0	86.5
3 (2.2)	86.5	85.5	89.5	89.5	89.5	88.5	85.5	87.5
5 (3.7)	88.5	86.5	89.5	89.5	89.5	89.5	86.5	88.5
7.5 (5.5)	89.5	88.5	91.7	91.0	91.0	90.2	86.5	89.5
10 (7.5)	90.2	89.5	91.7	91.7	91.0	91.7	89.5	90.2
15 (11)	91.0	90.2	92.4	93.0	91.7	91.7	89.5	90.2
20 (15)	91.0	91.0	93.0	93.0	91.7	92.4	90.2	91.0
25 (18.5)	91.7	91.7	93.6	93.6	93.0	93.0	90.2	91.0
30 (22)	91.7	91.7	93.6	94.1	93.0	93.6	91.7	91.7
40 (30)	92.4	92.4	94.1	94.1	94.1	94.1	91.7	91.7
50 (37)	93.0	93.0	94.5	94.5	94.1	94.1	92.4	92.4
60 (45)	93.6	93.6	95.0	95.0	94.5	94.5	92.4	93.0
75 (55)	93.6	93.6	95.4	95.0	94.5	94.5	93.6	94.1
100 (75)	94.1	93.6	95.4	95.4	95.0	95.0	93.6	94.1
125 (90)	95.0	94.1	95.4	95.4	95.0	95.0	94.1	94.1
150 (110)	95.0	94.1	95.8	95.8	95.8	95.4	94.1	94.1
200 (150)	95.4	95.0	96.2	95.8	95.8	95.4	94.5	94.1

Notes:

[3] From U.S. DOE 10 CFR Part 431, SubPart B, §431.25(h), Table 5, and NEMA MG-1 Table 12-12.

END OF SECTION

CONSTANT SPEED MOTOR CONTROLLERS 20 05 14.13

1 GENERAL

1.1 Scope

- .1 Provide constant speed motor controllers including magnetic, manual, reduced voltage and solid-state motor controllers, for electric motor-driven equipment provided under mechanical trades work.
- .2 Refer to specification section 20 05 14.16 for variable frequency drive motor controllers.

1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections;
 - .1 20 05 12 Wiring Requirements for Mechanical Services
 - .2 20 05 13 Common Motors Requirements for Mechanical Equipment
 - .3 20 05 49.23 Seismic Qualification for Mechanical Equipment
 - .4 20 05 53 Identification

1.3 Definitions and Abbreviations

- .1 The following definitions apply to this section.
 - .1 **Constant speed motor controllers** – a motor controller/starter other than VFDs, for operating control of single speed, multi-speed, and/or reversing operation as specified, consisting of a disconnecting means, a short-circuit protection device, a motor-starter contactor, a motor overload protection device, and a control circuit.
 - .2 **Mechanical breaker panel (MBP)** means a 120/208 V mechanical power panel with overcurrent protection circuit breakers provided as part of an MCC.
 - .3 **SCCR**: the RMS symmetrical short-circuit current rating of the motor controller, measured at the output of the controller (short-circuit withstand rating has the same meaning).
- .2 For other definitions, refer to definitions in specification section 20 05 12.

1.4 Applicable Codes and Standards

- .1 Product standards:
 - .1 IEEE 315 Standard for Graphical Symbols for Electrical and Electronic Diagrams
 - .2 CSA C9 Dry-Type Transformers
 - .3 CSA C22.2 No. 5 Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures.
 - .4 CSA C22.2 No. 14 Industrial Control Equipment
 - .5 CSA C22.2 No. 29 Panelboards and Enclosed Panelboards
 - .6 CSA C22.2 No. 39 Fuseholder Assemblies
 - .7 CSA C22.2 No. 94.1 Enclosures for Electrical Equipment, Non-environmental Considerations
 - .8 CSA C22.2 No. 94.2 Enclosures for Electrical Equipment, Environmental Considerations
 - .9 CSA C22.2 No. 106 HRC – Miscellaneous Fuses
 - .10 CSA C22.2 No. 248.8 Low-voltage Fuses – Part 8: Class J Fuses
 - .11 CSA C22.2 No. 254 Motor Control Centres

1.5 Design Criteria

- .1 Device legend with list of abbreviations, general schematic wiring diagrams for single and three phase motor controllers, are included at the end of this Specification section. This material is to be used in interpretation of specification and equipment schedule requirements for motor controllers and accessories within motor controller enclosures, motor and wiring protection components, and ancillary devices.

Seismic Qualification

- .1 Seismically qualify (certify) the following equipment specified herein:
 - .1 constant speed motor controllers,
- .2 The seismic qualification of the above-listed equipment is to conform to Specification section 20 05 49.23 for the following seismic qualification level and certification method:
 - .1 Functional seismic qualification (Level III) for motor control equipment: by shake table testing,
- .3 The following equipment specific seismic force parameters are to be used:

C _p	A _r	R _p	h _x /h _n
1.00	1.00	1.25	1.0

1.7 Submittals

- .1 Submit motor controller wiring diagrams that are specifically prepared for the project. The use of standard manufacturer wiring diagrams are permitted provided they clearly identify any included options that are required to meet these specifications.
- .2 Wiring diagrams format:
 - .1 ladder diagram form with energized conductor on the left and grounded conductor on the right,
 - .2 IEEE 315 graphic symbols with individual horizontal lines numbered sequentially and every conductor terminal matching identifying terminal numbers.
- .3 Submit certification test certificate for seismic qualification in accordance with Specification section 20 05 49.

2 PRODUCTS

2.1 General – Short Circuit Current Rating

Short circuit protection rating (SCCR) for motor controllers:

- .1 motor controller minimum SCCR value: 10 kAIC RMS symmetrical,
- .2 SCCR value to be marked on the motor controller nameplate. Where the SCCR nameplate rating references an instruction manual, provide a separate label that states the SCCR value.

2.2 Motor Controllers - General Requirements

- .1 General;
 - .1 These general requirements apply to all constant speed motor controllers unless otherwise specified.
 - .2 Motor controllers listed to CSA C22.2 No. 14.
 - .3 Size motor controllers for rated motor load and contactor coil load.
 - .4 Operating voltage: as shown on drawings.

- .5 Engraved Lamacoid nameplate identifying load served.
- .6 Supply motor controllers from one manufacturer.

Standard of Acceptance

- ABB
- Allen Bradley
- Baldor
- Benshaw
- Cutler Hammer
- Graham (Danfoss)
- Klockner Moeller
- Siemens
- Square D
- Toshiba
- WEG
- Yaskawa

.2 Electrical enclosure:

- .1 painted metal construction, hinged door with screwdriver-operated latches,
- .2 conforming to CSA C22.2 No. 94.1 /UL 50E and of the following types unless otherwise specified herein or in other specification sections of mechanical trades work;

indoor installation, general use: Type 1 or 12

(b) outdoor installation: Type 3, 3R or 4.

- .3 allow for additional space inside of enclosure to allow installation of motor current transducers/transmitters (provided under Division 25).

.3 Disconnecting means:

- .1 interlocked to disconnect all input power to the motor controller, and lockable in the open position,
- .2 door mounted or enclosure-flange mounted operating handle.

Overcurrent protection – Circuit Breakers:

- .1 magnetic-only, instantaneous-trip motor circuit protector type, to operate only when value of current reaches setting;
 - (a) adjustable trip settings on breakers to range from 3-8 times current rating,
 - (b) fixed instantaneous type to be minimum 8 times motor current rating,
- .2 listed to CSA C22.2 No. 5,
- .3 minimum interrupting rating: not less than the SCCR specified herein.
- .4 common-trip breakers with single handle for multi-pole applications,
- .5 accessories:
 - (a) on-off locking device,
 - (b) handle mechanism.

.5 Contactor and motor overloads:

- .1 NEMA magnetic contactor, with 120 VAC, 60 Hz control coil.
- .2 integral or bolt-on overload relay with monitoring of each phase:
 - (a) solid state, adjustable setting,
 - (b) manual reset button,
 - (c) sized and set to suit characteristics of motor,

(d) Form C overload status contacts.

.6 Control transformer:

- .1 120 VAC with fused primary and secondary circuits, sized for starter requirements plus an additional 50 VA for remote damper or valve actuator.

.7 Operating controls:

- .1 door panel mounted, momentary push-buttons (Start-Stop) or three-position selector switch (Hand-Off-Auto) as shown,
- .2 Hand-Off-Auto selector switches provided with additional contact block to allow remote monitoring when selector switch is in the Auto position.

.8 Pilot lights:

- .1 type: 120 VAC, push-to-test LED with lamp transformer,
- .2 quantity: three cover mounted pilot lights arranged for Fault (red), Ready (amber), and Running (green).

.9 Accessories:

- .1 numbered terminal strips and function identification for field-connected control devices,
- .2 auxiliary contacts and/or auxiliary relays to satisfy interlocking and automatic control requirements.

.10 Control units for motor winding over-temperature sensors:

- .1 control unit as specified herein, compatible with PTC sensors provided in applicable motors.

2.3 Single Phase Manual Motor Controllers

.1 Single pole manual type with interchangeable and adjustable overload heaters.

.2 Rating: motor rated up to ½ HP at 120 VAC and 1 hp at 240 VAC.

.3 Enclosure:

- .1 complete with mechanically fastened steel cover plate, pilot light and handle guard with standard junction box,
- .2 flush-mounted in all indoor spaces except in mechanical service rooms, electrical service rooms, vehicle garages, or where the finished wall is poured concrete:
- .3 surface mounted in mechanical service rooms, electrical service rooms, vehicle garages, or where the finished wall is poured concrete.
- .4 surface mounted for outdoor installations.

2.4 Full-Voltage Magnetic Motor Controllers ("FVNR")

.1 Type:

- .1 full-voltage across-the-line combination motor starter and disconnect switch,
- .2 for three phase motors, and for single phase motors requiring remote operating control,
- .3 non-reversing, single speed operation.

.2 For single phase motors;

- .1 less control transformer for 120 V motors,
- .2 single-pole, single phase motor contactors, or three-pole three-phase motor contactors with power wiring arranged to feed through all three contacts.

2.5 Two-speed and Reversing Motor Controllers (“FVTS”, “FVR”, “FVTSR”)

.1 Type:

- .1 full-voltage across-the-line combination motor starter and disconnect switch,
- .2 additional contactors and control circuits to perform required operating function:
 - (a) two speed operation (“FVTS”),
 - (b) reversing operation (“FVR”), and/or
 - (c) two-speed forward, single low-speed reversing (“FVTSR”).
- .3 control interlocking to prevent simultaneous operation in multi-speeds or bi-directionally,
- .4 adjustable time delay relays minimum 0-60 seconds on change of motor speed or motor direction, for operation in both BAS-Auto mode and local-Hand mode,
- .5 suitable for two-speed AC motors with two-windings (6 leads).

2.6 Reduced Voltage Autotransformer Magnetic Motor Controllers (“RVAT”)

.1 Type:

- .1 autotransformer reduced-voltage combination motor starter and disconnect switch;
 - (a) two or three core transformers,
 - (b) selectable 50%, 65% and 80% autotransformer voltage taps,
 - (c) adjustable transition time delay,
 - (d) RUN contactor/circuit energized in close-transition with late-break starting contactor – no power interruption during transition.

Reduced Voltage Solid-State Motor Controller (“RVSS”)

.1 General:

- .1 Control and logic module consisting of power supply, silicon control rectifier (“SCR”) circuitry, I/O circuitry, digital programming keypad, backlit LCD display, automatic full-speed bypass contactor with overloads, serial communication port and auxiliary contacts.
- .2 Power module consisting of three back-to-back SCR pairs mounted on heat sinks with minimum thermal capacity of 600% of unit current rating for 10 seconds.
- .3 Protection from transients through a combination of MOV's and capacitors rated for minimum 300 joules.

.2 Full speed bypass:

- .1 parallel bypass arrangement for full motor horsepower rating of unit with;
 - (a) full-voltage across-the-line contactor in parallel to, or as part of, the solid state starter,
 - (b) SCRs disconnected when at full operating speed,
 - (c) bypass switch on enclosure face plate to simultaneously disconnect input and output of solid state starter and provide total isolation of solid state starter in OFF and BYPASS positions,
 - (d) with current overload protection and motor thermal overload protection.

.3 Control circuitry:

- .1 Hand-Off-Auto primary control switch,
- .2 adjustable acceleration/deceleration ramp time,
- .3 water-hammer start-up and shut-down control (for pumps); stop-ramp adjustable time up to 120 seconds,
- .4 adjustable starting current limit,

- .5 monitoring through LCD display of;
 - (a) phase to phase supply voltage,
 - (b) line current in each phase,
 - (c) power input in kW,
 - (d) kWhr,
 - (e) elapsed time,
 - (f) power factor,
 - (g) motor thermal capacity used.
- .6 protection and diagnostic routines for;
 - (a) power loss,
 - (b) single phasing,
 - (c) line fault (shorted SCR, missing load connection),
 - (d) voltage unbalance,
 - (e) phase reversal,
 - (f) under-voltage,
 - (g) over-voltage,
 - (h) stall and jam,
 - (i) overload and under load,
 - (j) excessive starts per hour,
 - (k) controller over temperature,
 - (l) automatic reset of non-critical faults. System to accept five automatic resets of recurring non critical fault within any ten minute interval. If frequency of fault occurrence exceeds this limit, fault to be automatically upgraded to critical status, and on recurrence of fault, system to initiate motor shut down requiring manual reset.
- .4 Inputs/Outputs:
 - .1 three configurable discrete inputs: Stop, Fault Reset, Local/Remote selection.
 - .2 three configurable discrete outputs: Starter OFF, Running, Alarm (summary)
 - .3 one configurable analog output, 4-20 mA: kW
- .5 BAS communications interface:
 - .1 BACnet MSTP.
- .6 Overload protection :
 - .1 approval as motor thermal protective device,
 - .2 current sensing on three phases,
 - .3 electronic memory to predict motor temperature condition.

2.8 Motor Thermal (over-temperature) Protection

- .1 Single phase motors:
 - .1 Not applicable: thermal motor protection provided with motor under Section 20 05 13.
- .2 Three phase motors - less than 37 kW (50 HP):
 - .1 Application:

- (a) constant speed motors less than 37 kW (50 HP) that are mounted in air ducts, plenum chambers or in air stream inside air handling equipment.

.2 Winding sensors:

- (a) winding sensors provided in motors under Section 20 05 13.

.3 Control unit:

- (a) compatible with three (3) Positive Temperature Coefficient ("PTC") temperature sensors, one in each motor winding, wired in series,
- (b) electronic motor protection module, single channel, 3 sensors per channel,
- (c) 120 VAC line power,
- (d) manual reset.

Standard of Acceptance

- ° Texas Instruments - Klixon model 42AA100E

.3 Three phase motors - 37 kW (50 HP) and larger:

.1 Application:

- (a) constant speed motors 37 kW (50 HP) and larger.

.2 Winding sensors:

- (a) winding sensors provided in motors under Section 20 05 13.

.3 Control unit:

- (a) compatible with three (3) Positive Temperature Coefficient ("PTC") temperature sensors, one in each motor winding, wired in series,
- (b) temperature monitoring relay, single channel, 3 sensors per channel,
- (c) 120 VAC line power,
- (d) unit holds relay contacts on power supply failure,
- (e) automatic/manual reset, with remote reset.

Standard of Acceptance

- ° Siemens - 3RN2

.4 Additional requirements for three phase motor thermal protection:

- .1 control unit mounted inside motor controller enclosure,
- .2 120 VAC power to control unit fed from motor controller,
- .3 a momentary normally-closed Reset push-button located on front of starter enclosure door,
- .4 test and test-reset push-buttons located on front of starter enclosure door,
- .5 auxiliary output relay for safety interlock to motor contactor,
- .6 red pilot light indicating high-winding temperature,
- .7 1 N.O. contact for remote alarm monitoring.

3 EXECUTION

3.1 General

- .1 Coordinate location of motor controllers with the trade contractors under Division 25 and 26, specifically but not exclusively for termination requirements for power and control wiring.

- .2 Provide each controlled motor with a dedicated VFD, unless otherwise shown to group motors on a common VFD on a special case basis.

3.2 Motor Controller Selection and Installation

- .1 Except where equipment is otherwise specified or shown to be provided with a variable speed drive motor controller, provide constant-speed motor controllers of the applicable type listed in the following table, unless otherwise shown in other Specification sections.

Equipment Type	Phase	HHA Controller Diagram Type	Motor Controller Type HP Rating		
			FVNR, FVR, FVMS FVMS-R	RVSS	RVAT
			Motor HP	Motor HP	Motor HP
Fans	1	K, L, LF	≤ 0.5	---	---
	3	A, B, BF	≤ 50	≤ 50	> 50
Packaged Equipment	3	(Note 1)	≤ 50	≤ 50	> 50

Notes:

- (1) Control type as specified in separate equipment specification sections.
- .2 Where motor controllers are not located in an MCC, install motor controllers adjacent to controlled equipment or as otherwise shown. Position the motor controller so that:
- .1 the door front is readily visible and accessible from the work space,
 - .2 for wall-hung motor controllers: with the top of the motor controls located between 1700 and 1800 mm above the local work surface and all adjacent motor controllers aligned to the same height,
 - .3 with a minimum clear space of 1000 mm (40 in.) in front of the motor controller.
- .3 Mount motor controllers to building walls or structure, on Unistrut or similar mounting rails; do not weld miscellaneous support steel to building structure. Secure with seismic-rated fasteners where seismic restraint is required in accordance with specification section 20 05 49.
- .4 Where there is no adjacent or insufficient wall space or building structure upon which to mount the motor controller, provide a floor-mounted fabricated support assembly to mount the motor controller. Design the support assembly to:
- .1 support the dead-weight of the motor controller,
 - .2 withstand a 220 N (50 lbf) horizontal force from any direction applied to the starter enclosure, with a maximum deflection of 3 mm (1/8 in).
 - .3 resist seismic movement where seismic restraint is required in accordance with specification section 20 05 49.
- .5 Adjust motor circuit breakers equipped with adjustable trip settings as required to suit each motor in-rush current requirement.
- .6 Adjust motor overload protection devices equipped with adjustable trip settings to not exceed;
- .1 125% of motor full load current rating, for motors marked with a 1.15 or higher service factor, and
 - .2 115% of motor full load current rating, for motors marked with a service factor less than 1.15, and for motors that are not marked with a service factor.

3.3 Motor Winding Over-Temperature Protection

- .1 Coordinate with motor suppliers that the motor winding temperature sensors provided by the motor supplier is compatible with the thermal protection control units, as applicable.
- .2 Provide control wiring between PTC sensors in three phase motors and the over-temperature control units located in motor controllers.

3.4 Identification

- .1 Provide identification nameplates for motor controllers in accordance with Section 20 05 53.

3.5 Wiring Diagrams

- .1 The included device legend and motor controller wiring diagrams are to be read in conjunction with equipment specifications, control sequences, and motor/starter schedules for implementation of control sequences and identification of components required in each in each motor controller.
- .2 In the following standard details, motor overcurrent protection is shown as a circuit breaker for illustration purposes. Refer to this specification section and other mechanical trades work equipment specification sections for requirements for the use of circuit breakers or fuses.
- .3 The following standard details provide indicative wiring requirements for motor controllers.
 - .1 20 05 14 – 000 Device Legend
 - .2 20 05 14 – 001 Type “A”, 3 Phase - Start/Stop
 - .3 20 05 14 – 002 Type “B”, 3 Phase - Hand-Off-Auto
 - .4 20 05 14 – 003 (1/2) Type “BF”, 3 Phase - Hand-Off-Auto - Smoke Fans
 - .5 20 05 14 – 003 (2/2) Type “BF”, 3 Phase - Hand-Off-Auto - Smoke Fans
 - .6 20 05 14 – 004 Type “C”, 3 Phase - Hand-Off-Auto - Duplex Lead-Lag Starters
 - .7 20 05 14 – 009 Motor Winding Temperature Protection (3 Phase)
 - .8 20 05 14 – 011 Type “K”, 1 Phase - On/Off
 - .9 20 05 14 – 012 Type “L”, 1 Phase - Hand-Off-Auto
 - .10 20 05 14 – 013 (1/2) Type “LF”, 1 Phase - Hand-Off-Auto - Smoke Fans
 - .11 20 05 14 – 013 (2/2) Type “LF”, 1 Phase - Hand-Off-Auto - Smoke Fans

DEVICE SYMBOLS

DISCONNECT	FUSE	MOTOR CIRCUIT PROTECTOR MCP	STARTER	OVERLOADS	MOTOR
TRANSFORMER	GROUND	CONDUCTORS	TERMINALS	SOLENOID	
RELAY COIL	RELAY CONTACTS	TIME DELAY: ON-DELAY		TIME DELAY: OFF-DELAY	
CONTROL SWITCHES			PILOT LIGHTS		
					R: RED A: AMBER G: GREEN W: WHITE B: BLUE
PRESS. SWITCH	TEMP. SWITCH	LIMIT SWITCH	FLOW SWITCH	LEVEL SWITCH	METERS

ABBREVIATIONS

AR	ALARM / INTERFACE RELAY
CCT	CONTROL CIRCUIT
CR	CONTROL RELAY
DISC	DISCONNECT SWITCH
DPS	DIFFERENTIAL PRESSURE SWITCH
DVR	DOUBLE VOLTAGE RELAY
F	FIRESTAT
FAS	FIRE ALARM
FMA	FLOAT MECHANICAL
FR	FALUT RELAY
FS	FLOW SWITCH
FTS	FLOAT SWITCH
FUSE	FUSE
FZ	FREEZESTAT

HOA	HAND-OFF-AUTO
LS	LIMIT SWITCH
M	MOTOR / MOTOR CONTACTOR
MTB	MOMENTARY TEST BUTTON
NC	NORMALLY CLOSED
NO	NORMALLY OPEN
OL	OVERLOAD
PB	PUSHBUTTON
PE	PRESSURE ELECTRIC SWITCH
PS	PRESSURE SWITCH
T	THERMOSTAT
TDR	TIME DELAY (RELAY)

LEGEND

A B	SCOPE OF WORK: DIVISION "A" / DIVISION "B" BOUNDARY
-------	---

HHA Angus

Sheet Title

MOTOR CONTROLLERS
DEVICE LEGEND

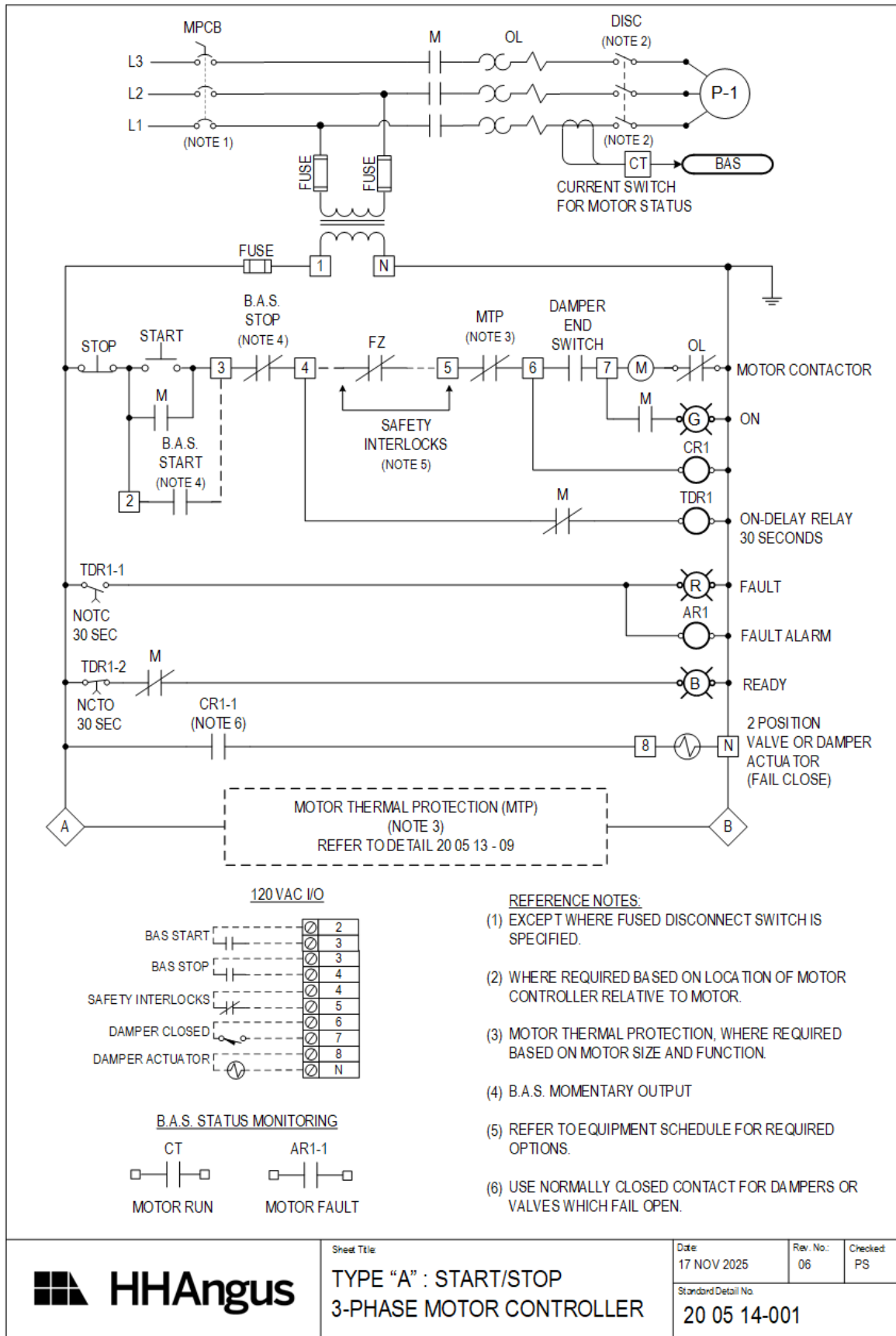
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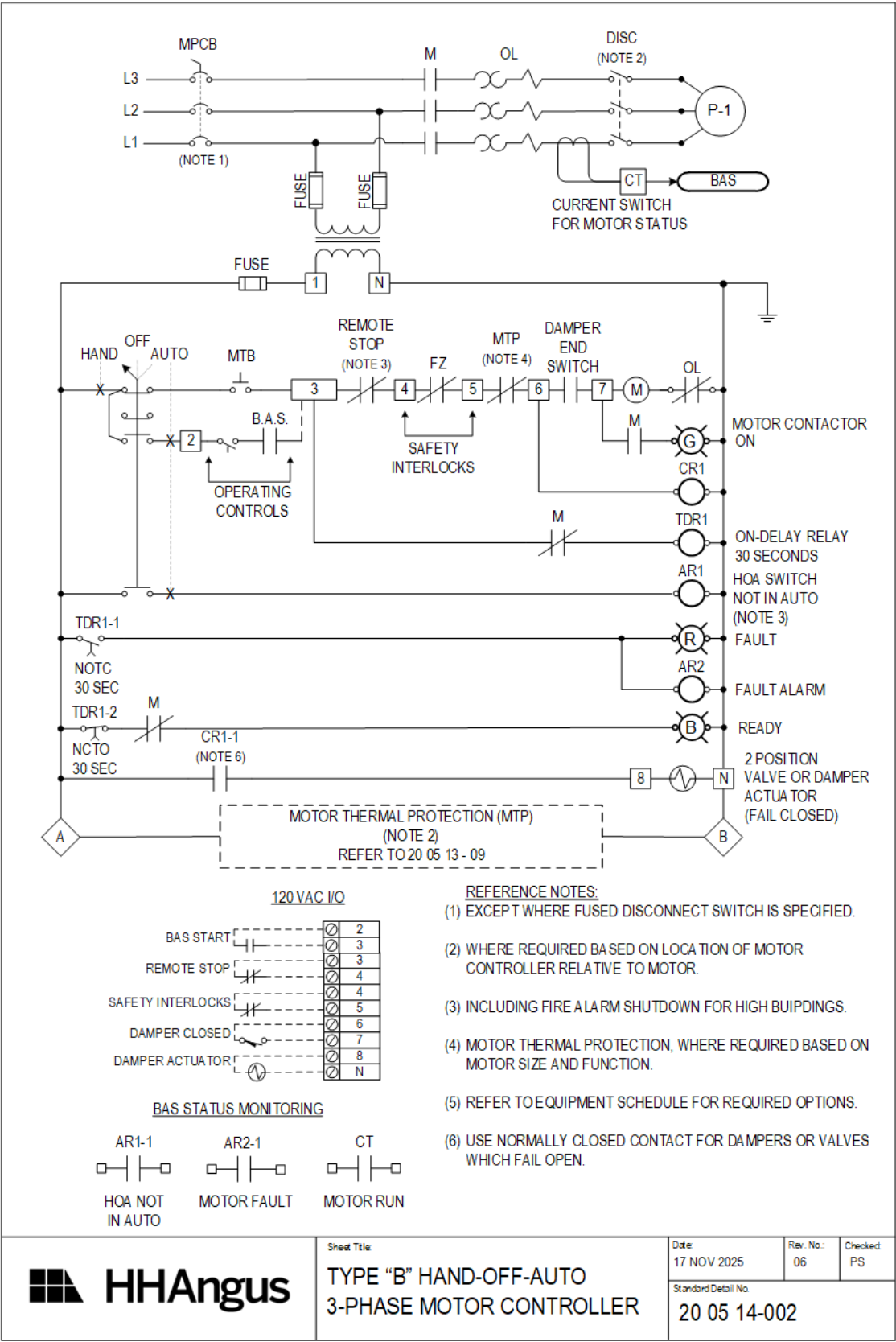
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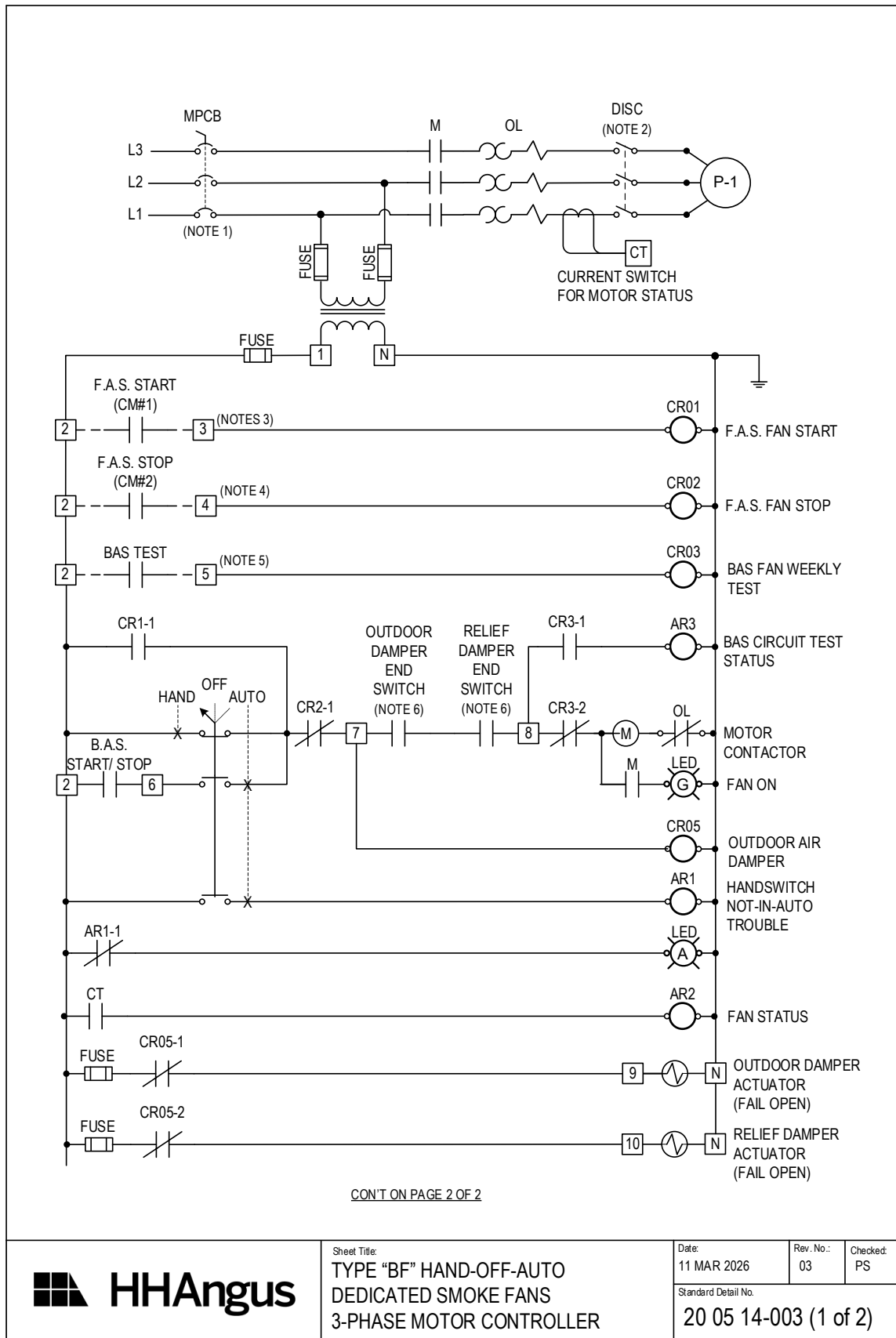
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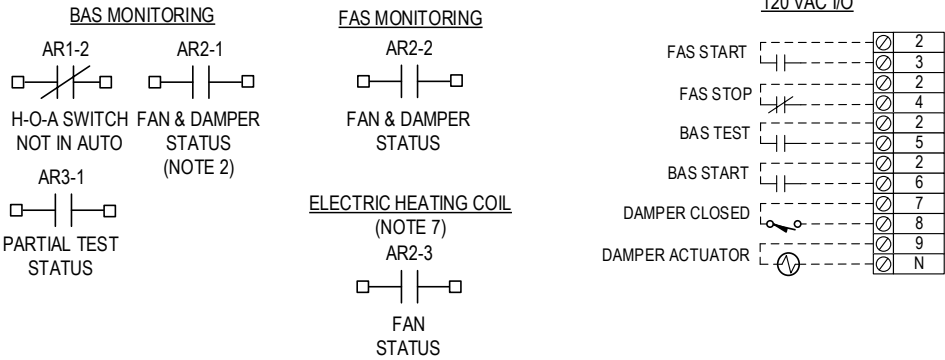


CON'T FROM PAGE 1 OF 2

FIRE ALARM INTERFACE REQUIREMENTS

CM	CM	TWO CONTROL MODULES FOR REMOTE FAN START AND FAN STOP.
MM		ONE MONITORING MODULE FOR FAN AND DAMPER STATUS

EXTERNAL WIRING DETAILS



REFERENCE NOTES:

- (1) MOTOR PROTECT CIRCUIT BREAKER EXCEPT WHERE FUSED DISCONNECT SWITCH IS SPECIFIED.
- (2) SEPARATE DISCONNECT SWITCH REQUIRED BASED ON LOCATION OF MOTOR CONTROLLER RELATIVE TO MOTOR AS PER ELECTRICAL CODE.
- (3) F.A.S. CONTROL MODULE No. 1: FAN START
- (4) F.A.S. CONTROL MODULE No. 2: FAN STOP
- (5) B.A.S. WEEKLY TEST MOTOR CONTACTOR BYPASS CONTROL.
- (6) OUTDOOR AIR / RELIEF AIR DAMPERS FAIL OPEN. DAMPER END-SWITCH CONTACT CLOSSES WHEN DAMPER > 85% OPEN.
- (7) WIRED TO ELECTRIC DUCT HEATER FOR PROOF OF AIRFLOW (WHERE DUCT HEATER IS USED).



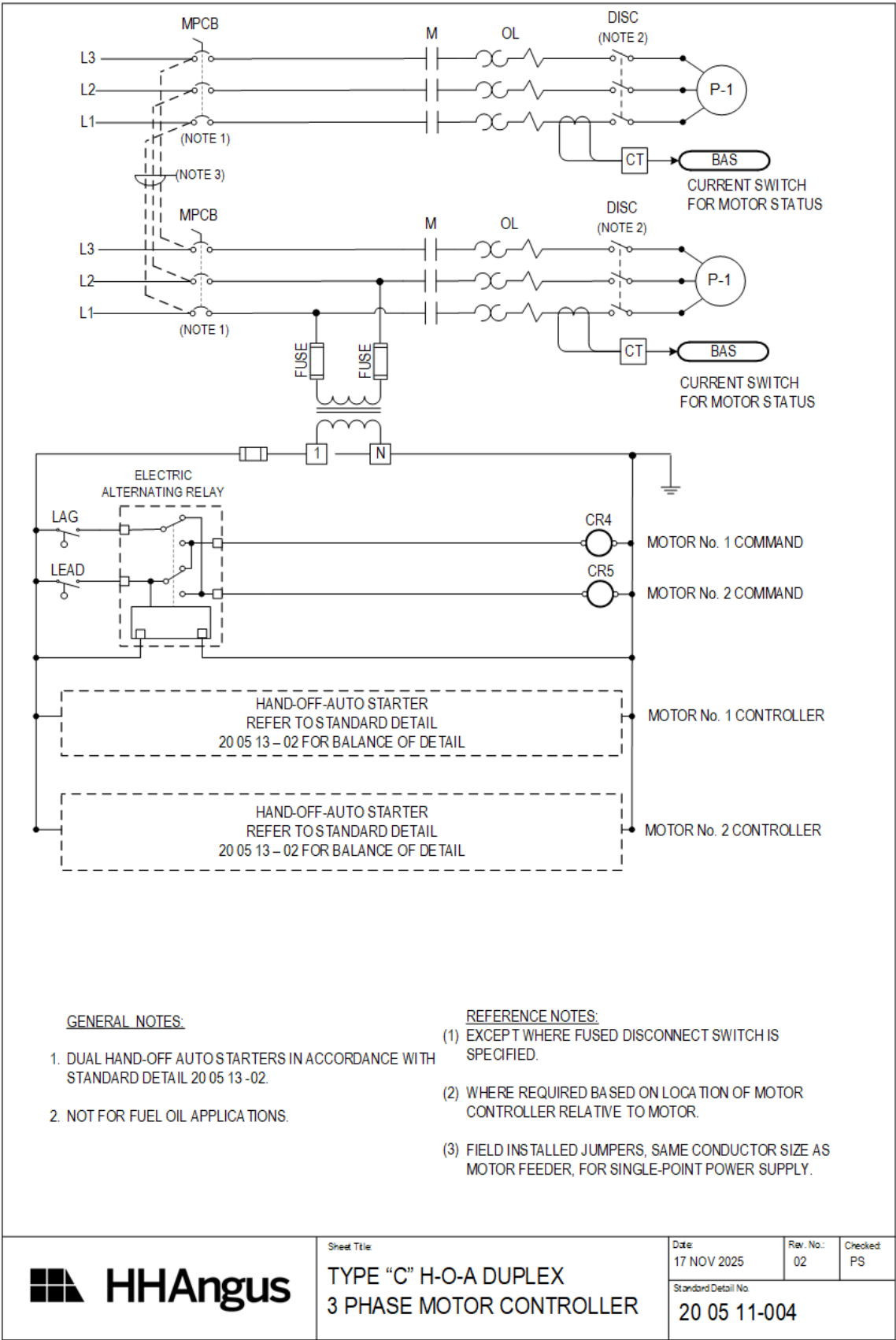
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DEDICATED SMOKE FANS
3-PHASE MOTOR CONTROLLER

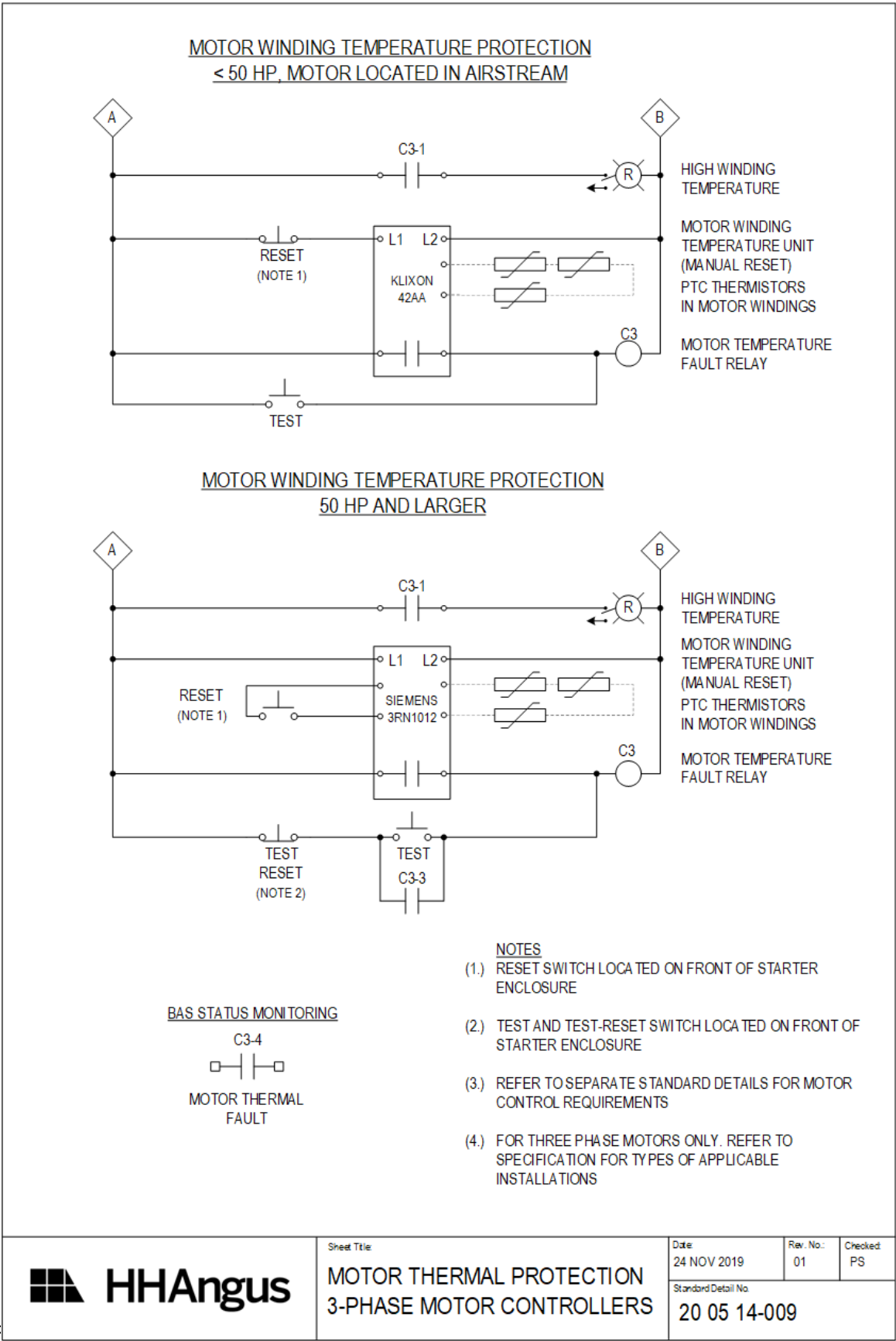
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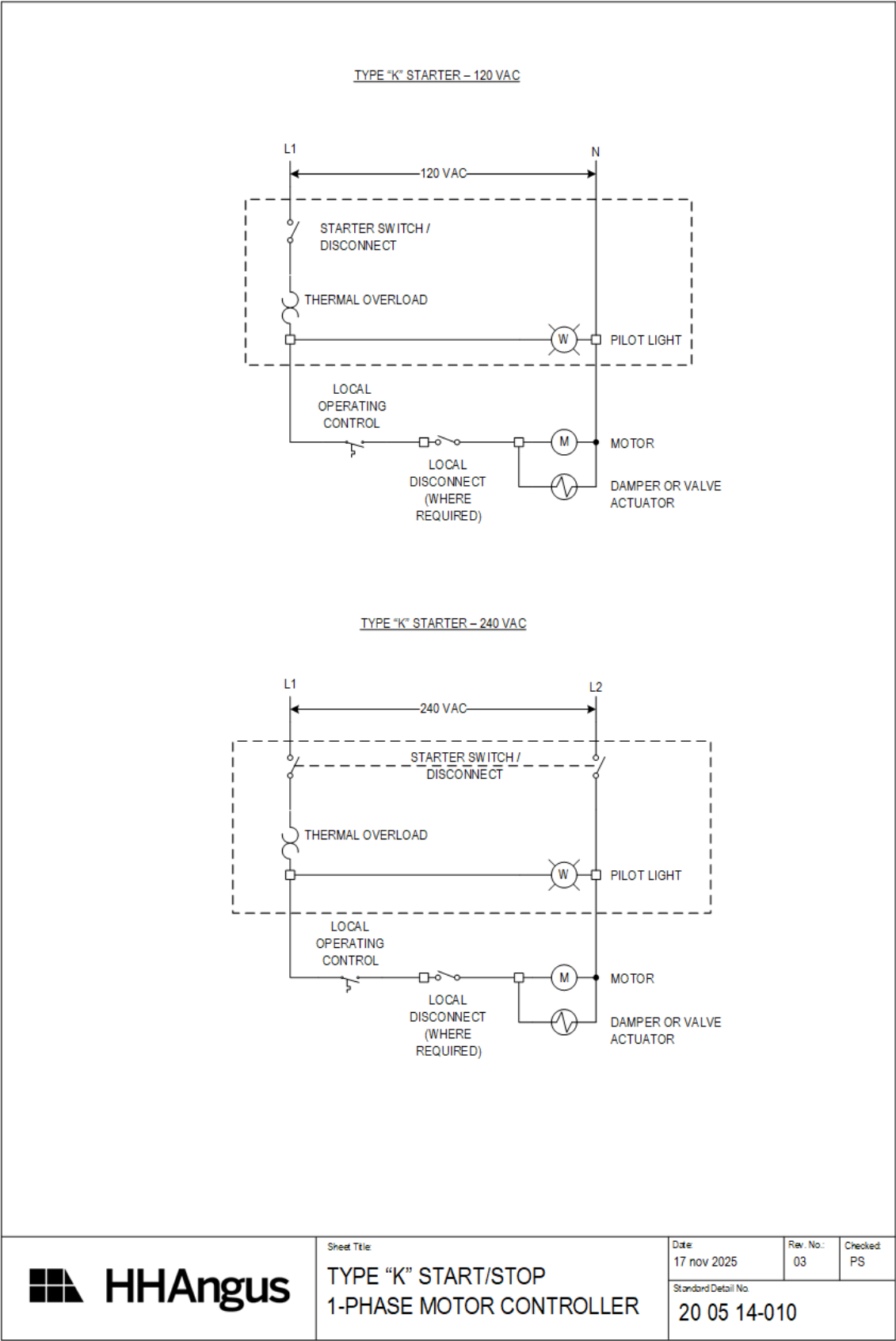
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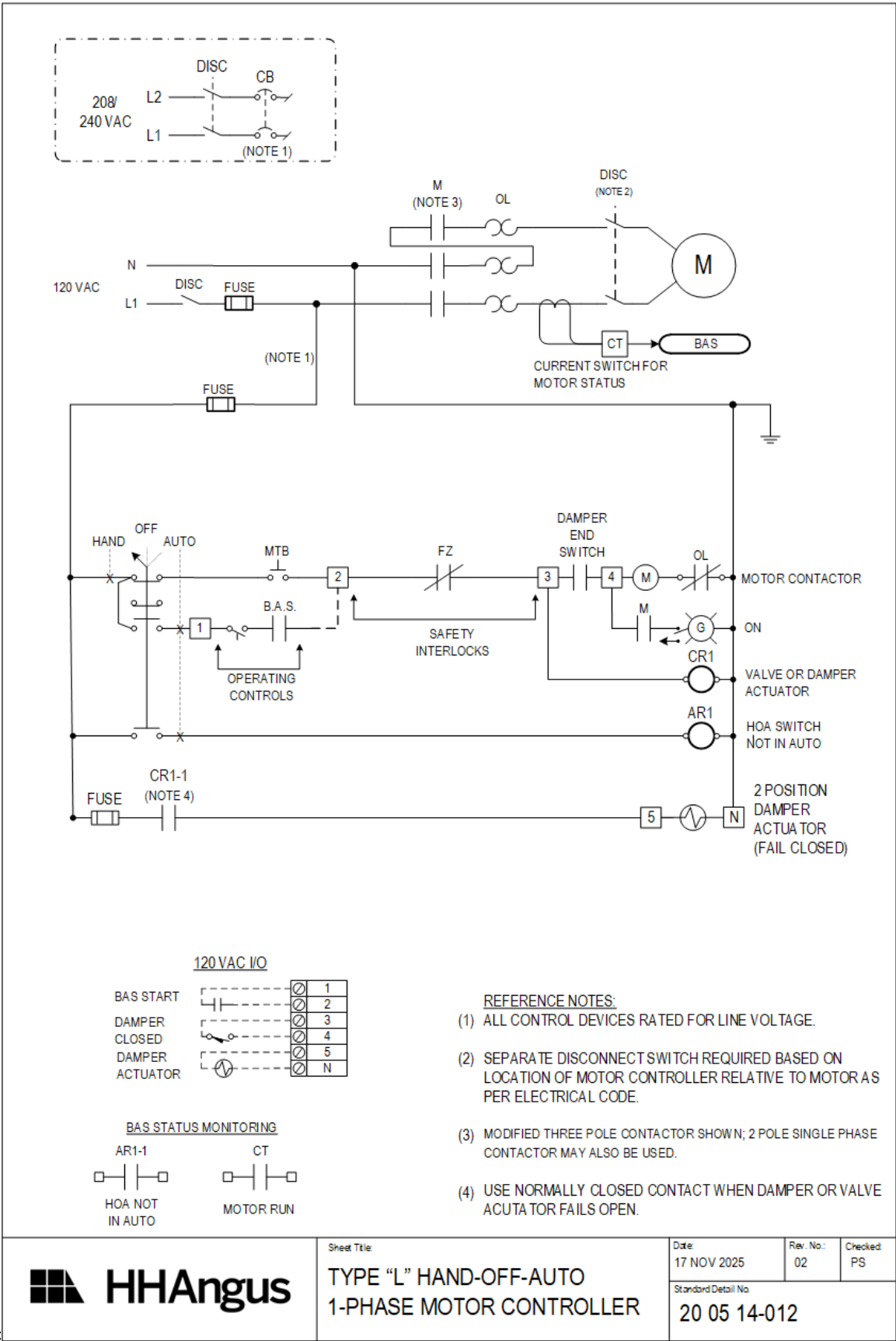
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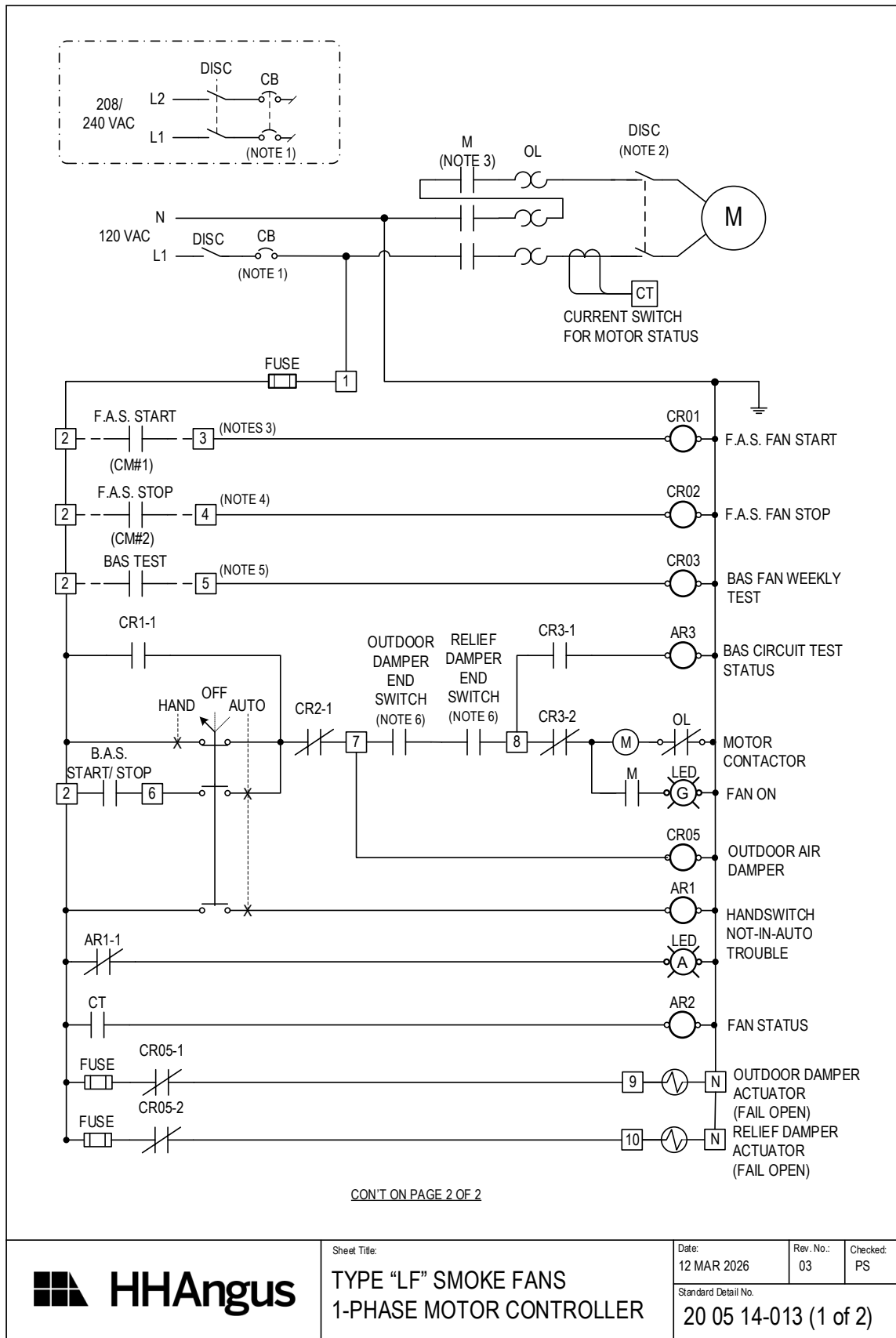
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20 05 11-003 (2 of 2)











Sheet Title:
**TYPE "LF" SMOKE FANS
1-PHASE MOTOR CONTROLLER**

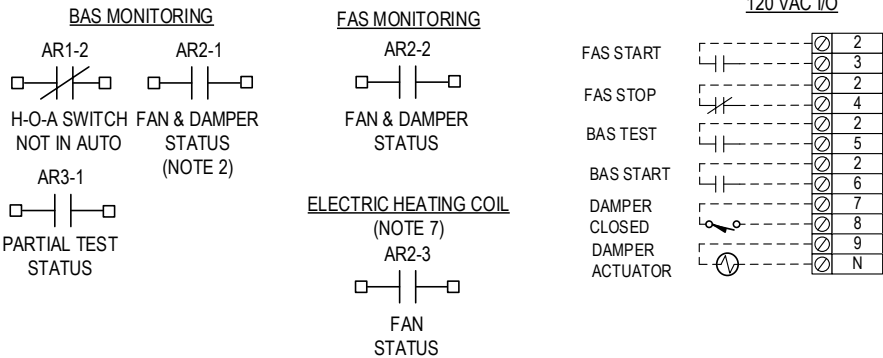
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Standard Detail No. 20 05 14-013 (1 of 2)		

CON'T FROM PAGE 1 OF 2

FIRE ALARM INTERFACE REQUIREMENTS

CM	CM	TWO CONTROL MODULES FOR REMOTE FAN START AND FAN STOP.
MM		ONE MONITORING MODULE FOR FAN AND DAMPER STATUS

EXTERNAL WIRING DETAILS



REFERENCE NOTES:

- (1) MOTOR PROTECT CIRCUIT BREAKER EXCEPT WHERE FUSED DISCONNECT SWITCH IS SPECIFIED.
- (2) SEPARATE DISCONNECT SWITCH REQUIRED BASED ON LOCATION OF MOTOR CONTROLLER RELATIVE TO MOTOR AS PER ELECTRICAL CODE.
- (3) F.A.S. CONTROL MODULE No. 1: FAN START
- (4) F.A.S. CONTROL MODULE No. 2: FAN STOP
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- (6) OUTDOOR AIR / RELIEF AIR DAMPERS FAIL OPEN. DAMPER END-SWITCH CONTACT CLOSES WHEN DAMPER > 85% OPEN.
- (7) WIRED TO ELECTRIC DUCT HEATER FOR PROOF OF AIRFLOW (WHERE DUCT HEATER IS USED).



Sheet Title:
TYPE "BF" SMOKE FANS
1-PHASE MOTOR CONTROLLER

Date:
11 MAR 2026

Rev. No.:
03

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Standard Detail No.
20 05 11-013 (2 of 2)

END OF SECTION

VARIABLE FREQUENCY DRIVE MOTOR CONTROLLERS

20 05 14.16

GENERAL

1.1 Scope

- .1 Provide variable frequency drive ("VFD") motor controllers, harmonic filtration equipment, and load-side power conditioning equipment, for electric motor-driven equipment provided under mechanical trades work.

1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections;
 - .1 20 05 12 Common Electrical Requirements for Mechanical Services
 - .2 20 05 49.23 Seismic Qualification for Mechanical Equipment

1.3 Definitions and Abbreviations

- .1 The following definitions apply to this section.
 - .1 **Harmonic filter**: an electronic device which reduces the current harmonic distortion created by the VFD.
 - .2 **SCCR**: the RMS symmetrical short-circuit current rating of the VFD, measured at the load-side terminals of the VFD (short-circuit withstand rating has the same meaning).
 - .3 **THID**: current total harmonic distortion.
- .2 For other definitions, conform to definitions in specification section 20 05 12.

1.4 Applicable Codes and Standards

- .1 Product standards:
 - .1 CSA C22.2 No. 5 Molded-case Circuit Breakers, Molded-case switches and Circuit-breaker Enclosures
 - .2 CSA C22.2 No. 14 Industrial Control Equipment
 - .3 CSA C22.2 No. 39 Fuseholder Assemblies
 - .4 CSA C22.2 No. 94.2 Enclosures for Electrical Equipment, Environmental Considerations
 - .5 CSA C22.2 No. 106 HRC – Miscellaneous Fuses
 - .6 CSA C22.2 No. 274 Adjustable Speed Drives
 - .7 ICC ES ACC-156 Acceptance Criteria for Seismic Certification by Shake-Table Testing of Nonstructural Components
 - .8 IEC 61800-3 Adjustable Speed Electrical Power Drive Systems – Part 3: EMC Requirements and Specific Test Methods

Seismic Qualification

- .1 Seismically qualify (certify) the following equipment specified herein:
 - .1 variable frequency drives,
 - .2 harmonic filters.
- .2 The seismic qualification of the above-listed equipment is to conform to Specification section 20 05 49.23 for the following seismic qualification level and certification method:

- .1 Functional seismic qualification (Level III) for motor control equipment and non-vibration isolated equipment: by shake table testing,
- .3 The following equipment specific seismic force parameters are to be used:

C_p	A_r	R_p	h_x/h_n
1.00	1.00	1.25	1.0

1.6 Submittals

- .1 Submit shop drawing material in accordance with the requirements of Division 01.
- .2 Submit shop drawings for VFD motor controller and include the following minimum information:
 - .1 outline dimensions, conduit entry locations and weight,
 - .2 power efficiency rating,
 - .3 input THID,
 - .4 device SCCR value that will be marked on each drive unit,
 - .5 protection method used to meet the required short-circuit current rating,
 - .6 the interrupting rating of the required integral or external overcurrent protection device,
 - .7 included AC line reactor capacity to suit the available short-circuit (fault) current (ASCC),
 - .8 control and power wiring diagrams,
 - .9 complete technical product description including a list of options provided,
 - .10 termination diagrams for electrical contacts, relays, thermostats, timers and components in control circuits shown.
- .3 Include SCCR data for each size of VFD supplied to the project, including:
 - .1 VFD model reference and HP rating,
 - .2 site-specific available short-circuit current value (ASCC) as specified herein,
 - .3 disconnecting means by type,
 - .4 overcurrent protection device by type,
 - .5 overcurrent protection rating, SCCR kA RMS symmetrical (at the input side of the drive),
 - .6 AC line reactor, size to suit the site-specific ASCC.
- .4 Where an external disconnecting means with overcurrent protection equipment is being supplied (due to the VFD not being available with such integral devices), submit shop drawings of the overcurrent protection equipment with confirmation from the VFD manufacturer that it meets their protection requirements.
- .5 Submit shop drawings for harmonic filters and include:
 - .1 certified factory test results for harmonic mitigation performance and energy efficiency under actual VFD drive loading, including product serial numbers.
- .6 Submit certification test certificate for seismic qualification in accordance with Specification section 20 05 49.

1.7 Product Support

- .1 Manufacturer to have factory trained application engineering and service personnel locally available at the installation locations and/or available through a toll free 24/365 technical support line.

1.8 Warranty

- .1 Provide an extended warranty covering parts, labour, travel time and expenses, for VFDs for a period of not less than twenty-four (24) months from the date when the equipment is handed over to the Owner.

2 PRODUCTS

2.1 General – Short Circuit Current Rating

Required short circuit protection rating (SCCR) for VFD motor controllers:

- .1 packaged VFD minimum SCCR value: 10 kAIC RMS symmetrical.
- .2 SCCR rating may be met by;
 - (a) design and testing of VFD package and provided with internal overcurrent protection device, or
 - (b) field-installed external overcurrent protection device field-installed on the line side of drive.
- .3 SCCR value to be marked on the VFD nameplate. Where the SCCR nameplate rating references an instruction manual, provide a separate label on the VFD that states the SCCR value.
- .4 Where the VFD requires field-installed external overcurrent protection to meet the required SCCR rating, the drive manufacturer is responsible to provide information to the installation contractor for the required circuit breaker or fuse type and rating that they require to be included in the external protection device.

2.2 Variable Frequency Drives (VFD) – General Requirements

- .1 Type:
 - .1 electronic pulse-width-modulating type for speed control of NEMA Design B inverter-duty induction motors, using constant voltage/frequency control,
 - .2 designed for control of HVAC fans and pumps, with internal PID control loops,
 - .3 six-pulse drive:
 - (a) input stage AC-DC rectifier: diode or IGBT power switches,
 - (b) DC bus link capacitors,
 - (c) output stage DC-AC inverter: IGBT power switches.
 - .4 motor-horsepower rated,
 - .5 listed to CSA C22.2 No. 274 and conform to CSA C22.2 No. 14.
- .2 VFDs to include the following equipment either as an integral part of the drive, or as a separate field-installed device:
 - .1 main power disconnecting means with overcurrent protection to meet the SCCR rating,
 - .2 input harmonic filtration where specified based on motor HP rating,
 - .3 output load voltage spike suppression and reflected wave reduction devices where specified based on motor feeder length,
- .3 Principle operating features:
 - .1 operating speed range: minimum 10:1, except where specified in other specification sections for mechanical trades work.
 - .2 ability to automatically restart after an over-current, over-voltage, under-voltage, or loss of input signal protective trip.
- .4 Operating voltage:
 - .1 +10%, -10% of nominal supply voltage range to drive,

- .2 input frequency: 60 Hz,
- .3 protection circuitry to lock-in drive or bypass over this voltage tolerance.
- .5 Output voltage frequency range: 0 – 320 Hz.
- .6 Output switching frequency:
 - .1 2 kHz to 12 kHz, adjustable/selectable,
 - .2 automatic switching frequency de-rating in case of overheating.
- .7 VFD efficiency:
 - .1 output current not less than 97% of input current at 100% full load.
- .8 Power factor:
 - .1 not less than 0.98 lagging in operating range from 75% to 100% full load.
- .9 Drive overload rating:
 - .1 110% of normal duty current rating for 1 minute every 10 minutes,
 - .2 130% of normal duty current for 2 seconds.
- .10 Environmental operating conditions without derating:
 - .1 temperature: -10 to +50°C (14 to 122°F) continuous,
 - .2 altitude: 0 - 1000 m (0 - 3300 ft) above sea level,
 - .3 humidity: 5 to 95% relative humidity non-condensing.
- .11 Seismic rating:
 - .1 designed to withstand the seismic loads in accordance with specification section 20 05 49,
 - .2 product-type seismically rated for structural and functional integrity based upon shake table test to ICC ES ACC-156.
- .12 Supply VFDs from one manufacturer.

Standard of Acceptance

- ABB - fig. ACH580
- Danfoss - fig. VLT
- Eaton - fig. H-Max
- Benshaw - fig. H2
- Siemens - fig. BT300
- Yaskawa - fig. H600
- Schneider Electric - fig. Altivar 212W, 61W

2.3 VFD - Enclosure and Electrical Protection

- .1 Electrical enclosure:
 - .1 enclosures to be of the following types in accordance CSA C22.2 No. 94.1/UL50:
 - (a) indoor installations: Type 1 or 12
 - (b) outdoor installation: Type 3, 3R or 4.
- .2 Cooling fans:
 - .1 designed to maintain operating function of VFD at maximum environmental temperature and humidity conditions,
 - .2 designed for easy replacement, and without requiring dismounting the VFD or removal of circuit boards,

- .3 operate under temperature control.
- .3 Service disconnect switch:
 - .1 disconnect switch with overcurrent protection device,
 - .2 interlocked to disconnect all input power to the VFD, and lockable in the open position,
 - .3 door mounted or enclosure-flange mounted operating handle,
- .4 Overcurrent protection device:

motor circuit protectors (breaker): magnetic-only instantaneous trip, adjustable setting, to CSA C22.2 No. 5, with minimum interrupting capacity not less than the required SCCR value or provided with supplemental fuses to achieve the SCCR rating,

- .5 Equipment and motor protection:
 - .1 under- and over-voltage protection, phase loss protection and phase unbalance protection,
 - .2 current limiting device adjustable from 70% to 100% of rated motor current,
 - .3 ground fault protection,
 - .4 motor and motor cable short-circuit protection for line-to-line and line-to-ground faults,
 - .5 instantaneous electronic overcurrent-protection,
 - .6 motor overtemperature protection (calculated, or measured where otherwise specified),
 - .7 motor overload protection,
 - .8 phase-loss detection (both line and load side),
 - .9 underload supervision (belt loss detection),
 - .10 overload supervision,
 - .11 loss of control signal input reference,
 - .12 motor stall protection.
- .6 AC Mains surge protection device:
 - .1 transient surge protection consisting of 4 MOVs (phase-to-phase and phase-to-ground), or
 - .2 transient voltage surge suppressor/surge protection device (TVCSS/SPD).

2.4 VFD - Control Inputs/Outputs

- .1 Internal 24 VDC power supply for process transducer inputs.
- .2 Analog inputs;
 - .1 two (2) configurable inputs for current or voltage signals, 0-10 V or 0-20 mA;
 - (a) frequency/speed setpoint value command,
 - (b) actual feedback input.
- .3 Analog output:
 - .1 two (2) configurable outputs for 0-20mA and/or 0-10VDC;
 - (a) current actual value,
 - (b) voltage actual value
- .4 Digital inputs:
 - .1 six (6) inputs, 12 to 24 VDC, 10 to 24 VAC,
 - .2 Stop/Start command,
 - .3 constant frequency/speed selection bypass command,

- .4 start permissive interlock,
- .5 3 other programmable inputs.
- .5 Digital outputs:
 - .1 four (4) programmable Form-C relay outputs, 250 VAC/30 VDC, 2A RMS continuous;
 - (a) auxiliary output control (e.g., damper or valve command),
 - (b) motor run status,
 - (c) drive fault status,
 - (d) passive harmonic filter capacitor contactor control.

2.5 VFD - Programming and Functions

- .1 General:
 - .1 built-in time clock in the VFD keypad with battery backup of 10 years minimum life span,
 - .2 time clock date-and-time stamp for faults and records operating parameters at the time of fault. On battery failure, the VFD automatically reverts to hours of operation since initial power up,
 - .3 time clock programmable to control start/stop functions, constant speeds, PID parameter sets and output Form-C relays,
 - .4 self-tuning function to automatically match VFD to the motor impedance,
 - .5 motor flux optimization circuit to automatically reduce applied motor voltage to the motor to optimize energy consumption and reduce audible motor noise;
 - (a) selectable software for optimization of motor noise, energy consumption, and motor speed control.
 - .6 programmable number of restart attempts, trial time, and time between attempts.
 - .7 utilize pre-programmed application macros specifically designed to facilitate start-up,
 - .8 application macros provide one command to reprogram all parameters and customer interfaces for a particular application to reduce programming time, and
 - .9 two (2) user macros to allow the end-user to create and save custom settings.
 - .10 password protection against parameter changes.
- .2 General control functions:
 - .1 three (3) programmable critical frequency lockout ranges to prevent VFD from operating the load continuously at an unstable speed, fully adjustable, from 0 to full speed.
 - .2 two (2) PID Set point controllers allowing pressure or flow signals to be connected directly to the VFD;
 - (a) microprocessor for the closed-loop control,
 - (b) 250 ma of 24 VDC auxiliary power and be capable of loop powering a transmitter supplied by others,
 - (c) PID set-point adjustment from the VFD keypad, or via the communications bus,
 - (d) two (2) independent parameter sets for the PID controller and the capability to switch between the parameter sets via a discrete input, serial communications or from the keypad.
 - .3 the independent second PID loop able to utilize the second analog input and modulate one of the analog outputs to maintain the set point of an independent process (i.e., valves, dampers, etc.),
 - .4 all set points, process variables, etc. to be accessible from the serial communication network,
 - .5 programmable "Sleep" and "Wake up" functions to allow the drive to be started and stopped from the level of a process feedback signal,

- .6 "bumpless transfer" of speed reference and output when switching between "Hand" and "Auto" modes – speed changes by controlled ramp rate,
 - .7 programmable loss-of-load (broken belt / broken coupling) with programmable time delay for motor start-up, via the serial communications bus,
 - .8 programmable underload and overload curve functions to allow user defined indications of broken belt or mechanical failure / jam condition causing motor overload,
 - .9 loss of input reference (4-20mA or 2-10V): User option of either (1) stopping and displaying a fault, (2) running at a programmable preset speed, (3) hold the VFD speed based on the last good reference received, or (4) cause a warning to be issued as selected by the user, with alarm output via the serial communication bus,
- .3 Programmable time-delay functions:
- .1 VFD start delay and a keypad indication that this time delay is active,
 - .2 four (4) separate, independent timer functions that have both weekday and weekend settings,
 - .3 output relay provides a contact closure to signal a valve/terminal boxes to open prior to the motor starting,
 - .4 field programmable from 0 - 120 seconds,
 - .5 start-delay active regardless of the start command source (keypad command, input contact closure, time-clock control, or serial communications), and when switching from drive to bypass (where bypass is specified).
- .4 Speed control functions:
- .1 minimum five (5) programmable preset speeds,
 - .2 two (2) independently adjustable acceleration and deceleration ramps with 1 - 1800 seconds adjustable time ramps.
 - .3 minimum speed setting adjustable from 0 to 70%,
 - .4 maximum speed setting adjustable from 50 to 150%,
- .5 Upset condition recovery functions:
- .1 flying start into a rotating load, to match output drive frequency to motor frequency before taking load,
 - .2 control-board kinetic energization protection: control deceleration of motor to use motor-load inertia to keep drive controller energized as long as possible during loss of mains AC failure,
 - .3 carrier frequency control circuit to reduce the carrier frequency based on actual VFD temperature that allows higher carrier frequency settings without derating the VFD.
- .6 Passive harmonic filter low-load function:
- .1 digital output relay opens capacitor-bank contactor in passive harmonic filters when motor control speed is $\leq 70\%$ of rated motor speed, and when the VFD is Off.
 - .2 adjustable control setpoint.
- .7 Fireman's override control function (constant frequency/speed selection bypass command):
- .1 on receipt of a contact closure from the Fire Alarm System or Building Automation System, the VFD operates in one of two selectable modes:
 - (a) operate at a programmed predetermined fixed speed ranging from -500Hz (reverse) to 500Hz (forward), or
 - (b) operate in a specific fireman's override PID algorithm that automatically adjusts motor speed based on override set point and feedback; setpoint adjusted over the serial communications bus.

- .2 operating mode overrides all other inputs (analog/digital, serial communication, and all keypad commands), except safety run interlocks, and force the motor to run in one of the two modes.
- .3 "Override Mode" displayed on the keypad.
- .4 upon removal of the override signal, the VFD resumes normal operation, without the need to cycle the normal discrete input run command.

2.6 VFD - Operator Interface

- .1 Digital display panel:
 - .1 removable back-lit LCD display operator interface unit, with navigation keys and minimum of two (2) soft keys to operation and programming,
 - .2 Bluetooth or WiFi accessibility, with free down-loadable app which replicates control panel functions on a mobile device or tablet,
 - .3 Hand-Off-Auto section and manual speed control without having to navigate to a parameter,
 - .4 Fault reset and Help keys,
 - .5 Digital display with keypad, including quick-access for "Hand-Off-Auto" selection, fault reset, and "Help" functions,
- .2 Loss-of-load alarm,
- .3 Display unit:
 - .1 LCD display, text or graphic display,
 - .2 user selectable language: English or French.
 - .3 complete descriptive words for programming and fault diagnostics,
 - .4 faults displayed in complete descriptive words.
- .4 "Help" button access to on-line assistance for programming and troubleshooting, including a minimum of 14 programming assistants:
 - .1 start-up
 - .2 parameter
 - .3 PID
 - .4 reference
 - .5 I/O
 - .6 serial communications
 - .7 option module
 - .8 panel display
 - .9 low noise set-up
 - .10 maintenance
 - .11 troubleshooting
 - .12 drive optimizer
- .5 Operating values displayed in engineering units, including the following:
 - .1 output frequency,
 - .2 motor speed (RPM, %, or Engineering units),
 - .3 motor current,
 - .4 motor torque,

- .5 motor power (kW),
- .6 DC bus voltage,
- .7 output voltage.

2.7 VFD - Building Automation System ("BAS") Integration

- .1 Two communication ports: EIA-485 and RJ45,

BAS network interface: BACnet MS/TP

- .3 BACnet device protocols certified by BTL listing to ASHRAE Standard 135 BACnet as an Application Specific Controller,
- .4 If additional hardware is required to obtain the BACnet interface, the VFD manufacturer to provide one BACnet gateway per drive; multiple VFDs sharing one gateway is not acceptable.
- .5 BAS digital communication functions include:
 - .1 write command:
 - (a) run-stop control,
 - (b) speed set adjustment,
 - (c) proportional/integral/derivative PID control adjustments,
 - (d) current limit,
 - (e) accel/decel time adjustments,
 - (f) remote VFD fault reset,
 - (g) lock and unlock the keypad.
 - .2 read command:
 - (a) monitor current values including process variable feedback, output speed / frequency, current (in amps), % torque, power (kW), kilowatt hours (resettable), operating hours (resettable), and drive temperature.
 - (b) monitor the VFD relay output status, discrete input status, and all analog input and analog output values.
 - (c) Monitor all diagnostic warning and fault information,
- .6 BAS may force digital and analog outputs via the serial interface; this control is independent of any VFD function except the local Emergency Shut-Down function.

2.8 VFD - Input RFI Filters

- .1 VFD integral RFI/EMC filter, Category C2 to IEC/EN 61800-3.

2.9 VFD – Internal Harmonic Filters

- .1 VFD internal harmonic filters:
 - .1 dual (positive and negative) DC bus chokes equivalent to 5% impedance,
 - .2 and 3% impedance AC line reactor where required as specified in Part 3 – EXECUTION.

2.10 Line Reactor Harmonic Filter

- .1 3% impedance AC line reactor, copper windings on iron core, for installation inside of VFD enclosure or as a separate device.
- .2 Enclosure: to CSA C22.2 No. 94.1/94.2, Type 1 or 3R (for filters not forming part of the VFD).
- .3 Refer to article in Part 3 – EXECUTION for when this harmonic filter type is required based on motor HP rating.

Standard of Acceptance

- MTE - fig. RL Line Reactors

2.11 Field-Installed Disconnect Switches

- .1 Field-installed disconnect switches to conform to Specification section 20 05 12, except/and as specified herein.
- .2 Disconnects with overcurrent protection device:
 - .1 include fuses or circuit breakers which have a short-circuit interrupting capacity equal to or greater than the SCCR specified for VFDs.
 - .2 select fuse or circuit breaker type and rating in accordance with VFD manufacturer installation instructions for the purpose of achieving the required SCCR value.

3 EXECUTION

3.1 General

- .1 Provide each controlled motor with a dedicated VFD, unless otherwise shown to group motors on a common VFD on a special case basis.

3.2 VFD Installation

- .1 Except where the VFD is provided with a Type 12 enclosure, provide temporary dust protection around installed VFDs until the drives are energized.
- .2 Install variable speed drives in accordance with manufacturer's requirements. Provide field wiring in accordance with Specification section 23 05 12.
- .3 Install VFD as close as possible to controlled equipment unless otherwise shown. Position the motor controller so that:
 - .1 the door front is readily visible and accessible from the workspace,
 - .2 for wall-hung motor controllers, install with the top of the motor controls located between 1700 and 1800 mm above the local work surface and all adjacent motor controllers aligned to the same height,
 - .3 there is a minimum clear space of 1000 mm (40 in.) in front of the motor controller.
- .4 Mount motor controllers to building walls or structure, on Unistrut or similar rails;
 - .1 do not weld miscellaneous support steel to building structure,
 - .2 secure VFDs with seismic-rated fasteners where seismic restraint is required in accordance with specification section 20 05 49.
- .5 Where there is no adjacent or insufficient wall space or building structure upon which to mount the motor controller, provide a floor-mounted fabricated support assembly to mount the motor controller. Design the support assembly to:
 - .1 support the dead-weight of the motor controller,
 - .2 withstand a 220 N (50 lbf) horizontal force from any direction applied to the VFD enclosure, with a maximum deflection of 3 mm (1/8 in).
 - .3 resist seismic movement where seismic restraint is required in accordance with specification section 20 05 49.
- .6 Provide control wiring between the VFD and associated harmonic filter to disable the filter when the drive is at low-speed or is Off.

3.3 Motor Feeder Installation

- .1 Provide inverter-duty motor feeder cable in accordance with Specification section 20 05 12, between VFD and the controlled motor, including connections to specified load-side filters.

3.4 Disconnect Switch Installation

- .1 Provide disconnect switches with overcurrent protection for:
 - .1 VFDs not provided with integral disconnect switches,
 - .2 VFDs with integral bypass motor controllers, and
 - .3 VFDs which have an internal SCCR rating that is less than the minimum SCCR value specified herein.
- .2 Locate the disconnect switch immediately upstream of the VFD;
 - .1 install the disconnect switch within 9 m (29 ft) and in line-of-site of the VFD and the motor served by the VFD,
 - .2 where a VFD has an associated harmonic filter installed immediately adjacent to the VFD, the disconnect switch may be mounted ahead of the harmonic filter.
- .3 Where a disconnect switch is required between the drive and the motor, provide an un-fused disconnect switch that has an auxiliary contact switch to indicate when the disconnect switch is not closed.
- .4 Where a VFD is provided with a dedicated harmonic filter, install the disconnect switch ahead of the harmonic filter.

3.5 Harmonic Filters Installation

- .1 Provide harmonic filters for VFDs based on drive HP rating in accordance with the following table 1, to not exceed the maximum current total harmonic distortion when measured at the line side of the filter/drive assembly.

Table 1: Harmonic Filter Requirements					
Individual Motor Rating HP	Harmonic Filter Method				Maximum THID Rating
	Dual DC Choke 5%	AC Line Reactor 3%	Passive Filter	Active Filter	
≤ 5	Included	---	---	---	45%
>5 and ≤ 40	Included	Yes	---	---	35%
>40 and ≤ 100	Included	---	Yes	---	8%
>100	Included	---	---	Yes	5%

- .2 Install harmonic filters in accordance with the manufacturer's instructions.
- .3 Where a 3% impedance AC line reactor is required, if it is not provided integral to the VFD, provide a field-installed reactor in its own electrical enclosure as specified herein, located immediately ahead of the VFD.

3.6 Control Wiring for Remote Disconnect Switch at Motor

- .1 Where a separate disconnect is installed between the drive and the controlled motor, provide interlock control wiring between disconnect switch auxiliary-contact switch and the VFD, to prevent drive from operating if the motor disconnect switch is open.

3.7 Cleaning

- .1 Vacuum clean the inside of VFD panels to remove construction dirt and debris before energizing the VFD.
- .2 Do not start-up VFDs until the local area has been brought to final clean, floors are sealed, and any drywall in the same space is sanded and painted.

3.8 Temporary Use of VFDs During Construction

- .1 Except where a VFD is provided with a Type 12 enclosure, VFDs are not specified for operation in a construction dust-laden environment. Except for VFDs in Type 12 enclosures, do not operate VFDs for the purpose of temporary construction heat or ventilation prior to final construction cleaning of the space in which the drives are located.
- .2 If such heating equipment is to be used prior to final construction clean, provide temporary dust protection enclosures around the VFDs and provide ventilation to the temporary enclosure with a source of filtered supply air.

3.9 Start-Up and Testing

- .1 Provide the services of a certified factory authorized representative for the start-up of each drive, including any configuration and programming required. Complete and submit a VFD manufacturer's start-up inspection and test form for each drive.
- .2 Set the carrier frequency to 4 kHz as the default value. Where noise is found to be objectionable, increase carrier frequency to the lowest possible value until noise level is acceptable or cannot be discerned from the background noise.
 - .1 where a load-side dV/dT filter is installed, do not use a carrier frequency greater than 4 kHz.
- .3 Commission harmonic mitigation devices on-site. Test the performance of these devices at 0%, 30% and 100% motor load;
 - .1 for the purpose of this test "100% motor load" means the motor current draw when the equipment driven by the motor is operating at its full design load,
 - .2 measure voltage, current, power factor, harmonic distortion (by frequency) and total harmonic distortion at the line-side terminals to the drive/harmonic mitigation device assembly,
 - .3 obtain measurements with a recording type Fluke 41 or equivalent harmonics analyzer for individual and total harmonic currents and voltages,
 - .4 submit written test records to Consultant for review, and include the test records in the operation and maintenance manuals.
- .4 Commission load-side motor protection filters onsite. Test the performance of these devices at 30% and 100% motor load;
 - .1 for the purpose of this test "100% motor load" means the motor current draw when the equipment driven by the motor is operating at its full design load,
 - .2 measure peak-overshoot and peak-normal voltage at VFD load terminals, at load-filter output terminals, and at motor terminals,
 - .3 voltage rise time at the same locations,
 - .4 obtain measurements with a recording type voltage meter capable of recording and graphically displaying peak voltage and voltage rise-time,
 - .5 submit written test records to Consultant for review, and include the test records in the operation and maintenance manuals.

3.10 Setting Skip-Speed for Driven Equipment Natural Frequency

- .1 Conduct a vibration field test on the following driven equipment to determine its first natural frequency:
 - .1 all cooling towers,
 - .2 each style of pump and HP rating,
- .2 Based on the vibration field tests, program the VFD skip-speed function to prevent operation of the motor at the speed corresponding to the driven-equipment's first natural frequency;
 - .1 set the skip speed range setpoint to be equal to $\pm 5\%$ of measured equipment first natural frequency, unless a wider or narrower range is determined by field testing.
- .3 Provide a machine printed, self-adhesive label and place below the drive nameplate, identifying the skip-speed frequency programmed in the drive.

This drive has been programmed to skip over the following speed range: Hz to Hz
--

3.11 Demonstration and Training

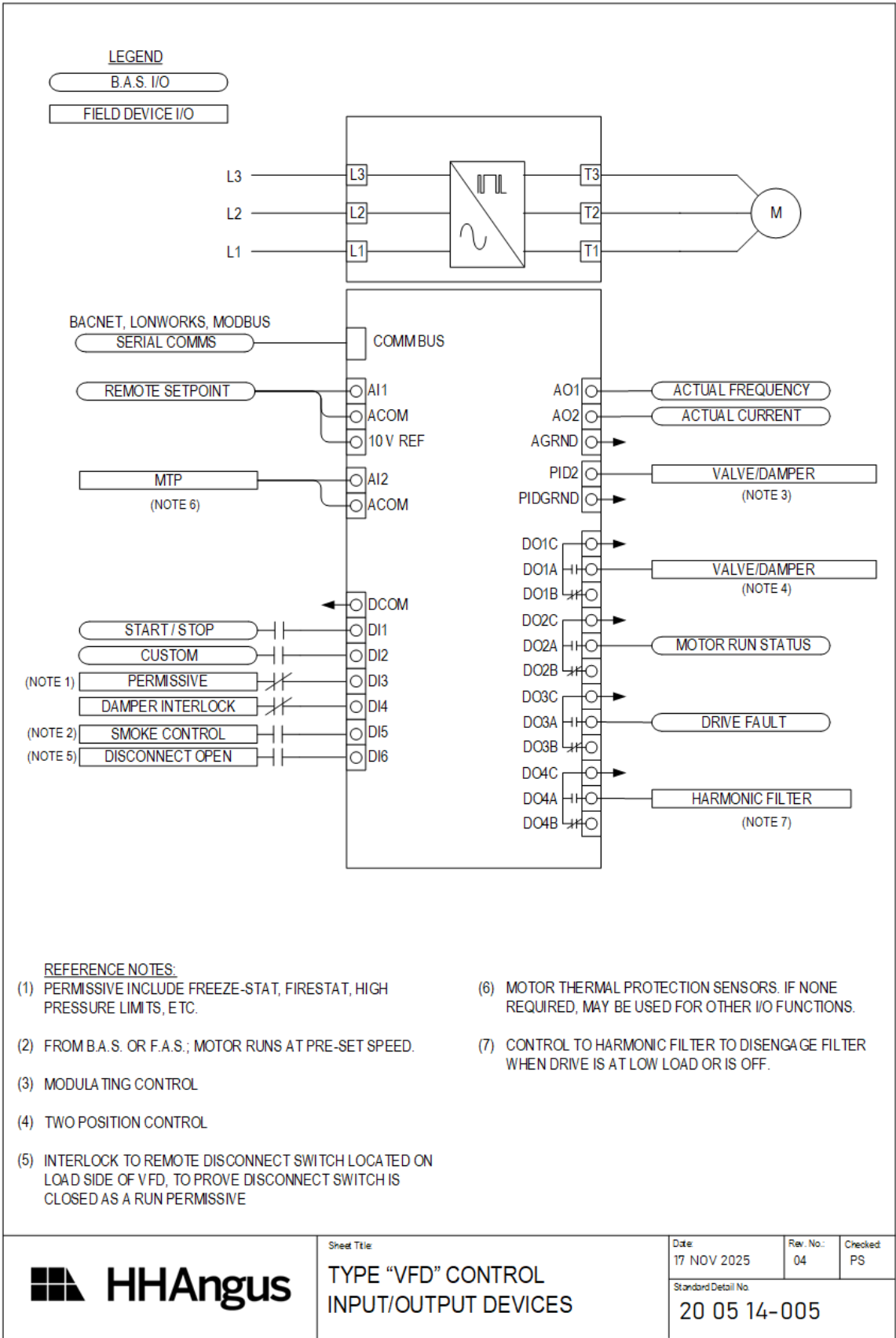
- .1 Provide the services of a factory trained manufacturer's representative to provide training to Owner's operations staff. Include in training;
 - .1 installation instructions,
 - .2 programming of VFD,
 - .3 operation of VFD,
 - .4 at-site servicing of VFD,
 - .5 replacement of VFD keypad controller,
 - .6 manual and automatic operation of bypass, if applicable,
 - .7 serial communications,
 - .8 fireman's smoke control override,
 - .9 method of isolating VFD and bypass (if provided) for servicing the equipment,
 - .10 purpose and function of harmonic filters,
 - .11 purpose and function of load-side motor protection filters.

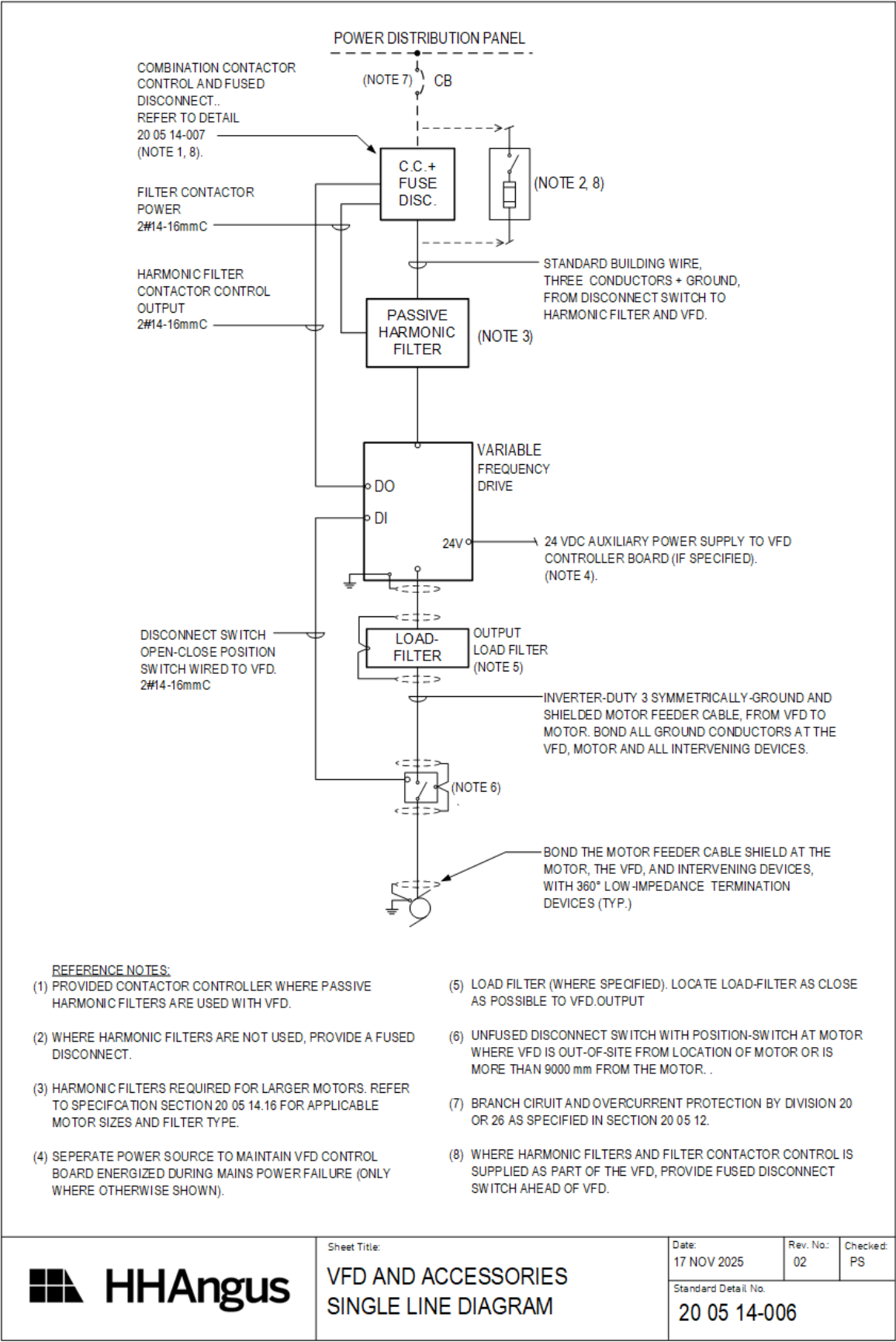
3.12 Hand-Over

- .1 Provide to the Owner the service and maintenance manuals, wiring and interconnection diagrams and the start-up reports.

3.13 Wiring Diagrams

- .1 The included VFD motor controller wiring diagrams are to be read in conjunction with equipment specifications, control sequences, and motor/starter schedules for implementation of control sequences and identification of components required in each in each motor controller.
- .2 The following standard details provide indicative wiring requirements for VFD motor controllers.
 - .1 20 05 14-005 Type "VFD" – Control Input/Output Devices
 - .2 20 05 14-006 VFD and Accessories - Single Line Drawing





END OF SECTION

FLEX CONNECTIONS

20 05 16

1 GENERAL

1.1 Scope

- .1 Provide flexible connections as shown.

1.2 Applicable Codes and Standards

- .1 Installation codes and standards:
 - .1 Refer to each piping specification section for applicable piping installation codes.
 - .2 CAN/CSA-S16.1 Limit States Design of Steel Structures.
 - .3 CSA W59 Welded Steel Construction (Metal Arc Welding).
- .2 Product standards:
 - .1 ASME B1.20.1 Pipe Thread, General Purpose, Inch
 - .2 ASME B16.5 Pipe Flanges and Flange Fittings
 - .3 ASTM A53 Standard Specification for Pipe, Steel, Black and hot dipped, zinc-coated, welded and Seamless
 - .4 ASTM A240 Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
 - .5 CSA B51 Boiler, Pressure Vessel, and Pressure Piping Code,
 - .6 CSA G40.20/G40.21 General Requirements for Rolled or Welded Structural Quality Steel.

2 PRODUCTS

Bellows-Style Pump and Equipment Connectors

- .1 Application:
 - .1 for axial and lateral movements, and vibration isolation at pumps,
 - .2 travel: 0.50 mm (1/2 in) compression, 6 mm (1/4 in) extension, and 3 mm (0.12 in) lateral offset, minimum.
 - .3 size: NPS 2 to NPS 24
- .2 Construction:
 - .1 bellows: hydraulically formed to ASTM F1120, minimum three ply laminated, stainless steel T304 or T321 to ASTM A240,
 - .2 pipe flange plate: ASTM A36 carbon steel to ASME/ANSI B16.5 class 150 or Class 300 as required for each pump service,
 - .3 integral thrust tie-rods to balance full pressure thrust loads,
 - .4 flow liner: ASTM A240 T304 stainless steel.
 - .5 working pressure: 1030 kPa (150 psig) and 2070 kPa (300 psig) at up to 121°C (250°F),
 - .6 factory tested to 1 ½ times maximum working pressure; furnish test certificate,

- .7 CRN to CSA B51.

Standard of Acceptance

- Senior Flexonics – fig. TCS-R SS
- Hyspan - fig. 5500 series
- Flex-Hose Co - fig. Pumpflex

Corrugated-Style Pump and Equipment Connector

- .1 Application:
- .1 for lateral offset movements and vibration isolation at pumps and other equipment subject to vibration,
 - .2 size: NPS 2 to NPS 10
- .2 Construction:
- .1 inner tube: T304 stainless steel corrugate tubing,
 - .2 outer braid; Type 304 stainless steel woven mesh braid, to restrain hose from elongation and to limit hose movement,
 - .3 minimum permanent parallel offset:
 - (a) NPS 2-1/2 and smaller: 13 mm (1/2 in.)
 - (b) NPS 3 and larger: 19 mm (3/4 in.)
 - .4 pipe connections:
 - (a) NPS 2-1/2 and smaller: ASME A53 Schedule 40 pipe with threaded ends to ASME B1.20.1.
 - (b) NPS 2-1/2 and larger: ASTM A36 carbon steel flanges to ASME/ANSI B16.5 class 150.
 - .5 working pressure: 1100 kPa (160 psig) at up to 121°C (250°F),
 - .6 field pressure test: capable of being hydrostatically pressure tested at not less than 120% of unit MAWP, when installed at smallest 90° radii or at maximum parallel offset, at a test temperature of 21°C (70°F),
 - .7 factory tested to 1 ½ times maximum working pressure; furnish test certificate,
 - .8 CRN to CSA B51.

Standard of Acceptance

- Senior Flexonics – fig. BSN/BSFS
- Hyspan - fig. 4500 series
- Metraflex fig. SST/SLP
- Flex-Hose Co - fig. Pumpsaver

Flexible Rubber Pump and Equipment Connector

- .1 Application:
- .1 for axial, lateral and angular movements,
 - .2 travel and pipe size:

Parameter	Single Arch	Double Arch
Axial travel	19 mm (3/4 in.)	50 mm (2 in)

Lateral travel	9.5 mm (3/8 in.)	28 mm (1.125 in)
Angular deflection	15°	35°
Pipe size, NPS	1-1/2 to 12	14 to 24

.2 Construction:

- .1 Spherical bellows, reinforced EPDM inner liner and outer cover, with wire reinforced flange collars, with floating flanges,
- .2 tie rod control units with vibration isolation washers,
- .3 with stabilizing ring for double arch units,
- .4 working pressure: 1450 kPa (210 psig) at up to 37°C (100°F)
- .5 factory tested to 1½ times maximum working pressure; furnish test certificate

Standard of Acceptance

- Senior Flexonics – fig. 101/102
- Garlock Canada - fig. 206
- Metraflex - fig. Metrasphere/Doubleshere
- Proco - fig. 231, 232
- Flex-Hose Co fig. FlexZorber series

Flexible Metal Hose

.1 Application:

- .1 for connections to duct mounted reheat coils, and fan coil units.
- .2 travel limitations;
 - (a) parallel offset equal to the diameter of the hose,
 - (b) single 90 degree bend in one plane.
- .3 size: NPS 1/2 to NPS 2.
- .4 hose length:
 - (a) minimum: 300 mm (12 in).
 - (b) maximum for straight or parallel offset: 300 mm (12 in)
 - (c) maximum for one 90 degree bend in one plane: minimum bend radius plus 200 mm (8 in), not including end fittings, or the specified minimum length whichever is greater.

.2 Construction:

- .1 inner hose: corrugated T316 or T321 stainless steel,
- .2 outer jacket: braided T300 series stainless steel wire mesh, to restrain hose from elongation and to limit hose movement,
- .3 end connections:
 - (a) schedule 40 stainless steel pipe, threaded to ASME B1.20.1,
 - (b) with union at one end connection.
- .4 working pressure: 2070 kPa (300 psig) at up to 121°C (250°F),
- .5 field pressure test: capable of being hydrostatically pressure tested at not less than 120% of unit MAWP, when installed at smallest 90° radii or at maximum parallel offset, at a test temperature of 21°C (70°F),

- .6 factory tested to 1 ½ times maximum working pressure,
- .7 CRN to CSA B51.

Standard of Acceptance

- Senior Flexonics - fig. 101 series
- Metraflex - fig. SuperFlex
- Flex-Hose - fig. Pumpsaver
- Flexpression - fig. Series I

3 EXECUTION

3.1 Equipment Connector Selection and Installation

- .1 Provide pump connectors as follows:

Service	Limits	Connector Type
Steam, heating and cooling coils, and humidifiers	Air handling units supported on spring vibration isolators	Flexible Metal Hose
	Other air handling units	None required
Hot water reheat coils, Fan Coil units	Optional : All sizes	Flexible Metal Hose, Flexible Non-Metallic Hose

- .2 Connector and hose sizing:
 - .1 nominal diameter: same size as piping serving the equipment, not the equipment fitting size.
- .3 Support or guide piping firmly adjacent to equipment connectors and prevent pipes from swaying.
- .4 Where equipment connectors are to be installed at steam coils, locate connectors;
 - .1 between control valve and coil on steam supply side, and
 - .2 after steam trap on condensate line.
- .5 Where equipment connectors are to be installed at chilled and/or hot water coils, locate connectors;
 - .1 between strainer and coil on the supply side, and
 - .2 between coil and control valve on return side
- .6 At reheat coils installed in terminal boxes or in ductwork, arrange equipment connectors so there are no bends, and no axial offsets greater than the OD of the connector measured from the centerline of the connector.

END OF SECTION

INDICATING GAUGES 20 05 19

1 GENERAL

Scope

- .1 Provide temperature and pressure measuring devices and flow indicators as shown.

1.2 Submittals

- .1 Submit manufacturer's catalogue literature for;
 - .1 thermometers,
 - .2 pressure gauges.
- .2 Product data sheets to include:
 - .1 measurement range,
 - .2 maximum operating pressure,
 - .3 installation accessories
- .3 Where there are multiple piping system design pressures based on building elevation, submit separate shop drawings for measuring and indication devices based on applicable piping system design pressure.

1.3 Applicable Codes and Standards

- .1 Installation codes and standards:
 - .1 CSA B51 Boiler and Pressure Vessel Code
- .2 Product standards:
 - .1 ASME B40.100 Pressure Gauges and Gauge Attachments
 - .2 ASME B40.200 Thermometers, Direct Reading and Remote Reading
 - .3 ASME PTC 19.3 TW Thermowells

1.4 Quality Control

- .1 All products that are connected to or installed in a piping system are to have Canadian Registration Numbers in accordance with CSA B51.

2 PRODUCTS

2.1 Thermometers and Pressure Gauges - Selection Criteria

- .1 General:
 - .1 normal operating reading to be between one-half and two-thirds of full scale range,
 - .2 expected maximum and minimum readings to be within scale range.
 - .3 thermometers to have both Celsius and Fahrenheit scales,
 - .4 pressure gauges to have both kPa and psi scales.
 - .5 select pressure gauges and thermometers from manufacturer's standard product line.

Standard of Acceptance

- Terice
- Ashcroft
- Dwyer
- Weksler
- Winter
- Weiss
- WIKA

Direct Reading Thermometers – Liquid and Gases

- .1 For liquid and compressed gas service only.

Industrial, adjustable angle type;

- .1 indicator: 225 mm (9 in.) long, coloured organic spirit fill, magnifying lens type,
- .2 measurement units: dual scale °C/ °F,
- .3 case: cast aluminum with epoxy finish,
- .4 window: UV stabilized acrylic for temperature range up to 150°C (300°F), and glass for higher temperatures,
- .5 process connection: NPT threaded mount, and constructed of:
 - (a) for carbon steel pipe: brass,
 - (b) for stainless steel pipe or tube: 316L stainless steel tube and socket,
 - (c) for copper tube: brass
- .6 accuracy: ± 1 unit minor scale division,
- .7 conforms to ASME B40.200,
- .8 with matching thermowell.

Standard of Acceptance

- Terice – fig. BX9

2.3 Remote Reading Thermometers

- .1 Surface-mounted remote reading thermometer:
- .1 115 mm (4½ in) liquid filled or gas activated type,
 - .2 capillary sensing tube: armoured stainless steel capillary tube with union fitting connection, of length required to suit installation requirements,
 - .3 measurement units: dual scale °C/ °F,
 - .4 case: cast aluminum with epoxy finish, with mounting ring,
 - .5 window: clear glass with retaining ring or hinged bezel,
 - .6 process connection: NPT threaded mount, and constructed of:
 - (a) for carbon steel pipe: brass,
 - (b) for stainless steel pipe or tube: 316L stainless steel tube and socket,
 - (c) for copper tube: brass
 - .7 accuracy: ± 1 unit minor scale division,
 - .8 conforms to ASME B40.200,
 - .9 with matching thermowell.

Standard of Acceptance

- ° Terice - fig. V/L80341 (gas/liquid activated)
- ° Weksler - fig. 413B (gas activated)
- ° Ashcroft - fig. 600A Series (gas activated)

2.4 Thermometer Wells (Thermowells)

- .1 Manufactured from bar stock or forged brass,
 - .1 compatible with temperature sensors used,
 - .2 external NPT mounting threads,
 - .3 pressure rating: 2000 kPa (300 psig) at 121°C (250°F)
 - .4 C.R.N. registered.
- .2 Body material:
 - .1 for carbon steel piping: brass,
 - .2 for copper and brass tubing: brass.
 - .3 for stainless steel piping: 304 stainless steel.
- .3 C.R.N. to CSA B51.

Standard of Acceptance

- ° Terice - fig. 4350

2.5 Temperature Well Conversion Kits

- .1 Retrofit kit to convert straight liquid filled thermometer wells to accept bi-metal dial thermometers.

2.6 Pressure Gauges – Liquid and Steam Process

- .1 For measurement of pressure piping for liquid and steam systems.
- .2 Direct pressure measurement:
 - .1 display: Ø115 mm (4½ in. dia.) dial type, dry type, adjustable stainless steel pointer movement
 - .2 measurement units: dual scale kPa/ psi,
 - .3 case: fiberglass reinforced polypropylene, solid-front and blow-out back,
 - .4 window: acrylic,
 - .5 wetted parts:
 - (a) for carbon steel pipe: brass,
 - (b) for stainless steel pipe or tube: 316L stainless steel tube and socket,
 - (c) for copper tube: brass
 - .6 accuracy: 0.5% full scale reading,
 - .7 maximum service temperature: 121°C (250°F)
 - .8 conforms to ASME B40.100 Grade 2A.
 - .9 C.R.N. to CSA B51.

Standard of Acceptance

- ° Terice – 450B, 450SS

2.7 Pressure Gauges – Ventilation

- .1 For measurement in HVAC ventilation systems.
- .2 Direct or differential pressure measurement:
 - .1 process service: ventilation air,
 - .2 display: Ø115 mm (4½ in. dia.) dial type, adjustable stainless steel pointer movement, pressure relief plug, and NPT 1/8 low- and high-pressure inlet ports, and tubing adaptors,
 - .3 measurement units: dual scale Pa / in. w.c.
 - .4 case: cast aluminium with bezel with epoxy finish coat,
 - .5 window: acrylic,
 - .6 accuracy: ±2% full scale reading,
 - .7 service pressure range: -500 mm Hg to 103 kPa (- 20 in.Hg. to 15 psig)
 - .8 maximum service temperature: -6.5°C to 60°C (20 to 140°F),
 - .9 accessories:
 - (a) attached surface mounting plate,
 - (b) adjustable signal flag for measurement across air filter banks.

Standard of Acceptance

- ° Dwyer - fig. 2000, 2000-ASF series

2.8 Pressure Gauge Accessories

- .1 Pressure snubbers:
 - .1 brass or T303 stainless steel construction,
 - .2 C.R.N. to CSA B51.
- .2 Gauge isolation ball valves:
 - .1 for water, compressed gases, and fuel oil services,
 - .2 NPS 1/4, brass body, quarter-turn ball valves with Teflon seats,
 - .3 minimum pressure rating: 2000 kPa (300 psig) at 121°C (250°F),
 - .4 C.R.N. to CSA B51.

Standard of Acceptance

- ° Terice - fig. 866

- .5 alternate product: NPS 1/4 or 1/2 size as specified for associated liquid or gas piping system.
- .3 Gauge isolation valves for steam service:
 - .1 isolation valves as specified for associated steam piping system.
- .4 Coil syphons:
 - .1 1/4" NPT x 180° coil, seamless 304SS, schedule 40 body,

- .2 minimum pressure rating: 3500 kPa (500 psig) at 343°C (650°F),
- .3 C.R.N. to CSA B51.

Standard of Acceptance

- ° Terice – 885-4

2.9 Test Port Plugs

- .1 Piping test port plugs with gauge adaptors for pressure tests or insertion of pocket thermometer probes.
 - .1 Wetted parts: lead-free brass, with BUNA-diaphragm core,
 - .2 size: 1/2" NPT with MNPT threaded connection, with probe guard
 - .3 pressure rating: 7000 kPa (1000 psi) from -40 to 150°C (-40 to 300°F)

Standard of Acceptance

- ° Winters – fig. STP-LF

3 EXECUTION

3.1 Installation - General

- .1 Install thermometers and gauges not more than 3 m (10 ft) from floor or platform, or install remote reading thermometers and gauges, with dial mounted at eye level, mounted on backplate and fastened to building structure.
- .2 Provide nameplates for each gauge and thermometer as specified in Section 20 19 00 Identification.

3.2 Thermometer Installation

- .1 Install thermometers on inlet and outlet of;
 - .1 water heating and cooling coils, and
 - .2 as shown.
- .2 Install thermometers in thermowells.
- .3 Install thermowells with extension necks where piping and equipment is to be insulated.

3.3 Pressure Gauge Installation

- .1 Install pressure gauges on inlet and outlet of;
 - .1 water heating and cooling coils, and
 - .2 as shown.
- .2 Provide an isolation valve for each pressure gauge. For differential pressure gauges, provide an isolation valve on each high and low pressure sensing lines.

3.4 Test Port Plugs

- .1 Install test port plugs in locations as shown. Test port plugs shall not be used in lieu of temperature or pressure gauges specifically shown.

END OF SECTION

GENERAL REQUIREMENTS FOR VALVES

20 05 23

1 GENERAL

1.1 Scope

- .1 Provide valves in piping systems for shut-off service, manual flow balancing, check-stops and valve bodies for automatic flow control.
- .2 This specification section provides general requirements for valves.

1.2 Related Sections

Refer to the following valve specification sections for requirements for general-duty valves in addition to the general requirements specified herein.

- 22 05 23.13 General-Duty Valves for Plumbing Piping
- 22 05 23.19 General-Duty Valves for Sewage Systems
- 23 05 23.13 General-Duty Valves for HVAC Water Piping

- .2 Refer to the following specifications sections for requirements for specific-duty valves in addition to the general requirements specified herein.

- 22 60 13.70 Medical Gas Piping

1.3 Submittals

- .1 Submit manufacturer product data-sheets for valves, including pressure-temperature ratings with confirmation that the valve meets the required MCPR rating specified for each valve.
- .2 Where valves are specified to be listed (certified) to a standard, include the following information for each affected product:
 - .1 applicable standard by name and reference number,
 - .2 name of accredited testing organization or their mark who certified the product, and
 - .3 the testing organization file reference number.
- .3 Where valves are required to have a CRN, include the CRN and its expiry date on each valve submittal.
- .4 Where manufacturer pre-printed data-sheets do not include this information, a schedule may be submitted which includes the manufacturers name, model number and the required listing and/or CRN information described above. Where the product is name-branded for a manufacturer, include the name of the source manufacturer.

1.4 Applicable codes and standards

- .1 Legislation:
 - .1 Valves installed in piping systems which are subject to provincial or federal pressure piping legislation shall have current Canadian Registration Numbers ("CRN") in accordance with CSA B51.
- .2 Installation standards, codes and guidelines:
 - .1 CSA B51 Boiler and Pressure Vessel Code.
 - .2 Refer to applicable piping specification sections for any other specific requirements.
- .3 Product standards:
 - .1 ANSI/ASME B1.20.1 Pipe Threads, General Purpose, Inch

.2	ASME B16.1	Cast Iron Pipe Flanges and Flanged Fittings
.3	ASME B16.5	Pipe Flanges and Flanged Fittings
.4	ASME B16.10	Face-to-Face and End-to-End Dimensions of Valves
.5	ASME B156.24	Cast Copper Alloy Pipe Flanges and Flanged Fittings
.6	ASME B16.34	Valves Flanged, Threaded and Welding Ends
.7	ASME B16.47	Large Diameter Steel Flanges: NPS 26 Through NPS 60
.8	ISO 5211	Industrial Valves – Part-turn Actuator Attachments
.9	MSS SP-25	Standard Marking System for Valves, Fittings, Flanges, and Unions
.10	MSS SP-42	Corrosion-Resistant Gate, Globe, Angle, and Check Valves with Flanged and Butt Weld Ends (Classes 150, 300, & 600)
.11	MSS SP-67	Butterfly Valves
.12	MSS SP-68	High Pressure Butterfly Valves with Offset Design
.13	MSS SP-70	Cast Iron Gate Valves, Flanged and Threaded Ends
.14	MSS SP-71	Cast Iron Swing Check Valves, Flanged and Threaded Ends
.15	MSS SP-72	Ball valves with Flanged or Butt-Welding ends for General Service
.16	MSS SP-78	Cast Iron Plug Valves
.17	MSS SP-80	Bronze Gate, Globe Angle and Check Valves
.18	MSS SP-85	Cast Iron Globe and Angle Valves, Flanged and Threaded Ends
.19	MSS SP-110	Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends
.20	MSS SP-125	Gray Iron and Ductile Iron In-Line, Spring-Loaded, Center-Guided Check Valves
.21	MSS SP-126	In-Line, Spring-Assisted, Center-Guided Check Valves (Carbon, Alloy Steel, Stainless Steel, & Nickel Alloys)
.22	MSS SP-136	Ductile Iron Swing Check Valves
.23	MSS SP-139	Copper Alloy Gate, Globe, Angle, and Check Valves for Low Pressure/Low Temperature Plumbing Applications
.24	NSF/ANSI 61	Drinking Water System Components – Health Effects
.25	NSF/ANSI 372	Drinking Water System Components – Lead Content (formerly NSF/ANSI 61- Annex G).

1.5 Quality and Equivalence

- .1 Valve selections are in general identified by model designations taken from manufacturers catalogues to indicate physical properties and quality requirements not otherwise described.

2 PRODUCTS

2.1 General

- .1 Refer to related specification sections.
- .2 Manufactures and/or trade names listed in Table 1 are acceptable for various indicated valve types, where products offered are essentially similar to those identified by manufacturer or model number under “Standard of Acceptance” designation in the related specification sections.

- .1 Refer to the General-duty valve specification sections and specific-duty valve requirements contained in the related piping system specification sections.
- .2 Additional specification requirements and/or certification requirements may be required by those sections.

Manufacturer	Gate, Globe, Angle, Check	Silent Check	DRV	Butterfly	Plug	Ball
A-Chem Valves & Controls	•			•		•
American Valve						•
APCO		•				
Apollo				•		•
Bonney Forge	•					
Beric	•					
Bray				•		•
Canadian Worchester Controls						•
Challenger				•		
Couplox				•		
Crane	•			•		•
Crane Centreline				•		
Crane Flowseal				•		
Dahl Bros	•					•
Demco				•		
DeZurik				!		
Durabla		•				
Grinnell				•		
Gruvlok				•		•
Hattersley Milliken (Crane)					•	
Jenkins	•			•		•
Keystone				•		
Kitz	•			•		•
MA Stewart (MAS)	•					•
Milwaukee Valve				•		•
Mueller		•		•	•	
Neo Valves	•					•
Nibco	•	•		•		•
Nordstrom					•	
Powell	•					
Preso			•			
S.A. Armstrong	•		•			
Shurjoint				•		•
Sure Seal				•		

Manufacturer	Gate, Globe, Angle, Check	Silent Check	DRV	Butterfly	Plug	Ball
Tour & Anderson			•			
Toyo Valve (Red & White)	•					•
Triad				•		
Trueline	•					•
Valmatic		•				
Velan	•			•		•
Victaulic				•		•
Watts	•			•		•
WKM				•		

3 EXECUTION

3.1 Valve Selection Criteria

- .1 Select valves in accordance with function criteria as shown in Table 2.

Table 2: Valve Function Selection						
Function	Gate	Butterfly	Ball	Globe	Plug	DRV
Shut-Off	•	•	•		•	
Flow balancing and shut-off [2]						
Flow Balancing only (excluding pumps)				•		•
Pump Balancing		• [1] [3]		•		•

Notes:

- [1] Gear operator with position limit memory stops.
[2] Each flow balancing valve shall be installed with an associated isolation valve. Flow balancing valves shall not be used for isolation.
[3] Sized one (1) NPS line size smaller than pipe line size (not pump discharge size).

3.2 Piping System Drain Valves

- .1 Provide drain valves on piping and at equipment as follows unless otherwise shown on drawings:
- .1 On pipe mains and branches NPS 3 and under, and for equipment with pipe connections NPS 4 and smaller:
 - (a) NPS ¾ ball valve in accordance with pipe system specification with integral NPSH ¾ hose end with cap and chain.
 - .2 On pipe mains NPS 4 to NPS 6, and for equipment with pipe connections NPS 6 and larger:
 - (a) NPS 1 ball valve, with a NPT threaded brass Cam and Groove female coupler fitting with dust-plug

- .3 On pipe mains NPS 8 and larger:
 - (a) NPS 2 ball valve, with a NPT threaded brass Cam and Groove female coupler fitting with dust-plug.

3.3 Valve Installation - General

- .1 Install shut off valves at:
 - .1 branch take-offs,
 - .2 to isolate piping to each piece of equipment, and
 - .3 in locations shown.
- .2 Remove internal parts of valves before soldering, welding or brazing pipe to valve body.
 - .1 Exception: where valve is provided with tube end extensions to allow soldering or brazing without removal of internal parts.
 - .2 For valves which do not permit disassembly including ball valves and inline check valves, comply with valve manufacturer instructions to protect valve internal components during soldering, brazing or welding.
- .3 Install butterfly valves between weldneck or slip-on flanges.

3.4 Valve Orientation and Accessibility

- .1 Arrange valve hand-wheels and operating levers to be accessible.
- .2 In equipment rooms and service spaces provide chain operators for valves mounted more than 2m (6 ft) above floor or access platform. Provide sufficient chain length to extend to 1.5m (4 ft-6 in) above floor or platform and to be hooked on clips secured to building structure, clear of walking aisles.
- .3 In horizontal piping (see figure 1);
 - .1 For OS&R valves, install the valve with stem vertical where the valve centerline is not more than 1200 mm above the adjacent floor or access platform. For greater heights, install the valve with stem horizontal. Where space is restricted, the valve may be installed with the valve spindle at a 45° angle from the vertical where the valve centerline is not more than 1500 mm above the floor or access platform.
 - .2 For gear operated valves, install with gear-box on top of the valve and hand-wheel shaft in the horizontal position.
 - .3 For lever operated valves, install with handle on top of valves where the valve centerline is not more than 1500 mm above the floor or access platform. Where spaces is restricted, the valve may be positioned with the lever handle shaft in the horizontal position. For greater heights, install valves with handle shaft in the horizontal position.

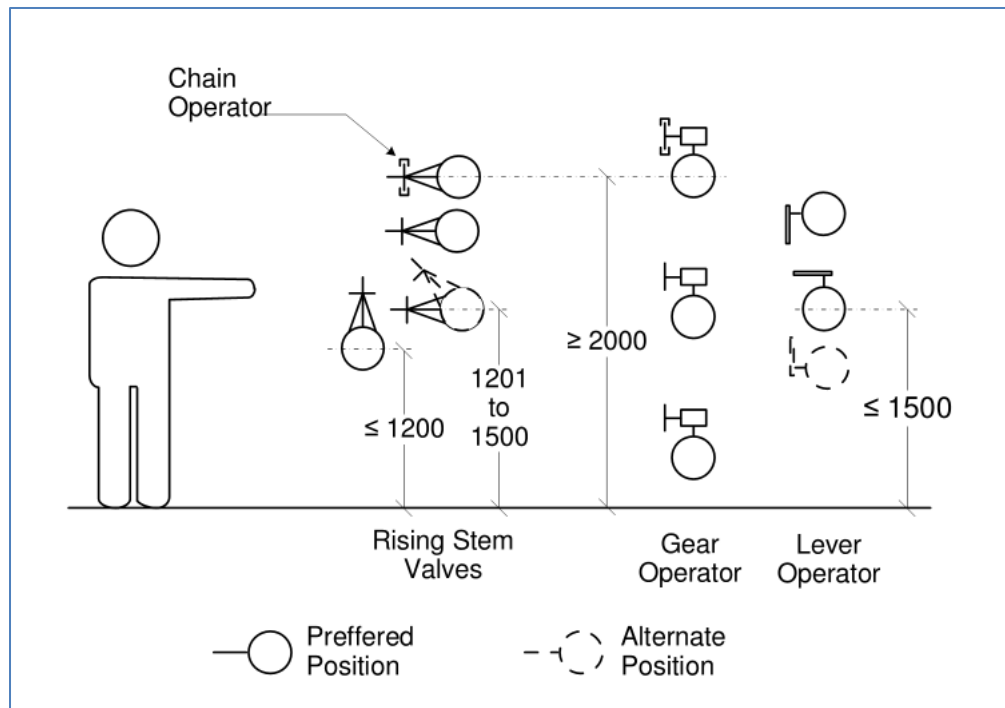


Figure 1: Valve Spindle Arrangement

- .4 In vertical piping, install with valve stem facing directly towards the means of access. Where access space in front of the valve is less than 900 mm (36 in), rotate the valve 45° from the straight forward position.

END OF SECTION

WELDING AND BRAZING

20 05 24

1 GENERAL

1.1 Scope

- .1 Weld or braze pipe and fittings for work of Division 20.

1.2 Definitions

- .1 The following definitions apply to this specification section:

AHJ (BPV): *the authority having jurisdiction which is responsible for boiler, pressure vessel and pressure piping safety in the province of the project.*

- .2 In this specification,
 - .1 the word “piping” also includes tubing as the case applies.
 - .2 the words “welding” or “welder” shall be read as to also refer to “brazing” or “brazer” unless the context otherwise dictates one or the other.

1.3 Applicable Codes and Standards

- .1 Installation codes and standards:
 - .1 ASME B31.1 Pressure Piping
 - .2 ASME B31.3 Process Piping
 - .3 ASME B31.9 Building Services Piping
 - .4 ASME BPVC Section V Nondestructive Examination
 - .5 ASME BPVC Section IX Welding and Brazing Qualifications
 - .6 CSA B51. Boiler, Pressure Vessel, and Pressure Piping Code

1.4 Quality Control

- .1 Welding of piping systems which have specified design pressures greater than 100 kPa (15 psi) to be carried out using approved welding procedures by welders certified for pressure piping by the AHJ (BPV), whether or not the piping system is subject to registration as pressure piping.
- .2 Welding procedures shall be registered with the AHJ (BPV), in accordance with CSA B51 and as qualified in accordance with ASME BPVC Section IX.
- .3 Welders shall be certified for welding of pressure piping in accordance with the requirements of the AHJ (BPV). Welders shall be qualified by their employer on the employers welding procedures.
- .4 For piping systems which have specified design pressure of 100 kPa (15 psi) or less, welding procedures and welders shall be qualified by the Contractor in accordance with the requirements of ASME B31.9.

2 PRODUCTS

2.1 Not used

3 EXECUTION

3.1 Welding Method and Quality

- .1 Welding, both shop and field, to be electric arc in accordance with recommendations of Canadian Welding Bureau unless other welding methods are specified in the piping specification sections.
- .2 Welds to be solid homogeneous part of metals joined and free from pits, slag-inclusions, and scale.
- .3 Weld surfaces to be smooth and regular and weld metal deposition to achieve full penetration groove weld fused to the base metal throughout joint thickness. Fillet welds, where permitted or required by applicable piping codes, shall achieve adequate depth of fusion of the base metal as required by those codes.
- .4 Brazed joints to use brazing filler and fluxes as specified for each applicable piping system. For socket joints, the tube and joint are to overlapped not less than four times the thickness of the thinner base material, with filter material penetrating to this full depth and finished with well-developed fillet.

3.2 Welded Connections to Existing Pressure Piping Systems

- .1 At the commencement of the Work, where registration and/or inspection of the piping system is required in accordance with provincial boiler and pressure vessel regulations, review with the AHJ (BPV) inspector to determine their weld testing requirements to validate the proposed welding procedures for connecting to existing piping, including but not limited to:
 - .1 acceptable dimensional misalignment between old and new pipe;
 - .2 requirements, if any, for metallurgical analysis of exiting piping;
 - .3 sample butt weld guided-bend test; and
 - .4 sample fillet weld test.
- .2 After testing requirements are determined, provide a proposed schedule for tie-in connections and required existing service shut-down periods, for approval prior to commencing work.
- .3 Prior to shut-down of existing piping systems for tie-ins, inspect the existing pipe O.D. dimensions to confirm their suitability for pipe attachment. Specifically, where the work requires a complete transection of an existing pipe, check the existing pipe for excessive out-of-roundness which would otherwise exceed the allowable misalignment as defined in the applicable ASME piping code. Where necessary, trim the pipe ends in accordance with the referenced piping code.

3.3 Welding Examination

- .1 For piping systems which are specified to be constructed to ASME B31.1 or ASME B31.3, examination of pipe welds, including both visual and other nondestructive examination performed in accordance with those piping codes shall be arranged and paid for by the Contractor, and are to be performed by a specialist testing company whose personnel are qualified to perform such examinations in accordance with ASME BPVC Section V.
- .2 For piping systems which are specified to be constructed to ASME B31.9, examination of pipe welds in accordance with that piping code shall be performed by the Contractor using personnel who are suitably experienced for such examinations.
- .3 Acceptance criteria for weld examination shall be in accordance with the specified ASME piping code applicable to each piping system and as may be specified in other Specification sections of Division 21 to 23.

- .1 for clarity, where ASME B31.9 code applies to a piping system, the weld examinations and weld defect acceptance criteria are summarized in the following table.

- (a) Notwithstanding the listed weld defect criteria, the overall quality of the weld shall also be able to meet the requirements for incomplete weld penetration and weld root concavity. However, examination of the interior surface of the weld is not required.

Table 1: Weld Defect Acceptance Criteria – ASME B31.9		
Type of Weld	Weld Defect	Acceptance Criteria
Girth (butt) weld, Groove weld, Fillet weld, Socket weld, Seal weld	Cracks	None
	Lack of fusion	Length of unfused areas $\leq$ 20% of pipe circumference or total length of weld, and not more than 25% in any 150 mm (6 in.) of weld
	Undercut	Not exceed the lessor of 1 mm (1/32 in.) or 12.5% of wall thickness.
	Weld surface	Weld reinforcement not to exceed 4.8 mm (3/16 in.)

3.4 Welding Inspection

- .1 Arrange and pay for any required inspection of welds by the AHJ (BPV).
- .2 Welders certificates and welding procedures used for the Work to be made available for inspection by the AHJ (BPV) on demand. Provide traceability of welders work by either stamping each weld with the welder's identifying number, or maintain a record log to record and identify each welders work.

3.5 Radiography

- .1 Notwithstanding that a referenced ASME piping code may not require radiographic or other non-visual non-destructive examination methods based on the service conditions of a piping system, provide radiographic examination of piping systems as specified herein.
- .2 Arrange and pay for services of an inspection company specializing in making and interpreting radiographic imaging of pipe welds.
- .3 For piping systems where ASME B31.3 is the specified piping code, the following rules apply:
- .1 The designated lots of piping for radiographic examination ("Lots") are defined as follows:
- (a) Lot 1: the aggregate of all piping within a boiler plant room or other mechanical service room.
- (b) Lot 2: the aggregate of all piping located in a vertical service space (total of all such piping).
- (c) Lot 3: the aggregate of all piping located in areas not defined in Lot 1 and Lot 2.
- .4 Submit a copy of the radiograph results and analysis for every weld so examined.
- .5 Radiography to be in accordance with ASME BPVC Section V, article 2. Weld acceptance criteria shall be in accordance with the specified ASME piping code.
- .6 Where a weld is found to be defective in a Lot, conduct two additional tests in the same Lot. If one of those additional tested welds is found defective, conduct an additional second set of two additional tests in the same Lot. If one of those welds fail, then conduct 100% radiographic examination of all butt welds in the Lot.
- .7 Repairs to defective welds shall be performed in accordance to the requirements of the specified ASME piping code.

END OF SECTION

PIPELINE HOT-TAPPING AND LINE STOPPING

20 05 26

GENERAL.

Scope

Make branch connections to existing piping systems by means of hot-tapping while maintaining main pipeline in service.

- .2 Installation of temperature thermowells to existing piping systems by means of hot-tapping while maintaining main pipeline in service.
- .3 Temporarily isolate portions of existing piping systems by means of pipe line-stopping only where hot tapping is not feasible.

1.2 Limitations on Use

- .1 Hot-tapping and/or line-stopping are not to be used where isolation and/or draining of the pipeline is permitted by the Owner.
- .2 Hot-tapping and/or line-stopping are only to be used where;
 - .1 permitted by the Owner,
 - .2 specified for particular branch connections and for temperature thermowells,
 - .3 the existing piping design pressure at the location of a welded-on hot-tap does not exceed 2100 kPa (300 psig),
 - .4 the existing piping design pressure at the location of a mechanical-bolted tapping-saddle does not exceed 1050 kPa (150 psig); and
 - .5 permitted by the AHJ responsible for boiler and pressure vessel safety.
- .3 The application of this specification is limited to the following piping systems:
 - .1 potable water systems,
 - .2 liquids no more hazardous than water, including building heating and cooling piping systems which contain industry-standard corrosion inhibitors and other related chemical treatment additives, including anti-freeze additives.

1.3 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
 - .1 20 05 24 Welding and Brazing
- 22 05 01 Plumbing Piping Systems – General Requirements
 - .3 22 05 23.13 General-Duty Valves for Plumbing Piping
 - .4 22 11 16.13 Domestic Water Piping – Copper
 - .5 23 05 01 HVAC Piping Systems - General Requirements
 - .6 23 05 23.13 General-Duty Valves for HVAC Water Piping
 - .7 23 21 13.23 Hydronic Piping – Carbon Steel

1.4 Definitions and Abbreviations

- .1 The following definitions apply to this section.
 - .1 **Hot-tapping** – the method by which a new branch connection is made to an existing mains pipe while the mains pipe is under pressure and continues operating.
 - .2 **Line-Stopping** – the method for temporarily blocking flow in an existing pipe by use of line-plugging or line-freezing.
 - .3 **Line-Freezing** – line-stopping by freezing the mains pipe fluid by application of cryogenic fluids to the exterior of the pipe.
 - .4 **Line-plugging** – line-stopping by insertion of a plug through a branch connection, and which may require the use of hot-tapping to make suitable branch connections.

1.5 Applicable Codes and Standards

- .1 Legislation;

TSSA SB-05-02(R2) Safety Information Bulletin: Hot Tap and Line Stopping for Pressure Equipment.

- .2 Installation codes and standards (as adopted and amended by the AHJ for pressure vessels):
 - .1 CSA B51 Boiler, pressure vessels, and pressure piping code
 - .2 ASME B31.1 Power Piping
 - .3 ASME B31.3 Process Piping
 - .4 ASME Section IX Boiler and Pressure Vessel Code: Qualification Standard for Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators – Welding, Brazing and Fusing Qualifications.
 - .5 ASME PCC-2 Repair of Pressure Equipment and Piping

1.6 Qualified Tradesperson

- .1 Work to be performed by qualified, licensed and recognized firm with an established reputation in this field, using tradesperson holding applicable certificates of competency (license) issued by the AHJ responsible for pressure piping system safety. The license shall include an endorsement for performance of hot-tapping operations, when required by the AHJ.

1.7 Registration and Inspection

- .1 Before commencing work, make arrangements and pay for registration and inspection by the AHJ responsible for boiler and pressure vessel safety as applicable to the piping system being modified. Include specific information required for hot-tapping and/or line stopping.
- .2 At the start of the Work, obtain existing pressure piping system registration numbers, if available, from the Owner and/or the AHJ.

1.8 Design Criteria

- .1 Specialist hot-tapping contractor to prepare hot-tapping procedures in accordance with, at a minimum, the requirements of the applicable piping code, ASME Section IX and ASME PCC-2.
 - .1 for hot-tapping by welding to steel pipe, develop welding procedures to provide for a resulting maximum allowable working pressure of the new branch fitting attachment that is not less than 2.0 times the piping system design pressure listed in the schedule at the end of this section, assuming the following wall thickness deductions:

- (a) 12.5% mill tolerance of new nominal wall thickness,
 - (b) 0.75 mm (0.030) corrosion allowance,
- .2 allowable pressure to be based on the measured actual wall thickness of the existing mains pipe.
- .2 Piping design and installation code:
 - .1 Refer to the applicable specification section for the piping system.
- .3 System design criteria.
 - .1 Refer to the applicable specification section for the piping system.

1.9 Submittals

- .1 Shop drawings:
 - .1 submit product data sheets for materials specified herein.
 - .2 submit shop drawings for fabricated components and equipment.
- .2 Submit written procedures for hot-tapping and/or line-plugging as applicable to the method used.
- .3 Submit calculations sealed by a professional engineer licensed in the province of the project, for the resulting maximum allowable working pressure of the resulting branch-to-main pipe fitting at the design temperature of the applicable piping system.

1.10 Quality Control

- .1 Welding of piping to conform to specification section 20 05 24 and as specified herein.
- .2 Produce and implement hot-tapping procedures, which includes but is not limited to:
 - .1 pre-installation inspections, preparation, welding, pressure testing, weld examination, and safety precautions,
 - .2 specific welding procedure specifications (WPS) suitable for hot tapping, which include
 - (a) requirements for groove welds for direct attachment of integrally reinforced welding branch fittings, with requirements (if any) for supplemental reinforcing pads,
 - (b) the use of fillet-weld attachments for split-tee welding fittings.
- .3 Hot-tap welding procedures are to be registered with the AHJ responsible for pressure piping safety, and as a minimum shall conform to ASME Section IX and ASME PCC-2.
- .4 Hot-tap branch fitting or fabricated split-tee assembly to have current Canadian Registration Number (CRN) in accordance with CSA B51.

2 PRODUCTS

2.1 Hot-Tapping – Steel Piping

- .1 Reinforced outlet fittings: as specified in the applicable piping specification section,
- .2 Flanges and gaskets: as specified in the applicable piping specification section.
- .3 Manufactured split-tees:
 - .1 fabricated split-tees with integral reinforced outlets branch fitting and branch end fitting,
 - .2 inside surface of split tee to be equal to the outside diameter of the mains pipe,
 - .3 designed for fillet welds of the split-tee to the mains pipe, and with flange-edge weld joint of mating flanges,

- .4 Branch pipe run end fitting:
 - .1 branch size NPS 2 and smaller: threaded.
 - .2 branch size NPS 2-1/2 and larger: flanged.
 - .3 for thermowells: threaded.

2.2 Hot-Tapping - Copper Tube

- .1 For potable water applications only.
- .2 Two-piece mechanical tapping saddle:
 - .1 body: two-piece body, T304 stainless steel to ASTM A240, providing 360° coverage of mains pipe,
 - .2 hardware: fastening hardware including threaded studs, washer bar to be T304 stainless steel to ASTM A240, and welded to the body.
 - .3 branch outlet fitting: T304 stainless steel to ASTM A240, with MNPT threaded end fitting to ASME AB1.20.1.
 - .4 gasket: gridded, multiple O-ring, NBR gasket providing complete coverage of mains pipe, bonded to the body,
 - .5 listed for low lead and contamination to NSF 61 and NSF 61+G
- .3 Pipe sizes:
 - .1 mains pipe size: NPS 2 to 8
 - .2 branch pipe size: at least one NPS size smaller than the mains pipe.
- .4 Performance:
 - .1 working pressure rating: 1000 kPa (148 psi),
 - .2 test pressure: 1.5 times working pressure.
 - .3 working temperature rating: -40 to 120°C (-40 to 248°F)

Standard of Acceptance

- ° PowerSeal Corp. - fig. 3425 PowerStop
- ° Pacific Flow Control Inc.

2.3 Hot Tapping for Thermowells (Carbon Steel Piping)

- .1 Carbon steel branch-welding fitting, with internal threads to accept thermowell,
- .2 Suitable for Ø15mm (1/2 in. dia.) and Ø20mm (3/4 in. dia.) thermowells.
- .3 Designed to allow removal of the temporary hot-tap isolation branch valve after installation of the thermowell.
- .4 Select hot tap size (outlet fitting and isolation valve) to allow installation of the thermowell to pass through the temporary hot-tap valve.

Standard of Acceptance

- ° PipeMan Products Inc. - fig. ThermSetter 5075/Thermfit

2.4 Valves

- .1 As specified in the applicable piping specification valve sections,
- Issued For Tender

- .1 branch size NPS 2 and under: full ported ball valve,
- .2 branch size NPS 2-1/2 and larger: gate valves.

3 EXECUTION

3.1 Site Safety

- .1 At all times manage the site safety protocols described in the hot-tapping or line-stopping procedure(s). Exclude all personnel not necessary for the actual hot-tap or line-stopping operation from the work area.

3.2 Site Investigation

- .1 Prior to performing any hot-tapping operation for weld-on branch connections, verify existing pipe wall thickness at the location of the hot-tap with an ultrasonic thickness gauge. Actual wall thickness to be used in verifying suitability of welding procedures and to determine if reinforcing pads are required.

3.3 Hot-Tapping

- .1 Pre-installation inspection and cleaning;
 - .1 Prior to hot-tapping the pipe, check mains pipe or tube that the work surface area is clear of pitting, damage or excessive surface corrosion.
 - .2 For steel piping, select a location which will be free of existing main pipe butt welds. For split-tee welding fittings, if the existing main pipe has a longitudinal manufacturer seam weld, grind any excess weld smooth to the main pipe surface as required to permit full contact between the split-tee welding fitting and the mains pipe.
 - .3 Clean the pipe surface at the area of the work, removing all dirt, oil, grease and debris from the external surface of the main pipe or tube. For copper tubing, clean the exterior surface of the copper tube with emery cloth.
- .2 Hot tapping machine;
 - .1 Select tapping machine and cutters as required to suit the product operating pressure and temperature, and mains pipe material.
 - .2 Bore cutter to be the maximum size possible to pass through the isolation valve. Check that the coupon retention system is not damaged prior to use.
 - .3 Support the tapping machine so as not to impose an overhung load on the isolation valve.
- .3 Hot-tapping for thermowells;
 - .1 Make hot-taps for installation of thermowells. Size the branch temporary isolation valve to suit the hot-tap thermowell fitting.
 - .2 After completion of the hot-tap thermowell and pressure testing, remove the temporary hot-tap branch valve. Check that the thermowell is firmly seated in the hot-tap branch thermowell fitting. If the thermowell is leaking, remove and reinstall the thermowell following the hot-tap thermowell manufacturer instructions.
- .4 Weld-on branch connection installation on steel pipe:
 - .1 Use an integrally reinforced outlet fitting directly welded to the pipe, or a split-tee fitting welded to the main pipe.

- .2 Where an integrally reinforced outlet fitting is directly welded to the main pipe, provide additional reinforcing pads where the welding procedure requires such additional reinforcement to attain the required maximum allowable working pressure.
- .5 Mechanical fitting installation on copper tube;
 - .1 Confirm existing mains tube OD is within the acceptable range of the mechanical fitting manufacturers installation instructions.
 - .2 Install the mechanical saddle fitting, including cleaning of the gasket and application of any required lubricant, in accordance with the fitting manufacturer's installation instructions.
 - .3 Tighten fitting bolts to the required torque specified by the manufacturer, and check that the gasket has compressed to the required thickness.
 - .4 Retighten the fitting bolts at other times as required by the manufacturer instructions.
 - .5 Where the operating fluid temperature is greater than 20°C, retighten the fitting bolts 48 hours after the completion of the hot tap. If there are small leaks observed at this time, retighten the fitting bolts following another 48 hour period. At all times, do not exceed the maximum torque value specified by the fitting manufacturer.
 - .6 If leaks continue to occur after two x 48 hour retightening periods, arrange with the Owner to shut-down the system, and replace the mechanical saddle fitting with new pipe-tee fitting.
 - .7 Record the torque values (required and measured) for the initial tightening and all subsequent re-tightening of the bolts, and measured compressed gasket thickness.

3.4 Hot-Tap Pressure Testing

- .1 Initial pressure testing:
 - .1 conduct an initial pressure test of the branch fitting after the branch connection fitting and isolation valve has been attached to the mains pipe/tube, but prior to drilling the branch opening,
 - .2 where the test pressure is 820 kPa (120 psig) or less, a pneumatic pressure test using CO2 or nitrogen may be used with a soap leak test.
 - .3 where the test pressure is greater than 820 kPa (120 psig), use a hydrostatic pressure test.
- .2 Secondary pressure test:
 - .1 Conduct a secondary pressure test after the hot tap machine has been installed but prior to drilling. Conduct the pressure test with the same method as described for the initial pressure test.
- .3 Final pressure test:
 - .1 After completion of the hot tap and removal of the hot-tapping machine, conduct an in-service soap pressure test to check for any final leaks. If leaks are discovered, modify the installation to make it leak-tight.

3.5 Line-Plugging

- .1 Not permitted.

3.6 Line-Freezing

- .1 Temporarily freeze the piping by use of freezing assembly jackets with cryogenic fluids (preferably liquid nitrogen). Freeze a sufficient length of pipe to achieve an ice plug which would have a nominal compression strength of at least 17 MPa (2500 psig). Allow greater ice plug length where welding on the pipe mains is required.

- .2 Once the line-stopping is achieved, in addition to the work required on the mains pipe that necessitated the line-stopping, add a drain connection consisting of:
 - .1 a branch pipe of not less than NPS 1 in size, of the same material as the mains pipe,
 - .2 a ball valve as specified for the applicable piping section, and
 - .3 a 100 mm long nipple with a hose-end fitting with cap.
- .3 After completion of the work on the main pipeline, partially open the new drain valve and leave open during melting of the plug. Provide temporary hoses to discharge fluid to a safe location until such time as both plugs are partially melted and operating fluid discharges from the drain.

3.7 Inspections

- .1 Coordinate with the AHJ inspector to allow them to witness the hot-tapping work.

3.8 Cleaning

- .1 After completion of the hot tap and removal of the hot tap machine, flush the branch assembly to remove any residual metal filings:
 - .1 for water systems, provide a temporary hose to drain water to a safe location.

3.9 Test and installation records

- .1 Submit a test record recording all pressure test results, including test method and test pressures, and in the case of a mechanical fitting include all bolt torque values and manufacturer torque requirements. Include time and date of each measurement and the name of the person conducting the test.
- .2 Submit a copy of the above test to the Owner and the Consultant.
- .3 Submit a copy of any AHJ inspection reports to the Owner and the Consultant.

3.10 Schedules

- .1 The schedules at the end of this section lists piping system parameters where hot-tapping or line-stopping is required.
 - .1 Schedule 1 Piping System Information for Hot Tapping and Line-Stopping

Schedule 1 – Piping System Information for Hot Tapping and Line-Stopping				
Parameter	Units	Location 1	Location 2	Location 3
Temporary Measure	---	Line-Stopping	Hot-Tapping	
Pipe Service	---	Heating Water	Domestic Water	
Fluid	---	HVAC Water	Potable Water	
Pipe Material	---	Carbon Steel	Copper	
Nominal Pipe Thickness ^[1]	---	Schedule 40	ASTM B88 Type L	
Mains Pipe Size	NPS	2	4	
Design Pressure, kPa (psi)	kPa (psi)	1000 (150)	825 (125)	
Operating Pressure	kPa (psi)	700 (100)	700 (100)	
Operating Temperature	°C (°F)	82 (180)	10 (50)	
Approximate Maximum Fluid Velocity	m/s (ft/s)	2.5 (8.2)	1.5 (5)	
Valve Specification Section	---	23 05 23.13	22 05 23.13	

Notes:

[1] Original nominal pipe thickness – actual existing thickness to be determined by ultrasonic thickness gauge prior to start of work.

End of Section

COMMON HANGER AND SUPPORT REQUIREMENTS FOR PIPING 20 05 29

1 GENERAL

1.1 Scope

- .1 Provide hangers and supports for piping, including insulation protection devices.
- .2 The requirements of this specification section apply to all piping systems, except where required otherwise by specific piping specification sections including:
 - .1 20 05 16 Flex Connections
 - .2 21 05 01 Common Work Results for Fire Suppression
 - .3 22 60 13.70 Medical Gas Piping
 - .4 Applicable sections of Division 22 sections for plumbing and drainage piping,
- .3 Provide engineering services associated with the design, analysis, and selection of custom piping supports, including pipe riser supports.

1.2 Related Work

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
 - .1 20 05 16 Flex Connections,
 - .2 20 05 48 Vibration Isolation
 - .3 20 05 49 Seismic Restraints for Mechanical Services
 - .4 20 07 19 Piping Insulation

1.3 Definitions and Abbreviations

- .1 The following definitions apply to this section:
 - .1 **Ambient piping:** piping with a fluid temperature greater than 16°C (61°F) and up to and including 40°C (104°F).
 - .2 **Cold piping:** piping with a fluid temperature greater than 4°C (39°C) and up to and including 16°C (61°F).
 - .3 **Dual temperature piping:** piping which operates non-simultaneously as both cold piping and hot piping depending on the season.
 - .4 **Hot piping:** piping with a fluid temperature greater than 60°C (140°F).
 - .5 **Low temperature piping:** piping with a fluid temperature greater than 40°C (104°F) and up to and including 60°C (140°F)

1.4 Applicable Codes and Standards

- .1 Product and installation codes and standards:
 - .1 ANSI/MSS SP-58 Pipe Hangers and Supports – Materials, Design, Manufacture, Selection, Application, and Installation
 - .2 CAN/UL 203 Standard for Pipe Hanger Equipment for Fire Protection Service
- .2 Refer to each applicable piping specification section for supplemental requirements for pipe supports.

1.5 Analysis, Design, and Inspection Services

- .1 Where custom fabricated pipe and equipment supports are proposed to be used, provide the services of a professional engineer, licensed in the province or territory of the Work and who specializes in the design of piping and equipment supports (the "Specialty Engineer"), for the design of piping and equipment support systems and to provide inspection services of the completed installation.
- .2 Provide services of a Specialty Engineer for the design and selection of constant-load and variable-load hanger supports. Where a manufacturer of such equipment provides this design service, this is deemed to meet this requirement.
- .3 Specialty Engineer design services to include;
 - .1 provide the design of the piping support system, including anchors, guides, expansion joints, and shall include seismic restraints where applicable,
 - .2 analysis of dead loads, thermal expansion loads, wind load, static seismic loads (where applicable) and capacity of materials utilized for connections to equipment and structure.
 - .3 provide design drawings showing locations of supports, restraints and details of construction and attachment of supports and restraints,
 - .4 seismic design to conform to Specification section 20 05 49 where applicable.
- .4 Specialty Engineer inspection services to include:
 - .1 at periods during installation and at completion of the installation of the piping supports and anchor devices, the Specialty Engineer shall inspect the installation, identify and report deficiencies (if any) which are observed, and re-inspect the installation after deficiencies have been corrected,
 - .2 Specialty Engineer to submit periodic inspection reports and a final inspection report after all work is completed and deficiencies have been corrected, confirming the installation conforms to the design requirements. Prepare and submit any required declarations or similar document to this effect where required by local legislation. Include in the final report site photographs of the complete installation prior to covering with insulation, with specific photos at pipe anchors, guides, and expansion joints.
- .5 Provide shop drawings of custom supports, which shall be sealed by the Specialty Engineer.
- .6 Provide signed declarations for commitment for general review and final review letters of conformity as required by applicable legislation at the place of the Work.

1.6 Design Criteria

- .1 The support spacing and hanger rod size specified herein is based on supporting a single pipe directly from the structure in accordance with MSS SP-58. If multiple pipes are supported from trapeze hangers (or similar), or from common hanger rods supporting a tier of multiple piping, then;
 - .1 the total load on the support rods or similar elements shall not exceed published tension load rating data in accordance with Table 2 of MSS SP-58.
 - .2 design of custom trapeze hangers shall meet the design criteria as specified in Part 2 of this section.
- .2 Provide complete custom engineered design services in accordance with the requirements of MSS SP-58 for support of vertical piping for the following portions of the Work:
 - .1 where horizontal piping is supported on;
 - (a) trapeze hangers or supported on/suspended from horizontal structural elements, or
 - (b) pipe racks.
- .3 Where the mechanical system are required to have seismic restraints, this section is to be read in conjunction with the requirements of Specification section 20 05 49.

1.7 Submittals

- .1 Submit manufacturer product data sheets for hanger components, and include:
 - .1 load ratings,
 - .2 typical composite detail drawings for complete hanger assembly, including upper attachment, hanger rods, hanger rod swivels, pipe attachments, shields and saddles, and load ratings, for each pipe condition and size.
- .2 Submit support details for glass, fibre-reinforced plastic, and other plastic piping systems which are coordinated with the piping material manufacturer installation instructions.
- .3 Where variable spring supports or constant load supports are shown, provide completely engineered design and fabrication drawings, including any supplementary steel requirements, and loads transferred to the building structure.
- .4 Submit engineered design drawings for fabricated trapeze hangers and completely engineered support systems, including
 - .1 construction detail drawings for each loading condition,
 - .2 span deflection calculations,
 - .3 building attachment load calculations and type.
 - .4 shop drawings to be sealed by a professional engineer licensed in the project location jurisdiction.
- .5 Where custom designed supports are proposed, shop drawings are to be sealed by a professional engineer licensed in the place of the Work.

1.8 Quality Control

- .1 Where custom engineered supports are used, provide the services of a specialist professional engineer licensed in the location of the Work, to design the support systems and to conduct an inspection of the completed installation that it is in general conformance with the sealed shop drawing requirements, and submit an inspection report to the Owner and the Consultant.

2 PRODUCTS

2.1 General

- .1 Fabricate pipe hangers, supports, sway braces and associated components from stock or production parts, manufactured and fabricated in conformance with MSS SP-58, and the requirements of the piping code specified for each piping system.
- .2 Pipe hangers and supports for fire protection systems to be listed to CAN/UL 203, except where such listing requirement is excluded under applicable NFPA standards.
- .3 Select elements of pipe support systems to provide adequate factors of safety under loads applied by gravity, by temperature induced expansion and contraction, by internal pressure in mechanically jointed plain end pipe, and by fluid flow pressure thrust.
- .4 Where specified products define the applicable pipe size NPS range (notwithstanding that the product may be available for larger pipe sizes), the maximum specified pipe size is limited to not exceed the load rating of the specified product under maximum allowable pipe spans as defined in MSS SP-58 for insulated pipe filled with water.
- .5 Product finishes (unless otherwise specified for each product):
 - .1 outdoors: hot dipped galvanized,
 - .2 in mechanical service rooms, pipe tunnels and pipe trenches: zinc-plated or hot-dipped galvanized,
 - .3 within data server and switch equipment rooms: plain carbon or hot-dipped galvanized,

- .4 all other indoor locations: plain carbon steel or zinc-plated steel.
- .6 Select pipe support products from manufacturers standard product line.

Standard of Acceptance

- Anvil
- Unistrut
- Taylor
- Acrow Richmond
- Portable Pipe Hangers
- Hilti
- nVent Caddy
- Pipe Shields
- Buckaroos

2.2 Upper Attachments – Anchors for Existing Concrete

.1 General:

- .1 upper hanger attachment for anchoring into existing concrete decks, for piping or equipment supports,
- .2 designed to receive USS coarse thread hanger rods.

.2 Drop-in anchors:

- .1 zinc-plated carbon steel drop-in friction anchor design, with matched drill bit and setting tool,
- .2 not to be used for seismic restraints or hanger rods at pipe hangers having seismic restraint,
- .3 rated for uncracked concrete,
- .4 listed to CAN/UL 203 for fire protection piping, for pipe NPS ¾ through NPS 8,
- .5 capacity rating with 4:1 safety factor to ultimate load,
- .6 minimum load rating in tension based on connected rod size:

Rod Nominal Size	Tension Load kN (lbf)	Single Pipe Size Limit NPS
Ø3/8	2.82 (635)	2
Ø1/2	4.2 (945)	3
Ø5/8	8.34 (1875)	4
Ø3/4	11.1 (2500)	8

Standard of Acceptance

- Hilti - fig. HDI, HDI+, HDI-L+

.3 Wedge anchors:

- .1 anchor-end wedging action on concrete, and not relying on friction between side of bolt and concrete hole wall,
- .2 zinc-plated carbon steel wedge anchor design with load washer and nut,
- .3 wedge anchor capacity as specified herein to be rated for cracked concrete having not less than 20 MPa (2900 psi) strength.

- .4 rated for cracked and uncracked concrete,
- .5 listed for seismic tension and shear loads in accordance with ACI 355.2 and ICC-ES AC193.
- .6 listed to CAN/UL 203 for fire protection piping, for pipe NPS ¾ through NPS 8,
- .7 extra-long bolt length to allow attachment of hanger rod coupling with full thread engagement in the coupling, while providing required load engagement length,
- .8 standard rating: minimum load rating in tension based on connected rod size:

Rod Nominal Size	Tension Load kN (lbf)	Single Pipe Size Limit NPS
Ø3/8	4.85 (1090)	2
Ø1/2	7.52 (1690)	3
Ø5/8	12.1 (2715)	4
Ø3/4	15.5 (3495)	8

Standard of Acceptance

- Hilti - fig. Kwick Bolt series

- .9 high-capacity rating: minimum load rating in tension based on connected rod size:

Rod Nominal Size	Tension Load kN (lbf)
Ø3/8	14.0 (3150)
Ø1/2	20.8 (4675)
Ø5/8	29.1 (6535)
Ø3/4	40.6 (9135)
Ø7/8	53.4 (12,000)

Standard of Acceptance

- Hilti - fig. HSL-3 series

2.3 Upper Attachment – Mounting Plates

- .1 Surface mounting plates to underside of concrete decks:
 - .1 for installation post concrete pour with either concrete inserts or drilled anchors,
 - .2 surface mount carbon steel plate, with either clevis hanger with pin (for use with hanging rod-eye) or for attachment of hanger rod and load nut,
 - .3 mounting holes in four corners of plate, sized for fastening bolts to achieve rated capacity,
 - .4 minimum load rating in tension based on connected rod size:

Rod Nominal Size	Tension Load kN (lbf)	Single Pipe Size Limit NPS
Ø3/8	3.25 (730)	2

Rod Nominal Size	Tension Load kN (lbf)	Single Pipe Size Limit NPS
Ø1/2	6.0 (1350)	3
Ø5/8	9.6 (2160)	4
Ø3/4	14.4 (3230)	8
Ø7/8	19.9 (4480)	12
Ø1	26.2 (5900)	18
Ø1-1/4	42.3 (9500)	20
Ø1-1/2	61.4 (13,800)	30

Standard of Acceptance

- Anvil - fig. 49 clevis plate,
- Anvil - fig. 52 load nut,
- Taylor - fig. 166 clevis plate,
- Taylor - fig. 167 load nut

Upper Attachments – Steel Structure

- .1 Steel beam clamp (bottom flange), pipe size NPS 8 and smaller:
 - .1 hanger clamp attachment to beam or joist bottom flange, applying concentric loading to the beam/joist web,
 - .2 for hanger rod sizes Ø3/8 to Ø7/8 in.,
 - .3 malleable iron or carbon steel, symmetrically loading beam clamp to MSS SP-58, type 30,
 - .4 listed to CAN/UL 203 for fire protection piping,
 - .5 minimum load rating in tension: 6.1 kN (1365 lbf)
 - .6 with extension piece swivel attachment to receive hanger rod.

Standard of Acceptance

- Anvil - fig. 218 with fig. 157 extension swivel.
- Taylor - fig. 410 with fig. 411 extension swivel.

- .2 Steel beam clamp (bottom flange), pipe size NPS 2½ to 24:
 - .1 hanger clamp attachment to beam or joist bottom flange, applying concentric loading to the beam/joist web,
 - .2 for hanger rod sizes Ø5/8 to Ø1-1/2 in.,
 - .3 forged steel, symmetrically loading heavy duty beam clamp, to MSS SP-58, type 28 or 29.
 - .4 load rating based on standard hanger rod load capacities in accordance with MSS SP-58,
 - .5 with weldless eye nut.
 - Anvil - fig. 228
 - Taylor - fig. 450

Steel beam (top flange) - for conduit, piping NPS 6 and smaller, and ductwork:

- .1 hanger clamp attachment to the top flange of beam or joist, applying an eccentric loading to the beam/joist,
- .2 carbon steel, hook rod with locking jaw, fasteners and lock washers, to MSS SP-58, type 25,
- .3 for hanger rod sizes Ø3/8 to Ø3/4 in.,
- .4 minimum load rating in tension:

Rod Nominal Size	Tension Load kN (lbf)	Single Pipe Size Limit NPS
Ø3/8	3.2 (730)	2
Ø1/2 to Ø3/4	4.2 (940)	6

- .5 listed to CAN/UL 203 for fire protection piping (rod size Ø3/8 and Ø1/2 in.)

Standard of Acceptance

- ° Anvil - fig. 227

Steel joists (joist bottom chord) – for piping NPS 2 and smaller:

- .1 steel washer plates for installation of support rod within the interstice space of double-channel steel joists and open-web steel joints, installed on top and bottom surface of the joist and secured with load nut (top washer plate) and locking nut (bottom washer plate).
- .2 load rating based on standard hanger rod load capacities in accordance with MSS SP-58,
- .3 carbon steel washer plates with locking nuts,

Standard of Acceptance

- ° Anvil - fig. 60
- ° Taylor - fig. 80

2.5 Upper Attachments – Wall Brackets

- .1 Medium and heavy-duty wall mounting brackets:
 - .1 welded carbon steel plate or channel assembly, designed to allow at least 75 mm (3 in.) of horizontal adjustment of hanger rod position, to MSS SP-58, Types 32 and 33,
 - .2 carbon steel backplates for through bolting of concrete walls where required by supported load and wall material,
 - .3 for bolting into concrete wall, concrete block, or welding to building structure (where permitted by structural engineer),
 - .4 minimum load rating:
 - (a) medium duty: 6.7 kN (1500 lbs).
 - (b) heavy duty: 13.4 kN (3000 lbs).

Standard of Acceptance

- ° Anvil - fig. 195 and 199
- ° Taylor - fig. 801 and 802.

- .2 Light-duty wall mounting brackets:
 - .1 welded carbon steel plate or channel assembly, single point rod support, to MSS SP-58, Types 31,

- .2 with carbon steel backplates for through bolting of concrete walls where required by supported load,
- .3 FM approved,
- .4 for bolting into concrete wall, concrete block, or welding to building structure,
- .5 minimum load rating: 3.35 kN (750 lbs).

Standard of Acceptance

- Anvil - fig. 194

2.6 Upper Attachment - Swivels

.1 Clevis swivel:

- .1 to allow rotation movement of suspended clevis hangers,
- .2 forged steel clevis with hanger pin, threaded rod socket, to MSS SP-58 type 14,
- .3 tension load capacity not less than the connected rod load capacity,
- .4 threaded end connected to concrete insert, with clevis end connected to weldless eye nut or welded eye rod.

Standard of Acceptance

- Anvil - fig. 299
- Taylor - fig. 63

.2 Weldless eye nut swivel:

- .1 to allow rotation movement of suspended clevis hangers,
- .2 forged steel eye nut, threaded rod socket, to MSS SP-58 type 17,
- .3 tension load capacity not less than the connected rod load capacity.
- .4 for connection to top of rod hanger, suspended from a clevis.

Standard of Acceptance

- Anvil - fig. 290
- Taylor – fig. 64

2.7 Hanger Rod

.1 Continuous threaded rod:

- .1 carbon steel, USS course thread,
- .2 tension load ratings to meet or exceed MSS SP-58.

Standard of Acceptance

- Anvil - fig. 146
- Taylor – fig. 54

.2 Welded eye rod:

- .1 carbon steel, USS course thread,
- .2 tension load ratings to MSS SP-58,
- .3 tension load ratings to meet or exceed MSS SP-58 for hanger rod.

Standard of Acceptance

- Anvil - fig. 278
- Taylor - fig. 53

.3 Rod connectors:

- .1 carbon steel, USS course thread,
- .2 with mid-point site hole,
- .3 tension load ratings to meet or exceed MSS SP-58.

Standard of Acceptance

- Anvil - fig. 135i
- Taylor - fig. 62S

2.8 Horizontal Pipe Support - Clevis

.1 Clevis support:

- .1 applicable piping materials:
 - (a) carbon steel and stainless steel pipe, schedule 10 to 80,
 - (b) cast iron DWV piping,
- .2 carbon steel, adjustable clevis, with clevis bolt reinforcing tube, to MSS SP-58 Type 1,
- .3 adjustable hanger height while under load,
- .4 listed to CAN/UL 203 for fire protection piping,
- .5 applicable pipe size:
 - (a) steel pipe: NPS ½ to NPS 16
 - (b) ductile or cast iron drainage pipe: NPS 3 to 24

Standard of Acceptance

- Anvil - fig. 260
- Anvil - fig. 590 (for ductile or cast iron drainage pipe)
- Taylor – fig. 24
- Taylor – fig. 27AC (for ductile or cast iron pipe)

.2 Clevis support with extended yoke for where yoke is located inside of pipe insulation:

- .1 applicable piping materials:
 - (a) carbon steel and stainless steel pipe, schedule 10 to 80,
 - (b) cast iron DWV piping,
- .2 carbon steel, adjustable clevis, with clevis bolt reinforcing tube, to MSS SP-58 Type 1,
- .3 adjustable hanger height while under load,
- .4 yoke sized for outside dimension of pipe only, with extended yoke to clear pipe insulation,
- .5 applicable pipe size:
 - (a) steel pipe: NPS ¾ to NPS 12

Standard of Acceptance

- Anvil - fig. 300
- Taylor – fig. 24L

.3 Clevis support with integral non-metallic insulation saddle:

- .1 alternate to using standard clevis hanger specified above with separate high density insulation inserts or pipe insulation saddles,
- .2 applicable piping materials:
 - (a) insulated carbon steel and stainless steel pipe, schedule 10 to 80,
 - (b) insulated cast iron drainage piping.
- .3 carbon steel, adjustable clevis, with clevis bolt reinforcing tube, to MSS SP-58 Type 1,
- .4 adjustable hanger height while under load,
- .5 listed to CAN/UL 203 for fire protection piping,
- .6 with glass-reinforced polypropylene saddle, sized to allow up to 50 mm (2 in.) insulation thickness,
- .7 yoke and clevis sized for outside dimension of pipe and insulation,
- .8 applicable pipe size:
 - (a) steel pipe: NPS ½ to NPS 8,
 - (b) copper tube: NPS ½ to NPS 8.
- .9 piping system design temperature limits: 4.4 to 100°C (40 to 212°F).

Standard of Acceptance

- ° Anvil - fig. 260 ISS

.4 Clevis support for copper pipe and tube:

- .1 for copper tube, NPS ½ to 4,
- .2 zinc-plated carbon steel yoke and clevis, adjustable clevis to MSS SP-58, type 1, copper plated or felt lined finish,
- .3 applicable tube size: NPS ½ to NPS 4,
- .4 sized for outside dimension of pipe/tube, or outside diameter of pipe and insulation as applicable.

Standard of Acceptance

- ° Anvil - fig. CT-65 or 260F
- ° Taylor – fig. 52

2.9 Horizontal Pipe Support – Clevis for Fire Protection

- .1 Pipe size range: NPS 2 to NPS 8.
- .2 Light-duty, side-opening clevis support:
 - .1 for fire protection service only,
 - .2 pipe size range: NPS 2 to 8,
 - .3 galvanized carbon steel, adjustable clevis with fixed yoke,
 - .4 listed to ULC/ORD-C203 or UL 203 for fire protection piping,
 - .5 sized for outside dimension of pipe (and insulation if applicable).
 - .6 sized for outside dimension of pipe (and insulation where applicable),
 - .7 nominal pipe size: NPS 2 to NPS 8.

Standard of Acceptance

- Hilti - fig. MH-SLC Speed Lock

2.10 Horizontal Pipe Support – Swivel Ring Hanger

- .1 For non-insulated drain-waste-vent piping, gas piping, and chemical piping.
- .2 Pipe swivel ring hangers:
 - .1 carbon steel ring strap, zinc plated, adjustable knurled swivel nut, to MSS SP-58 Type 10,
 - .2 copper plated or epoxy-coated for use on copper tubing,
 - .3 listed to ULC/ORD-C203 or UL 203 for fire protection piping,
 - .4 nominal pipe size: NPS ½ to NPS 4.

Standard of Acceptance

- Anvil - fig. 69, CT-69
- Taylor – fig. 41, 43

2.11 Pipe Straps

- .1 General:
 - .1 for non-insulated drain-waste-vent piping, gas piping, and chemical piping.
 - .2 pipe size: NPS 4 and smaller.
- .2 Zinc plated carbon steel U-loop straps for mechanical fastening to structure.

Standard of Acceptance

- Anvil - fig. 262

- .3 Hot-dipped galvanized carbon steel U-loop with clip-in or bolt-on attachment to modular channel supports.

Standard of Acceptance

- Unistrut

2.12 Horizontal Pipe Support – Pipe Roller (Type 41, 43, 44)

- .1 Suspended support pipe roller – trapeze hanger style:
 - .1 adjustable height, pipe roller support for overhead support, to MSS SP-58 type 41,
 - .2 dual-hanger rod trapeze style,
 - .3 pipe size range: NPS ½ to NPS 16, with or without insulation.

Standard of Acceptance

- Anvil - fig. 171
- Taylor – fig. 95

- .2 Suspended support pipe roller – clevis hanger style:
 - .1 adjustable height, pipe roller support for overhead support, to MSS SP-58 type 43,
 - .2 single rod clevis style,
 - .3 pipe size range: NPS ½ to NPS 8, with or without insulation.

Standard of Acceptance

- Anvil - fig. 181
- Taylor – fig. 93

.3 Bottom support pipe roller:

- .1 adjustable height, pipe roller with bottom support rods, to MSS SP-58 type 41,
- .2 for bottom support of piping,
- .3 with mounting rods and upper/lower retention nuts at both ends,
- .4 pipe size range: NPS ½ to NPS 16, with or without insulation.

Standard of Acceptance

- Anvil - fig. 177
- Taylor – fig. 95S

.4 Bottom support pipe roller with stand:

- .1 pipe roller with cast iron support stand, to MSS SP-58 type 44,
- .2 for bottom support of piping,
- .3 fixed height and adjustable height variants,
- .4 base drilled for fastening to supporting element,
- .5 pipe size range: NPS ½ to NPS 18, with or without insulation.

Standard of Acceptance

- Anvil - fig. 271 (fixed), fig. 274 (adjustable)
- Taylor – fig. 279S (fixed), fig. 280S (adjustable)

2.13 Horizontal Pipe Support – Slides

.1 Structural slide bases – welded attachment:

- .1 Tee or H shaped pipe support for welding to pipe, to allow axial and lateral movements,
- .2 carbon steel, structural shape or fabricated, to ANSI/MSS SP-58 Type 35,
- .3 operating temperature range: -28 to 200°C (-20 to 400°F),
- .4 pipe insulation thickness clearance: up to 75 mm (3 in.),
- .5 pipe size and load rating in accordance with the following table:

Slide Base Type	Vertical Support Load Rating kN (lbf)	Lateral Restraint Load Rating kN (lbf)	Uplift Restraint Load Rating kN (lbf)	Pipe Size Range NPS	
				Water	Steam, Gas
T	35.0 (8000)	9.0 (2000)	3.6 (800)	½ to 18	½ to 30
H	53.0 (12,000)	13.0 (3000)	5.3 (1200)	6 to 8	½ to 30
	53.0 (12,000)	18.8 (4000)	7.1 (1600)	10 to 20	
	107 (24,000)	26.0 (6000)	10.7 (2400)	24 to 30	

Standard of Acceptance

- Anvil - figs. 257A, 436A, 439A
- Taylor – figs. 257A

.2 Structural slide base assemblies with PTFE pads – welded attachment:

- .1 for piping with design temperatures greater than 121°C (250°F), including steam at pressures greater than 103 kPa (15 psig),
 - (a) may also be used for lower temperatures,
- .2 as specified above for slide bases and as follows,
- .3 PTFE bonded to underside of slide,
- .4 matching lower steel plates with bonded PTFE element (for fastening to structural support beam),

Standard of Acceptance

- Anvil - figs. 257, 436, 439
- Taylor – figs. 257

.3 Restraint variants for slides:

- .1 lug restraints to limit lateral movement due to thermal expansion of between 6 mm to 25 mm (1/4 to 1 in.),
- .2 where seismic restraint is required, lug restraints designed to limit lateral and vertical uplift movement to not more than 6 mm (1/4 in.),
 - (a) exception: if lateral movement of greater than 6 mm (1/4 in.) is shown, then the seismic design load is to be two (2) times the seismic load as shown in Specification section 20 05 49.

.4 Clamp for T and H slides supporting cold piping:

- .1 galvanized steel clamp for insulated cold piping, sized for outside dimension of insulated pipe,
- .2 rolled from structural plate steel with bolting flanges,
- .3 continuous single clamp for length of slide, or two (2) individual clamps at each end of the slide,
- .4 bottom half of clamp welded to T or H slides,
- .5 top half of clamp mechanically fastened to bottom half.

Standard of Acceptance

- Anvil - fig. 212 (2 clamp) 432 (continuous clamp)

2.14 Horizontal Pipe Support – Trapeze

.1 Manufactured trapeze support:

- .1 load ratings as per manufacturers data sheets,
- .2 carbon steel, double-C channel (strong-backs), HSS shape and equal-leg angles.

Standard of Acceptance

- Anvil - fig. 45, 46, and 50
- Taylor – fig. 170

.2 Fabricated trapeze support:

- .1 custom designed trapeze hangers of either hollow structural sections, double C channels (strongbacks), single C channel or unequal lengths angle channels, to support one or more pipes, conduits or ducts,
- .2 design of custom trapeze supports to conform to the requirements of MSS SP-58,
- .3 designed and sealed by a professional engineer licensed in the jurisdiction of the work.
- .4 design criteria:
 - (a) static design load: deadweight of supported services plus 1.5 kN (250 lbf) point load at the mid-span,
 - (b) dynamic loads: include for seismic loads where system is subject to seismic restraint, and for wind and snow loads where located outdoors, superimposed on static design load,
 - (c) maximum trapeze deflection at any point: 1/250 (0.4%) of trapeze span,
 - (d) design load for carbon steel materials: not to exceed 28% of minimum tensile strength nor exceed 50% of minimum yield strength in tension/compression and bending,
 - (e) design load for stainless steel and low alloy steel materials: not to exceed 20% of minimum tensile strength and 45% of minimum yield strength in tension/compression and bending.
- .5 for concurrent tension/compression loads and bending loads, the sum of the ratio of the stresses to allowable stress shall not exceed 1.0.

$$\frac{\text{Stress in Tension or Compression}}{\text{Allowable Tension or Compression Stress}} + \frac{\text{Stress in Bending}}{\text{Allowable Bending Stress}} \leq 1.0$$

- .3 Hanger rods:
 - .1 minimum of two support rods per trapeze,
 - .2 rod size selected not to exceed 80% of the allowable maximum rod tensile load rating in accordance with MSS SP-58,
- .4 Pipe restraint:
 - .1 restrain pipes from lateral movement with:
 - (a) bolt-on angle brackets or pipe U-bolts for manufactured hangers, or
 - (b) welded-on angles for fabricated hangers,
 - .2 restraints to permit axial linear movement and axial-rotation, except where otherwise shown to be an anchor.

2.15 Horizontal Pipe Support – Drainage MJ

- .1 For support of horizontal cast iron drainage piping, as an alternative to clevis hangers.
- .2 Designed to support each end of the pipe on both sides of a drainage MJ joint, and at intermediate supports, elbows and tees.
- .3 Carbon steel, plain finish.
- .4 Pipe size: NPS 2 to NPS 6

Standard of Acceptance

- Anvil - fig. 250
- Taylor – fig. 25

2.16 Vertical Pipe Stanchions

- .1 Pipe support stanchion, with welded attachment:

- .1 fixed height, or telescoping two-piece design with height adjustment, field-welded to pipe elbow or horizontal pipe,
- .2 carbon steel, structural cylinder shape,
- .3 designed for static loads of pipe and contents, as well as dynamic loads and anchor loads as shown,
- .4 nominal pipe size: NPS 2 to NPS 18.

Standard of Acceptance

- Anvil - fig. 62

2.17 Vertical Pipe Riser Clamps

- .1 Steel pipe, cast iron pipe:
 - .1 carbon steel clamps for carbon steel piping and cast iron piping,
 - .2 stainless steel clamps for stainless steel piping,
 - .3 listed to ULC/ORD-C203 or UL 203 for fire protection piping,
 - .4 supplied with field-welded pipe support lugs of same material as supported steel pipe (not including cast iron pipe).
 - .5 floor supported pipe riser clamps, to ANSI/MSS SP-58, type 8,

Standard of Acceptance

- Anvil - fig. 261
- Taylor – fig. 82

- .6 suspended pipe riser clamps, 4 or 6 bolt patterns, to ANSI/MSS SP-58, type 42,

Standard of Acceptance

- Anvil - fig. 40, 40SS
- Taylor – fig. 82HCopper pipe and tube:

- .7 floor supported pipe riser clamps, carbon steel with copper plated finish, to ANSI/MSS SP-58, type 8,

Standard of Acceptance

- Anvil - fig. CT-121
- Taylor – fig. 85

2.18 Cast Iron Pipe Joint Restraint

- .1 Joint restraint rodding assembly for cast iron and asbestos cement drain waste and vent pipe, for each branch, tee, wye and clean-out fittings on drainage piping NPS 5 and over.
- .2 Clamp and rod joint restraint:
 - .1 carbon steel pipe clamps with four bolt fasteners and rod washers, plain finish, to MSS SP-58, Type 8,
 - .2 carbon steel threaded rods and load nuts,
 - .3 two pipe clamps and two restraint rods required for each joint.

Standard of Acceptance

- Taylor – fig. 35

2.19 Insulation Shields

.1 Insulation shields:

- .1 galvanized steel protection shield, thickness and length as applicable to pipe size, to MSS SP-58 type 40
- .2 designed to meet MSS SP-58 maximum support spans with insulation inserts having a compressive strength of 620 kPa (90 psi).
- .3 pipe size: NPS ½ to 24,
- .4 insulation thickness: 12 mm to 50 mm (1/2 in. to 2 in.).
- .5 gauge: minimum 18 ga.
- .6 sleeve width: minimum 180 degree arc of insulation exterior surface
- .7 minimum sleeve length:
 - (a) pipe NPS ½ to 4: 300 mm (12 in.)
 - (b) pipe NPS 6: 450 mm (18 in.)
 - (c) pipe NPS 8 to 24: 600 mm (24 in.)

Standard of Acceptance

- Anvil - fig. 167 (up to NPS 24)
 - Anvil - fig. 168 (up to NPS 8)
 - Taylor – fig. 69H
- .8 sleeve length exemption: sleeve lengths may be reduced where shield is supplied as an integrated part of a high density insulation insert system. – refer to Specification section 20 07 19.
- ### **.2 Heavy-duty insulation shield:**
- .1 for piping NPS 18 and larger installed on roller hangers and trapeze hangers,
 - .2 insulation shield as specified above plus a heavy duty support plate as follows,
 - .3 support plate fabrication: 6 mm (1/4 in.) thick ASTM A36 galvanized steel rolled plate, inside diameter to fit outer radius of insulation shield,
 - .4 size:
 - (a) width: minimum 120 degrees arc of mating insulation shield,
 - (b) length: not more than 100 mm (4 in.) shorter than the primary shield.
 - .5 Support plate tack welded to the insulation shield.

2.20 Insulation Pipe Saddles

- .1 Carbon steel or stainless steel (to match pipe material) saddle welded to pipe with insulation inserted between saddle and pipe, to MSS SP-58 type 39.
- .2 For pipe sizes NPS ¾ to 36.
- .3 Insulation thickness range: 25 to 140 mm (1 to 5.5 in.)

Standard of Acceptance

- Anvil - fig. 160 to 166
- Taylor – fig. 70 to 77

3 EXECUTION

3.1 General

- .1 Where the specific requirements for pipe supports are specified in other sections of Division 20 to 23, the requirements of those sections take precedence over the requirements of this specification section.

3.2 Coordination with Concrete Work

- .1 Supply, deliver and install concrete inserts in ample time to be built into the work of Division 03.
- .2 Correctly position and set concrete inserts onto concrete formwork for pipes and equipment hangers. Secure inserts firmly to formwork before concrete is poured.
- .3 Do not use explosive drive pins in any section of the Work without obtaining prior approval from the Consultant.

3.3 Support and Hanger Installation – General Requirements

- .1 Support piping directly on or from structural building elements. Do not support pipe directly from other services. Multiple piping services may be supported on a common trapeze support.
- .2 Provide all miscellaneous materials including nuts, washers, and backing plates to make a complete installation.
- .3 Where wall brackets are used, select brackets and size mounting bolts and backing plates to suit the supported load, allowing for a safety factor by not loading the bracket more than 80% of its published load rating.
- .4 Do not support piping or tubing in direct contact with hangers or supports of dissimilar metallic material. Select hangers to include an electrical insulating material between the hanger and the pipe, or provide electrical insulating material.
- .5 Coordinate location of pipe supports with pipe flexible connectors, pipe guides and pipe anchors provided under specification section 20 05 16.
- .6 In steel framed construction, support piping from structural members. Where structural members are not suitably located for upper hanger attachment locations, and where inserts of adequate capacity cannot be installed in concrete slabs, provide supplementary steel framing members;
 - .1 fabricate supplementary steel from standard HSS sections, single EL section, double C “strongback” sections, or pipe lengths,
 - .2 size supporting steel to limit horizontal span deflection to 1/250 (0.4%) between connecting points to the structure,
 - .3 mechanically fasten supplementary steel to structural steel to prevent axial and transverse displacement, and rotation.
- .7 It is permissible to offset hangers and displace the hanging rod so that in the final operating position, the hanging rods are within 4° of vertical.
- .8 Provide a pipe support within 300 mm (12 in.) of;
 - .1 an elbow or tee,
 - .2 a concentrated load, including but not limited to valves, strainers and flanges,
 - .3 a connection to equipment.
- .9 Where hanger rods are used, provide load nuts on top and load nuts on the underside of attachment to the pipe support, including clevis hangers, roll supports, roll yoke hangers, and trapeze hangers.

3.4 Horizontal Pipe Support Spacing and Hanger Rod Size

- .1 Provide horizontal pipe supports at the spacing as detailed in the Schedule "A" included at the end of this Specification section, unless specified otherwise in other sections of Division 20 to 23.
 - .1 Schedule "A" includes alternate hanger rod size and support spans for reduced rod sizes.
- .2 Use threaded rod of the size based on pipe type and horizontal pipe hanger spacing as stated in the Schedule "A" for single rod hangers. Where the pipe hanger type requires two rods, the rod size may be reduced by one trade size but shall not be less than Ø3/8 in.
- .3 For piping using flexible roll-groove joints, there shall be not less than one hanger between pairs of joints.
- .4 Support plastic and other special piping, including anchors and guides, in accordance with the pipe manufacturer's requirements.

3.5 Horizontal Pipe Hanger and Support Selection

- .1 Select horizontal pipe hanger and support type based on pipe size and fluid service temperature in accordance with Schedules "B(1)" and "B(2)" at the end of this section.
- .2 For fire protection piping;
 - .1 use clevis hangers for all pipe sizes,
 - .2 swivel ring pipe hangers may be used for fire protection piping NPS 4 and smaller.
- .3 Swivel ring pipe hangers may only be used for;
 - .1 drain waste and vent (DWV) piping and tubing, NPS 4 and smaller,
 - .2 medical gas piping and laboratory gas piping, NPS 4 and smaller,
 - .3 compressed air piping and tubing located downstream of a refrigerated dryer, NPS 2 and smaller,
 - .4 chemical treatment piping NPS 2 and smaller.
- .4 For cast iron drainage and vent piping;
 - .1 use clevis hangers for suspended supports,
 - .2 drainage MJ type hangers may be used on hub-less cast iron piping,
 - .3 use roller or slide type supports for bottom supported piping. For slide supports, use a variant incorporating pipe band clamps in lieu of welded attachment.
- .5 For other piping, select pipe support types in accordance with Schedule B at the end of this section.
- .6 The use of a half-section of a suspended pipe clamp to support a horizontal pipe using two threaded rods is prohibited unless the manufacturer has written installation instructions permitting such use. The use of a pipe riser clamp for this purpose is prohibited.

3.6 Clevis Hangers

- .1 Where clevis hangers are used for cold piping, select clevis to fit the outside dimension of pipe and associated insulation.
- .2 Where clevis hangers are used for heating piping;
 - .1 select clevis to fit the pipe diameter only (clevis located inside of insulation) for small diameter piping in accordance with Schedule "C" at the end of this section,
 - .2 for larger diameter piping, select clevis to fit the outside dimensions of pipe and insulation – refer to Schedule "C" at the end of this section,

- .3 where the distance from the building support element to the clevis pin is less than the value shown in the standard details at the end of this section, use an alternative method of support;
 - (a) exception: where the pipe is installed tight to the structure, the exposed length between the structural attachment and the top of the clevis shall not exceed 25 mm (1 in.).
- .3 Where clevis hangers are used for stainless steel pipe or tube and for copper tube;
 - .1 use copper or epoxy finished carbon steel clevis hangers for copper pipe/tube,
 - .2 use stainless steel or alloyed steel clevis hangers (for stainless steel pipe/tube), or
 - .3 use a standard clevis hanger with integral non-metallic insulation saddles, and select hanger size for outside of the pipe and insulation.
- .4 Adjust clevis hangers to provide the required drainage slope and direction for each pipe.
- .5 Where the project requires seismic bracing of piping systems, add a Schedule 40 pipe over the clevis bolt, sized to provide at least 6 mm (1/4 in.) inside diameter clearance to the clevis bolt. This applies only where a transverse or longitudinal brace is attached to the clevis hanger.

3.7 Roll Hangers and Supports

- .1 For roll hangers, provide load and lock nuts to allow final adjustment of roll hanger to allow pipe drainage.
- .2 For roll supports supported above the structure element, the length of exposed threaded pipe between the roll support and the structural element shall not exceed 10 times the outside diameter of the rod.

3.8 Trapeze Hangers

- .1 Provide U-bolts or fabricated angles to restrict lateral pipe movement, while allowing pipe thermal axial motion and rotation;
 - .1 fasten U-bolts or angles to the trapeze hanger with top and bottom nuts,
 - .2 fabricated retention angles to extend vertically at least one-quarter the outside pipe/insulation diameter, and mechanically fasten to the trapeze,
 - .3 where seismic restraint is required, only use U-bolts.
- .2 Adjust trapeze hangers to provide the required drainage slope and direction for each pipe. If the trapeze serves multiple pipes having different drainage slopes or directions, provide shims under each pipe as necessary to provide required slope. Mechanically fasten or tack-weld the shim plates to the trapeze.

3.9 Slide Supports

- .1 For hot piping, weld the T or H slide directly to the pipe.
- .2 For cold piping, weld the T or H slide to the bottom half of a carbon steel clamp assembly.
- .3 Use slides with integral lateral movement limit lugs at pipe supports required to function as a guide. Movement clearance to be between 6 mm and 25 mm (1/4 to 1 in.).
- .4 Where seismic restraint is required, use slides with integral lateral and vertical-up movement limit lugs so that the maximum allowable movement does not exceed 6 mm (1/4 in.).
- .5 For fluid service temperatures of 121°C (250°F) and less, apply grease with a service temperature of not less than 200°C (392°F) over the entire bottom of the T or H slide.
- .6 For fluid service temperatures greater than 121°C (250°F) use a PTFE slide pad bonded to the underside of the slide and a matching PTFE slide pad bonded to the top of the structural steel support.

3.10 Vertical Pipe Supports

- .1 Pipe riser clamps:

- .1 provide pipe riser clamps for non-insulated pipes NPS 4 and smaller at every second floor level for vertical pipe risers passing through two or more floors, unless other vertical pipe support types are shown,
 - .2 for steel pipe, provide support lugs welded to steel piping so that pipe lugs bear on the top-surface of the riser clamp,
 - .3 for copper tube and pipe, arrange vertical piping so that a pipe joint bears on the top-surface of the riser clamp.
- .2 Fabricated pipe riser supports:
- .1 support piping NPS 6 and larger, using fabricated riser support brackets complete with reinforcing gusset plates welded or clamped to piping, designed not to exceed the maximum allowable local pipe stress at a load of not less than 200% of the supported load of:
 - (a) for the lowest support point of the riser, the supported pipe plus insulation weight for the lowest support interval plus the total water weight of the entire riser.
 - (b) except at the lowest support point of the riser, the pipe plus insulation weight for each support interval (except at the bottom of the riser).
- .3 Support vertical cold piping and hot piping for riser heights that are 25 m (82 ft) or less in height as follows:
- .1 provide spring vibration isolators in accordance with specification section 20 05 48, attached to pipe riser supports at intervals of every 2nd storey or 10 m (32 ft), whichever is less,
 - .2 provide a pipe anchor at the base of the riser or the mid-height of the riser.
- .4 Design riser anchors to support the deadweight of the riser pipe, fluid contents and insulation. Where seismic restraint is required, the anchors may also be designed to resist the seismic horizontal and vertical loads.
- .5 Where custom engineering riser supports are required, they are to be designed to meet the following criteria:
- .1 the maximum vertical movement of a horizontal branch pipe is not to exceed 20 mm (0.75 in) from its installation temperature to its in-service temperature,
 - .2 the maximum vertical movement of the horizontal mains pipe at the base or top of the riser is not to exceed 40 mm (1.5 in.) from its installation temperature to its in-service temperature, provided that the horizontal piping adjacent to the riser are also supported on variable spring supports for the first three horizontal support points.

3.11 Pipe Saddles and Shields

- .1 Provide pipe saddles and shields for insulated piping in accordance with Schedule "C" at the end of this section.
- .2 Provide pipe shields for uninsulated glass and plastic piping NPS 1-1/2 and larger.
- .3 Where piping is insulated and requires pipe shields, install the shields between pipe insulation and pipe support. Provide high-density insulation insert between pipe and insulation shields of the designation type as shown in Schedule "C" and as specified in accordance with specification section 20 07 19.
- .4 Where piping is not insulated and requires a pipe shield, install the shields between the pipe and the pipe support.
- .5 Where clevis hangers with integral insulation saddles are used, apply insulation sealant to the polypropylene saddle in accordance with the pipe hanger manufacturer's instructions;

- .1 for hot piping, coordinate with the pipe insulation contractor to apply sealant coating to the integral saddle at the time pipe insulation is installed,
- .2 for cold piping, seal the saddle's pipe contact surfaces with vapour-barrier sealant before the piping is installed. Finish sealing the remainder of the saddles' exposed faces when pipe insulation is installed.

3.12 Vibration Isolation Supports

- .1 Provide vibration isolators at pipe supports for horizontal piping in accordance with specification section 23 05 48.
- .2 Provide vibration isolators at vertical pipe (riser) supports in accordance with specification section 20 05 48.
- .3 When installed with clevis hangers, install the vibration isolators below the top surface of the clevis; do not attach the vibration isolator to the structural element.

3.13 Set-up After Installation

- .1 Adjust hangers to equalize hanger loads, to support piping true to line and grade, and to minimize loads transferred through connections to equipment and outlets.

3.14 Schedules

- .1 The following appended schedules form part of this Specification section.
 - .1 Schedule A1(a) Horizontal Pipe Support Loads and Support Spans – Schedule 20 to 80 Pipe
 - .2 Schedule A1(b) Alternate Hanging Rod Sizes and Support Spans for Schedule 20 to 80 Pipe
 - .3 Schedule A2(a) Horizontal Pipe Support Loads and Spans – Schedule 10/10S Stainless Steel Pipe
 - .4 Schedule A2(b) Alternate Hanging Rod Sizes and Support Spans for Schedule 10/10S Stainless-steel Pipe
 - .5 Schedule A3 Horizontal Pipe Support Loads and Spans – Copper and Stainless Steel Tube
 - .6 Schedule B Pipe Support Type Selection Requirements
 - .7 Schedule C Insulation Protection Requirements

3.15 Standard Details

- .1 The following standard details are appended to the end of this Specification section.
 - .1 20 05 29-010 Cold Piping and Dual-Temperature Piping – Clevis Hanger Detail
 - .2 20 05 29-011 Cold Piping and Dual-Temperature Piping – Roll Hanger Detail
 - .3 20 05 29-012 Cold Piping and Dual-Temperature Piping – Trapeze Hanger Detail
 - .4 20 05 29-013 Cold Piping and Dual-Temperature Piping – Slide Support Detail
 - .5 20 05 29-020 Hot Piping – Clevis Hanger Detail
 - .6 20 05 29-021 Hot Piping ≤ 100°C, Small Size Piping – Clevis Hanger Details
 - .7 20 05 29-022 Hot Piping – Roll and Trapeze Hanger Detail
 - .8 20 05 29-023 Hot Piping – Slide Support Detail
 - .9 20 05 29-030 Slide Supports – Guides and Seismic Restraint

Schedule A1(a)

**Horizontal Pipe Support Spacing
for
Carbon Steel, Galvanized Steel, Stainless-steel Piping
Schedule 20 to 80 Inclusive**

Notes for Schedule A1(a) and A1(b):

[1] Hanging rod size for single support. Where two supports are used, the rod size may be reduced by one size but not less than Ø3/8 in..

[2] Subject to load capacity of hanger components other than the hanging rod.

[3] Where piping is hydrostatically tested with water, temporary pipe supports are required to limit pipe span to the "liquids" values.

[4] For trapeze hangers only.

Pipe Size NPS	Rod Diameter Single Support [Note 1] Inches	Maximum Support Spacing, Liquids [Note 2] m (ft)	Maximum Support Spacing Steam, Gases [Note 2, 3] m (ft)
½	Ø 3/8	1.8 (6)	1.8 (6)
¾ to 1¼	Ø 3/8	2.1 (7)	2.1 (7)
1½	Ø 3/8	2.7 (9)	2.7 (9)
2	Ø 3/8	3.0 (10)	4.0 (13)
2½	Ø ½	3.3 (11)	4.3 (14)
3	Ø ½	3.3 (12)	4.6 (15)
4	Ø 5/8	4.2 (14)	5.2 (17)
6	Ø ¾	5.1 (17)	6.4 (21)
8	Ø ¾	5.7 (19)	7.3 (24)
10	Ø 7/8	6.7 (22)	7.9 (26)
12	Ø 7/8	7.0 (23)	9.1 (30)
14	Ø 1	7.5 (25)	9.8 (32)
16	Ø 1	8.0 (27)	10.7 (35)
18	Ø 1 [Note 4]	8.4 (28)	11.3 (37)
20	Ø 1-1/4 [Note 4]	9.0 (30)	11.9 (39.0)
24	Ø 1-1/2 [Note 4]	9.6 (32)	12.8 (42.0)
30	Ø 1-1/2 [Note 4]	10.0 (33)	13.4 (44.0)

Schedule A1(b)

**Alternate Rod Sizes and Pipe Spans
For Pipe Sizes NPS 10 to 16
Carbon Steel, Galvanized Steel, Stainless-steel Piping
Schedule 20 to 80 Inclusive**

The following table provides alternate combinations of rod hanger size and associated support spacing for select pipe sizes.

Pipe Size NPS	Rod Diameter Single Support [Note 1] Inches	Maximum Support Spacing, Liquids [Note 2] m (ft)	Maximum Support Spacing Steam, Gases [Note 2, 3] m (ft)
10	Ø 3/4	4.0 (13)	6.7 (22)
12	Ø 3/4	3.0 (10)	5.8 (19)
14	Ø 3/4	2.7 (9)	5.2 (17)
	Ø 7/8	5.8 (19)	9.1 (30)
16	Ø 3/4	2.1 (7)	4.6 (15)
	Ø 7/8	4.9 (16)	7.9 (26)

Schedule A2(a)
Horizontal Pipe Support Spacing
For
Stainless-steel Pipe
Schedule 10/10S

Notes for Schedule A2(a) and A2(b):

[1] Rod size for single support. Where two supports are used, the rod size may be reduced by one size but not less than Ø3/8 in..

[2] Subject to load capacity of hanger components other than the hanging rod.

[3] Where piping is hydrostatically tested with water, temporary pipe supports are required to limit pipe span to the "liquids" values.

[4] For trapeze hangers only.

Pipe Size NPS	Rod Diameter Single Support [Note 1]	Maximum Spacing, Liquids [Note 2] m (ft)	Maximum Spacing Steam, Gases [Note 2, 3] m (ft)
½	Ø 3/8	1.83 (6)	2.45 (8)
¾	Ø 3/8	2.1 (7)	2.75 (9)
1	Ø 3/8	2.45 (8)	2.75 (9)
1¼	Ø 3/8	2.75 (9)	2.75(9)
1½	Ø 3/8	2.75 (9)	3.65 (12)
2	Ø 3/8	3.10 (10)	4.0 (13)
2½	Ø 1/2	3.35 (11)	4.3 (14)
3	Ø 1/2	3.65 (12)	4.6 (15)
4	Ø 5/8	4.25 (14)	5.2 (17)
6	Ø 3/4	4.9 (16)	6.4 (21)
8	Ø 3/4	5.5 (18)	7.3 (24)
10	Ø 7/8	5.8 (19)	7.9 (26)
12	Ø 7/8	6.1 (20)	9.2 (30)
14	Ø 1	7.0 (23)	9.7 (32)
16	Ø 1	7.3 (24)	10.7 (35)
18	Ø 1 [Note 4]	7.3 (24)	11.3 (37)
20	Ø 1-1/4 [Note 4]	7.6 (25)	11.9 (39)
24	Ø 1-1/2 [Note 4]	7.3 (25)	11.9 (42)
30	Ø 1-1/2 [Note 4]	8.5 (28)	12.8 (44)

Schedule A2(b)

**Alternate Rod Sizes and Pipe Spans
For Pips Sizes NPS 10 to 16
Stainless-steel Pipe
Schedule 10/10S**

The following table provides alternate combinations of rod hanger size and associated support spacing for select pipe sizes.

Pipe Size NPS	Rod Diameter Single Support [Note 1] Inches	Maximum Spacing, Liquids [Note 2] m (ft)	Maximum Spacing Steam, Gases [Note 2, 3] m (ft)
10	Ø 3/4	4.9 (16)	4.9 (16)
12	Ø 3/4	3.7 (12)	3.7 (12)
14	Ø 3/4	2.7 (9)	2.7 (9)
	Ø 7/8	5.2 (17)	6.1 (20)
16	Ø 3/4	2.4 (8)	2.4 (8)
	Ø 7/8	4.3 (14)	5.2 (17)

Schedule A3

**Horizontal Pipe Support Spacing
For
Copper Tube and Stainless-steel Tube**

Notes for Schedule A3:

[1] Rod size for single support. Where two supports are used, the rod size may be reduced by one size but not less than M10 (3/8 in.).

[2] Subject to load capacity of hanger components other than the hanging rod.

Pipe Size NPS	Rod Diameter Single Support [Note 1] Inches	Maximum Spacing, Liquids and Gases [Note 2] m (ft)
½	Ø 3/8	1.5 m (5 ft)
¾ to 1¼	Ø 3/8	1.8 m (6 ft)
1½	Ø 3/8	2.4 m (8 ft)
2	Ø 3/8	2.4 m (8 ft)
2½	Ø 1/2	3.0 m (10 ft)
3	Ø 1/2	3.0 m (10 ft)
4	Ø 5/8	3.0 m (10 ft)
6	Ø ¾	4.3 (14)
8	Ø ¾	4.9 (16)

Schedule B

Pipe Support Type Selection Requirements

The following tables B(1) and B(2) lists hanger types which are to be used based on pipe size and service temperature. Refer to Schedule C for additional requirements concerning insulation protection.

Pipe Support Type Legend

CL	Clevis hanger
CL(EY)	Clevis hanger with extended yoke for installation under pipe insulation
CL(IS)	Clevis hanger with integral insulation saddle
CL(LD)	Clevis hanger, light duty
SW	Swivel hanger
RS	Roll support
RH	Roll hanger with clevis
RB	Roll support with integral base
TS	T slide
HS	H slide
TZ	Trapeze

Application Legend

A	Acceptable
---	Not permitted

**Table B(1):
Pipe Support Type Selection Requirements
For Fluid Service Temperatures up to 100°C (212°F) or Less**

Pipe/Tube Size NPS	CL	CL (EY)	CL (IS)	CL (LD)	SW [Note 1]	RS	RH	RB	TS	HS	TZ
½ - ¾	A	A	A	A	A	---	---	---	---	---	A
1 - 4	A	A	A	A	A	A	A	A	A	---	A
6	A	A	A	---	---	A	A	A	A	A	A
8	A	A	A	---	---	---	A	A	A	A	A
10	A	A	---	---	---	---	A	A	A	A	A
12	A	A	---	---	---	---	A	A	A	A	A
14	A	---	---	---	---	---	A	A	A	A	A
16	A	---	---	---	---	---	---	A	A	A	A
18	---	---	---	---	---	---	---	A	A	A	A
20	---	---	---	---	---	---	---	---	A	A	A
24	---	---	---	---	---	---	---	---	---	A	A
30	---	---	---	---	---	---	---	---	---	A	A

Notes:

[1] For uninsulated ambient piping/tubing only.

Table B(2):

Pipe Support Type Selection Requirements
Fluid Service Temperatures greater than 100°C (212°F)
Including Steam at All Pressures

Pipe/Tube Size NPS	CL	CL (EY)	CL (IS)	CL (LD)	SW	RS	RH	RB	TS	HS	TZ
½ - ¾	A	---	---	A	---	---	---	---	---	---	A
1 - 4	A	---	---	A	---	A	A	A	A	---	A
6	A	---	---	---	---	A	A	A	A	A	A
8	A	---	---	---	---	---	A	A	A	A	A
10	---	---	---	---	---	---	A	A	A	A	A
12	---	---	---	---	---	---	A	A	A	A	A
14	---	---	---	---	---	---	A	A	A	A	A
16	---	---	---	---	---	---	---	A	A	A	A
18	---	---	---	---	---	---	---	A	A	A	A
20	---	---	---	---	---	---	---	---	A	A	A
24	---	---	---	---	---	---	---	---	---	A	A
30	---	---	---	---	---	---	---	---	---	A	A

Schedule C

**Insulation Protection Requirements
For Pipe Hanger/Support**

Notes for Schedule C:

[1] For the column Hanger Support Position, "Insulation" means hanger or support element is outside of the pipe and insulation. "Pipe" means hanger or support element is in direct contact with the pipe and is encased in the pipe insulation.

[2] "Pipe" position only applies to clevis hangers. For all other pipe supports, use the "Insulation" hanger/support position.

[3] Include heavy-duty support plate welded to shield.

[4] Restrictions apply to minimum length of hanger rod for heating piping at this temperature range. Refer to standard details.

[5] Refer to specification section 20 07 19 Piping Insulation for type P-21, P-22 and P-23 high-density insert specifications.

[6] Where ambient piping is required to be insulated under section 20 07 19, insulation is to be protected in accordance with the requirements for Low Temperature Piping.

[7] Insulation for Dual Temperature Piping is to be protected in accordance with the requirements for Cold Piping.

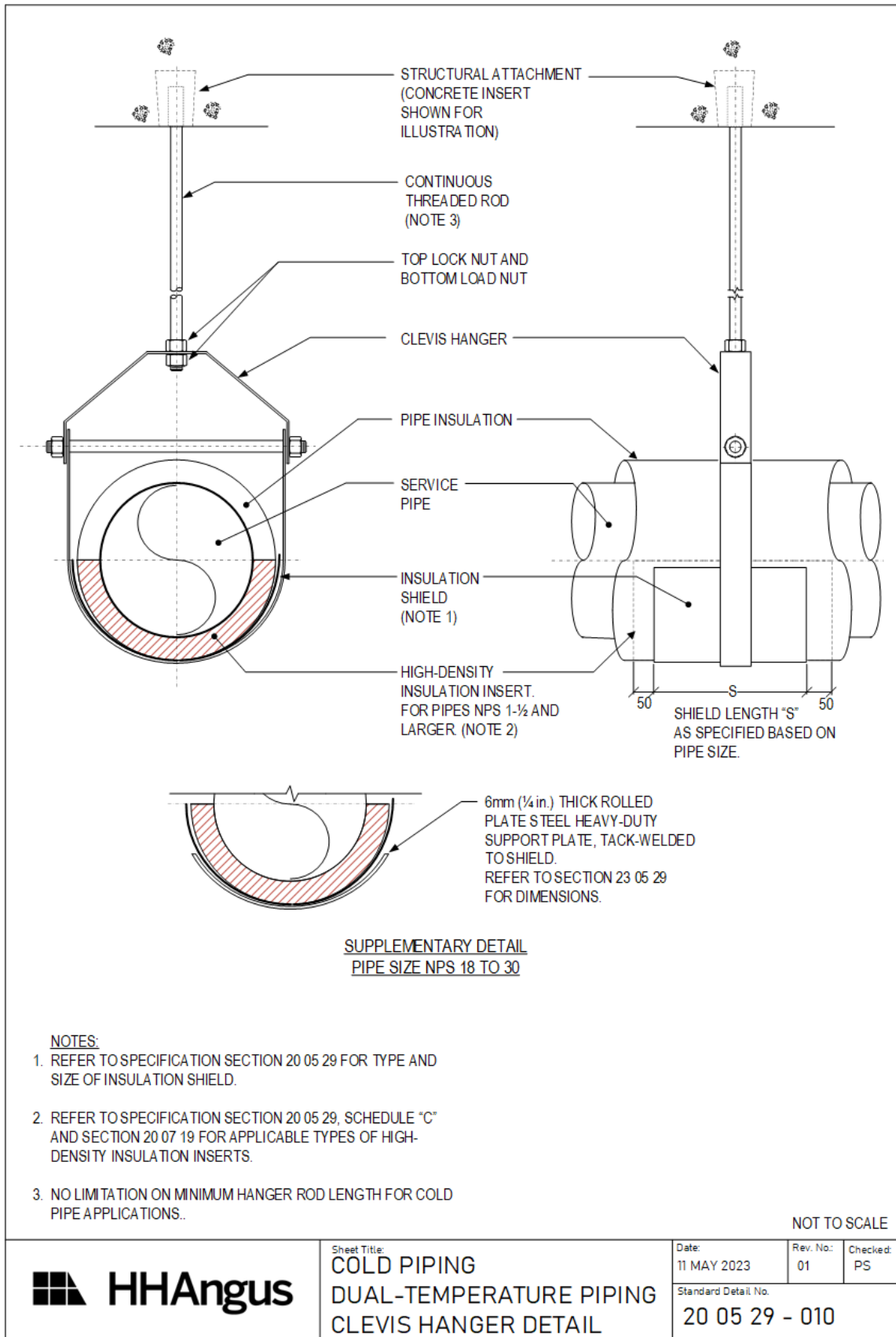
Application Legend for Insulation Saddle and Shields

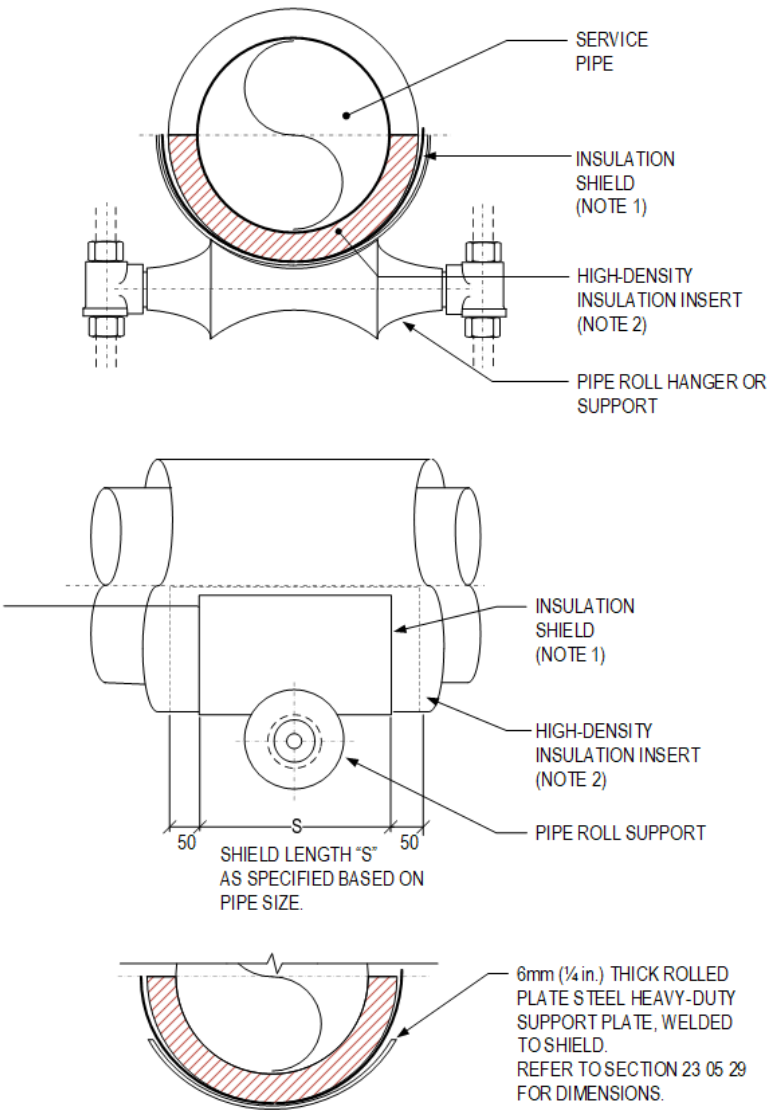
REQ	Required
ALT	Acceptable Alternate
	Not Applicable

Service Temperature °C (F)	Pipe Size NPS	Hanger/ Support Position [Note 1, 2]	Pipe Saddle	Insulation Shield	
				Shield	High-Density Insert Type [Note 5]
Hot Piping > 121 to ≤ 205 (> 250 to ≤ 400) Including steam >103 kPa (15 psi)	≥ 6	Insulation	REQ		
	>1-1/4 and ≤ 4	Insulation	ALT		
				ALT	P-23
	≤ 1-1/4	Insulation		REQ	
Hot Piping > 100 to ≤ 121 (> 212 to ≤ 250) Including steam ≤ 103 kPa (15 psi)	≥ 6	Insulation	REQ		
	>1-1/4 and ≤ 4	Insulation	ALT		
				ALT	P-21, P-22, or P-23
	≤ 1-1/4	Insulation		REQ	

Schedule C (Con't)

Service Temperature °C (F)	Pipe Size NPS	Hanger/ Support Position [Note 1, 2]	Pipe Saddle	Insulation Shield	High- Density Insert Type
Hot Piping 61 to 100 (141 to 212)	≥10 and ≤ 30	Insulation	REQ		
	≥ 6 and ≤ 16	Insulation	ALT		
				REQ	P-21, P-22, or P-23
	≥ 1-1/2 and ≤ 4	Insulation		ALT	P-21, P-22, or P-23
		Pipe [Note 4]	ALT		
	≤ 1-1/4	Insulation		ALT	
		Pipe [Note 4]	ALT		
Low Temperature Water 40 to 60 (104 to 140) [Note 6]	≥18 and ≤ 30	Insulation		REQ [Note 3]	P-21, P-22, or P-23
	≥ 6 and ≤ 16	Insulation		REQ	P-21, P-22, or P-23
	≥ 1-1/2 and ≤ 4	Insulation		ALT	P-21, P-22, or P-23
		Pipe	ALT		
	≤ 1-1/4	Insulation		ALT	
		Pipe	ALT		
Cold Piping 4 to 16 (39 to 61) [Note 7]	≥18 and ≤ 30	Insulation		REQ [Note 3]	P-21 or P-22
	≥ 1-1/2 and ≤ 16	Insulation		REQ	P-21 or P-22
	≤ 1-1/4	Insulation		REQ	
Fire protection piping	≥ 1-1/2	Pipe			
	≤ 1-1/4	Pipe			
MRI Quench Piping	All	Insulation		REQ	P-22





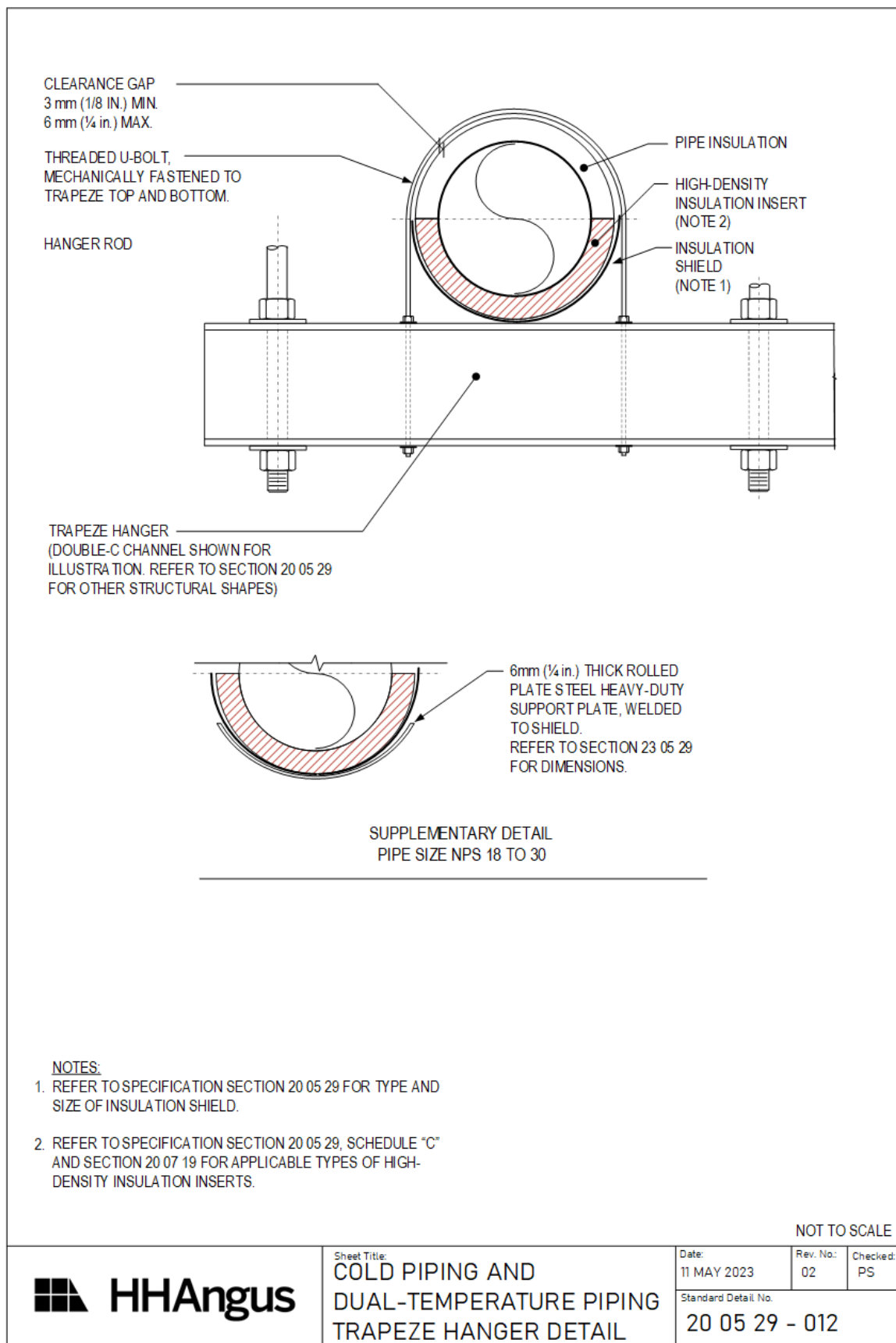
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PIPE SIZE NPS 18 TO 30

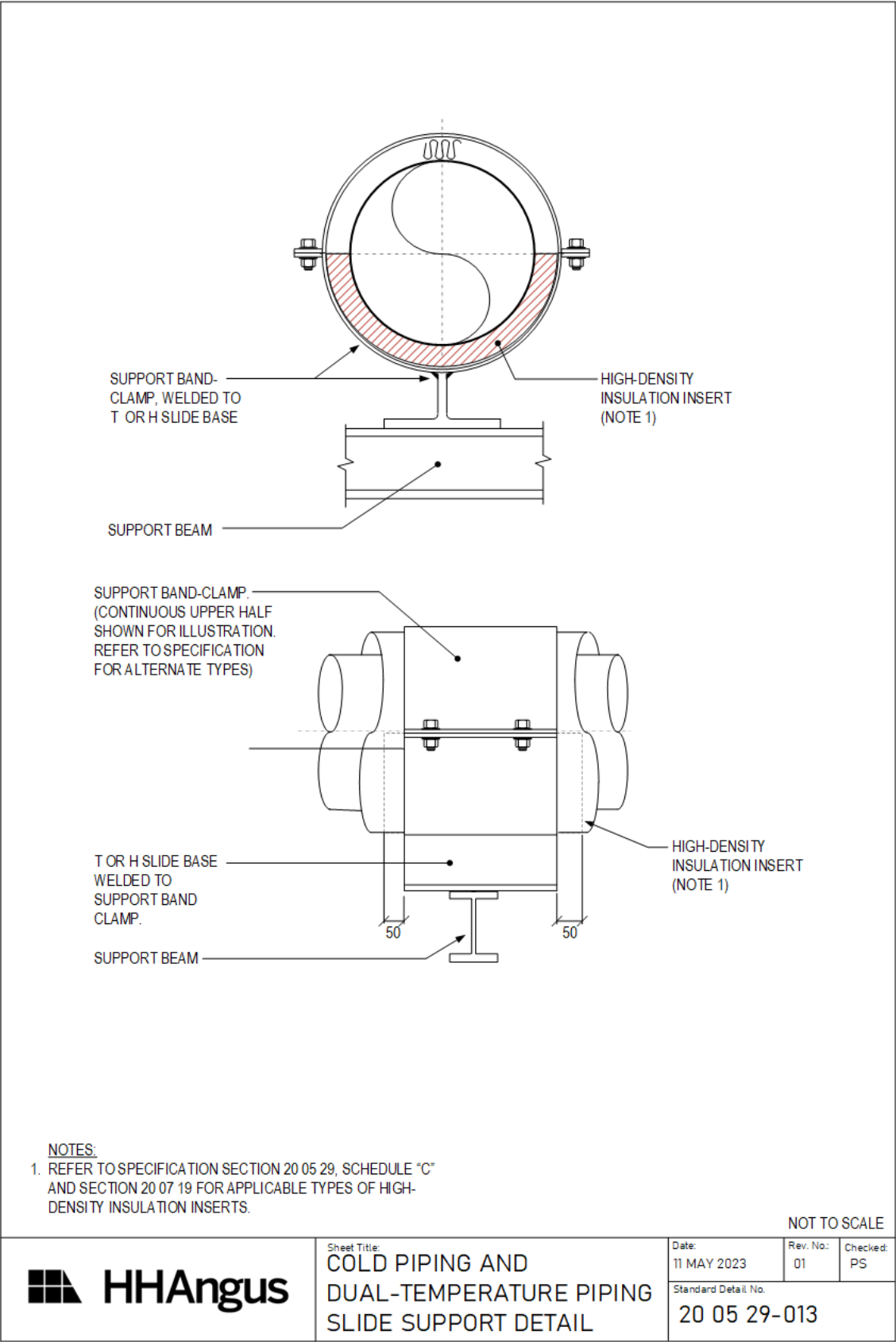
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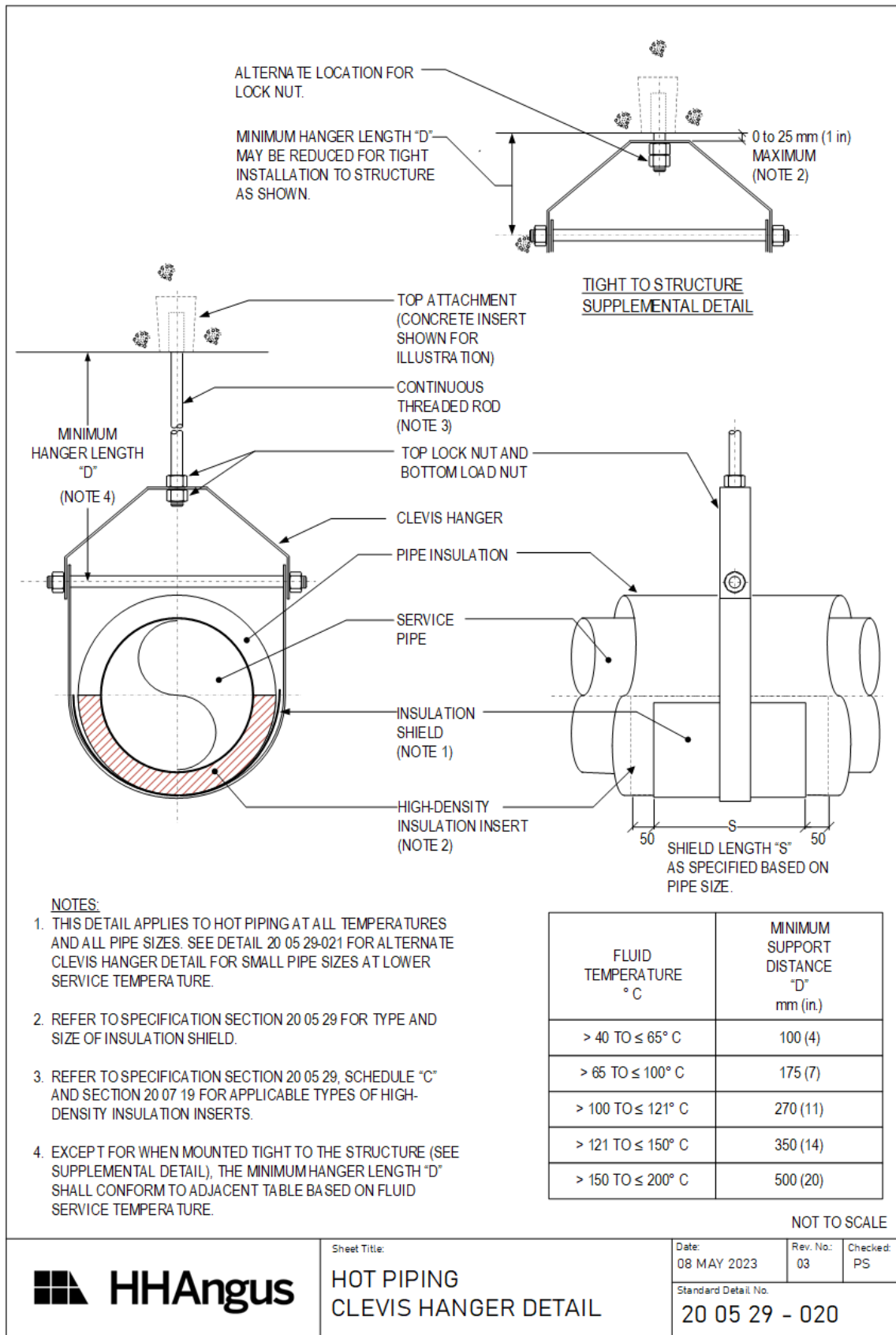
1. REFER TO SPECIFICATION SECTION 20 05 29 FOR TYPE AND SIZE OF INSULATION SHIELD.
2. REFER TO SPECIFICATION SECTION 20 05 29, SCHEDULE "C" AND SECTION 20 07 19 FOR APPLICABLE TYPES OF HIGH-DENSITY INSULATION INSERTS.
3. NO LIMITATION ON MINIMUM HANGER ROD LENGTH.

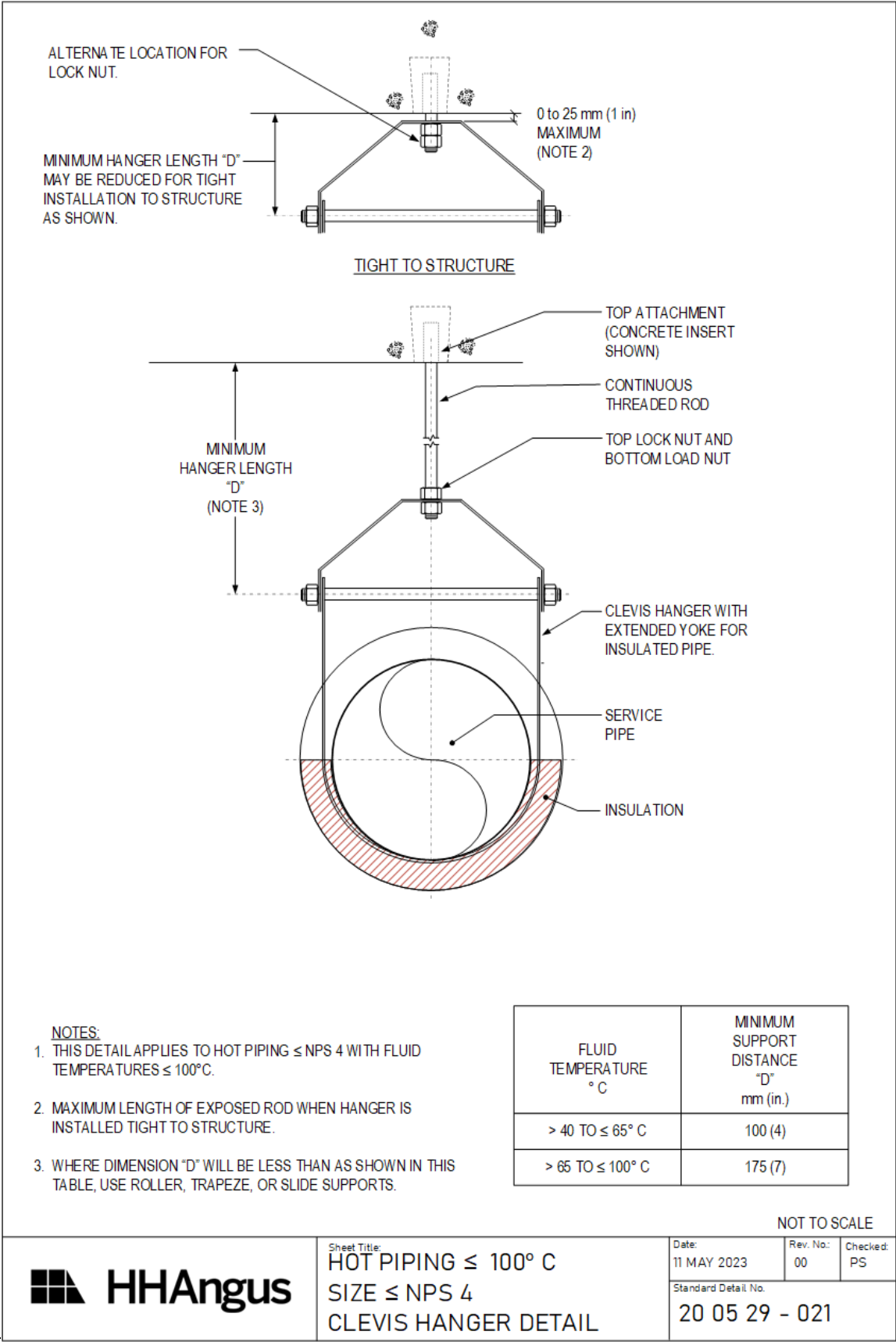
NOT TO SCALE

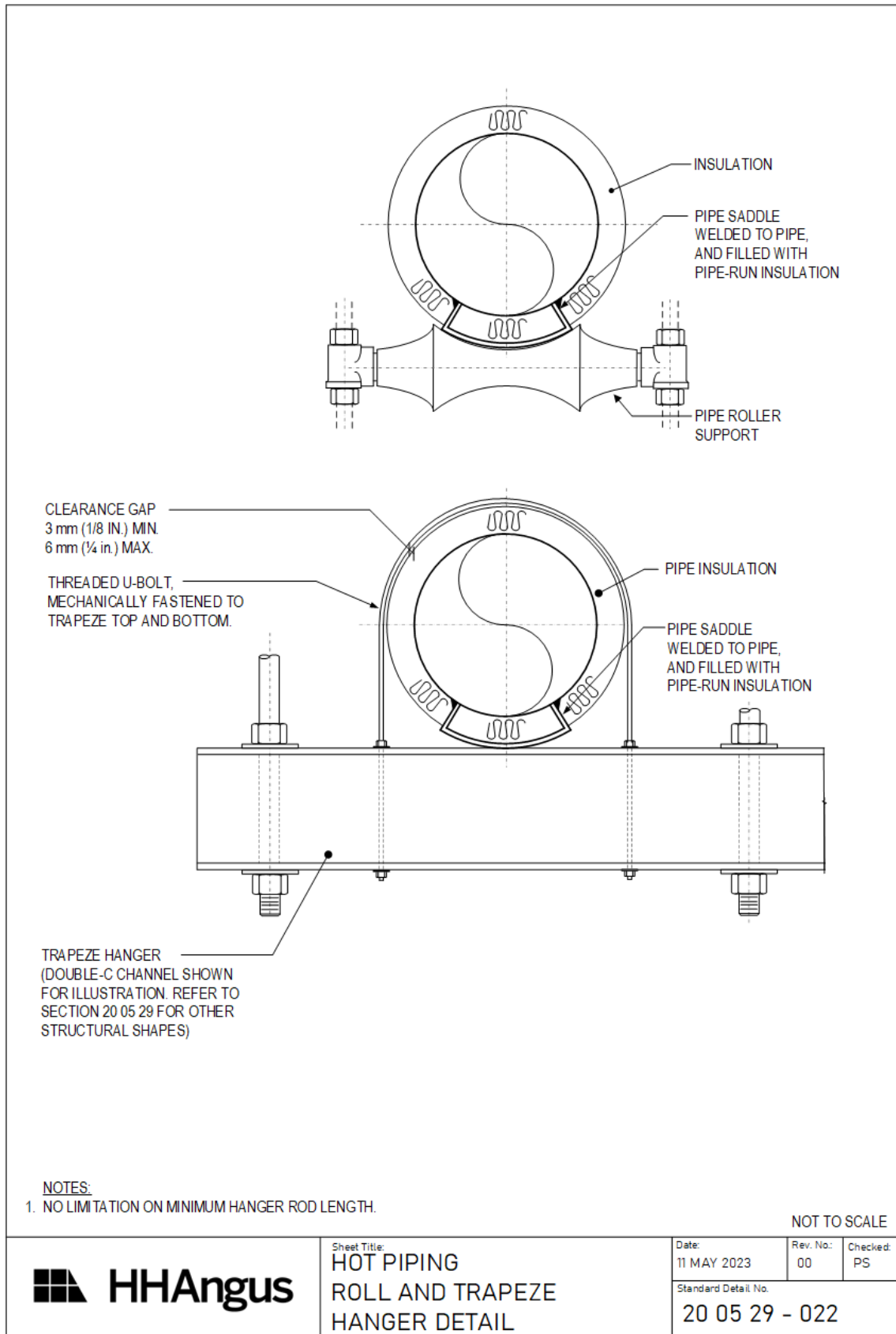
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		Standard Detail No. 20 05 29 - 011		

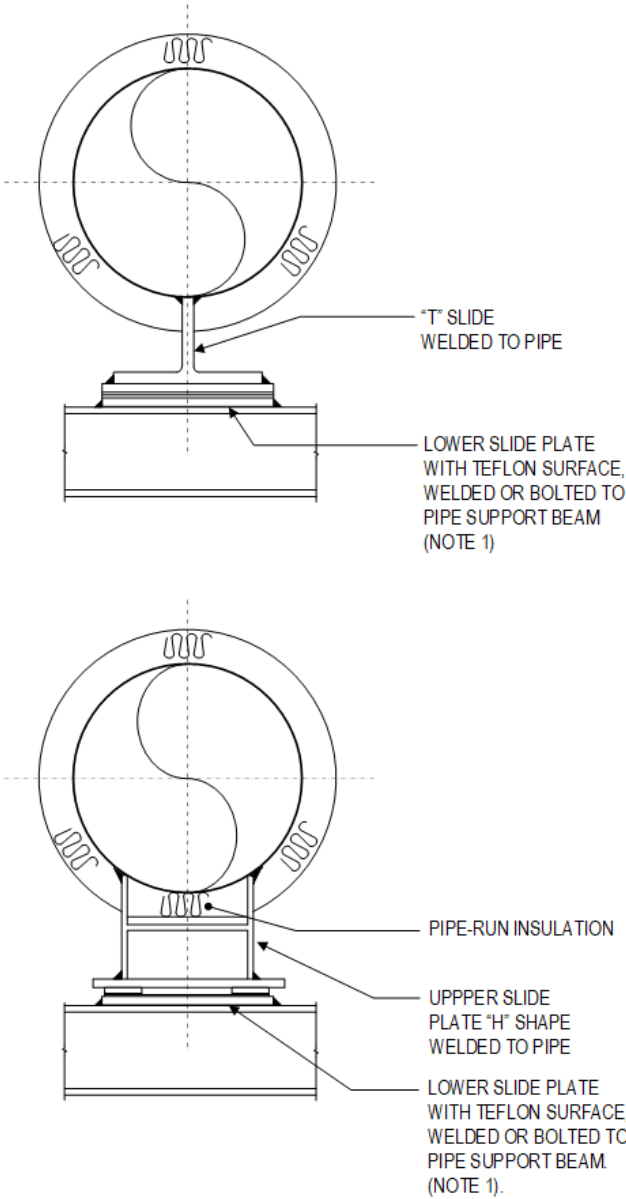












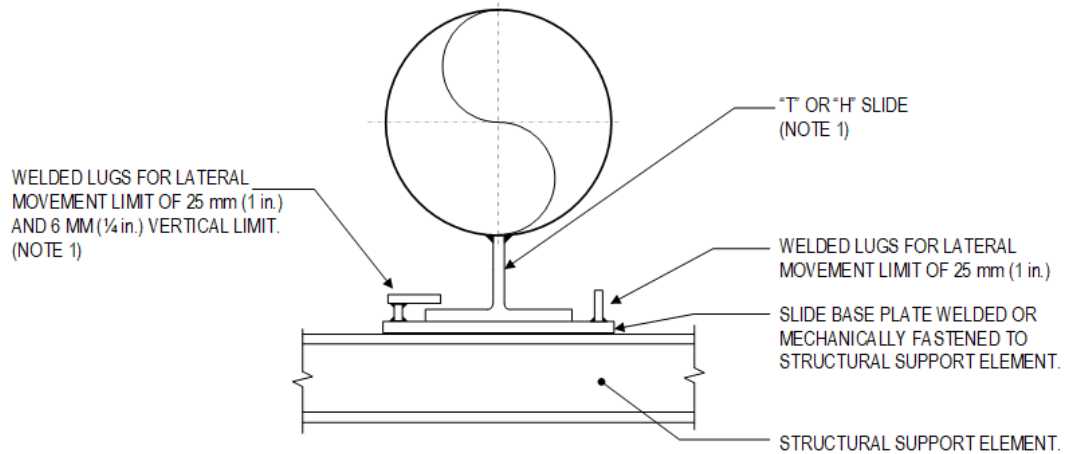
- NOTES:
1. TEFLON SLIDE PLATES ONLY REQUIRED FOR HOT PIPING WITH SERVICE TEMPERATURE > 121° C, INCLUDING STEAM AT PRESSURES > 103 kPa.

NOT TO SCALE

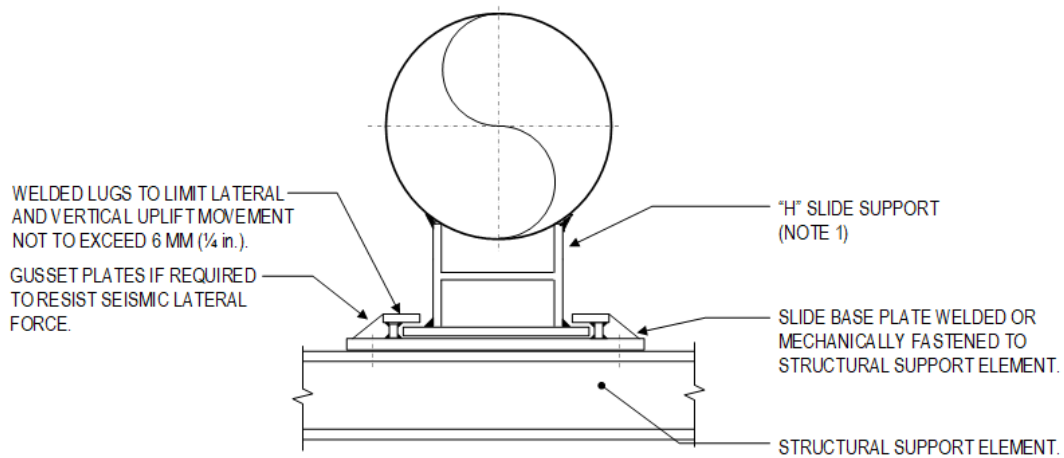


Sheet Title:
HOT PIPING
SLIDE SUPPORT DETAILS

Date: 11 MAY 2023	Rev. No.: 00	Checked: PS
Standard Detail No. 20 05 29 - 023		



COMBINATION PIPE SLIDE AND EXPANSION GUIDE



COMBINATION PIPE SLIDE AND TRANSVERSE SEISMIC RESTRAINT

NOTES:

1. REFER TO DETAILS 20 05 29-013 AND 20 05 29-023 FOR ADDITIONAL REQUIREMENTS FOR COLD PIPING AND HOT PIPING.

NOT TO SCALE



Sheet Title:
**SLIDE SUPPORTS
GUIDES AND
SEISMIC RESTRAINT**

Date: 11 MAY 2023	Rev. No.: 00	Checked: PS
Standard Detail No. 20 05 29 - 030		

END OF SECTION

VIBRATION ISOLATION

20 05 48

GENERAL

1.1 Scope

- .1 Provide vibration isolation equipment for;
 - .1 vibration control for motor-driven mechanical equipment,
 - .2 vibration control for piping and ductwork connected to motor drive equipment,
 - .3 movement control for piping due to thermal movement, and
 - .4 movement control for piping due to building movement.
- .2 Provide engineering services associated with the design, analysis and selection of vibration isolation supports, including pipe riser supports.
- .3 Refer to specification section 20 05 29 for installation requirements for variable and constant load supports for pipe riser in excess of 25 m (82 ft) in height.

1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
 - .1 20 05 12 Wiring Requirements for Mechanical Services
 - .2 20 05 29 Common Hanger and Support Requirements for Piping
 - .3 20 05 49 Seismic Restraint
 - .4 20 05 16 Flexible Connections
 - .5 23 33 05 Duct Accessories

1.3 Applicable Codes and Standards

- .1 Product standards:
 - .1 ASTM A653-19 Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
 - .2 ASTM B117 Standard Practice for Operating Salt Spray (Fog) Apparatus

1.4 Design Criteria

- .1 Isolator and base type designations are taken from the current ASHRAE Applications Handbook.
- .2 Base type, isolator type and minimum static deflection are shown in equipment schedules and/or equipment selection sheets.
- .3 Information shown in equipment schedules is to establish minimum standards and vibration isolation equipment to be selected to maintain noise levels in building below RC levels in following schedule.

AREA	NOISE CRITERIA (NC level)
Offices - private	32 to 34
-open plan	36 to 38
-business machine areas	40 to 42

AREA	NOISE CRITERIA (NC level)
-conference/boardrooms	30 to 32
Operating Rooms	25 to 27
Private Bedrooms	26 to 28
Hospital Wards	30 to 32
Public Areas	38 to 40

- .1 Provide a completely engineered design of pipe riser vibration isolated supports to minimize the pipe anchor loads under normal operating conditions, with engineering documents sealed by a professional engineer licensed in the jurisdiction of the Work.

Coordinate vibration isolation with seismic requirements under specification section 20 05 49.

1.5 Submittals

- .1 Submit shop drawings consisting of;
 - .1 product data sheets for isolation components,
 - .2 a schedule (or similar document) of vibration isolators selected for each piece of equipment, including equipment weight and isolator static deflection;
 - (a) where a common selection is used for multiple instances of the same equipment type, a single submission identifying all applicable equipment units is sufficient,
 - .3 drawing details for equipment bases, specific to each piece of equipment,
 - .4 fabrication details, location and size of anchor bolts and concrete requirements for inertia bases.
- .2 Submit shop drawings for the completely engineered pipe riser vibration isolation supports and pipe anchors;
 - .1 for each isolator, identify the estimated supported static loads, estimated supported operating loads (at temperature), spring deflections at static and operating conditions, spring deflections at static and operating condition, spring selections, and riser anchor design, including anchor loads at static and operating conditions,
 - .2 shop drawings to be sealed by a professional engineer licensed in the jurisdiction of the Work.

2 PRODUCTS

2.1 General Requirements

- .1 Provide vibration isolation equipment by one manufacturer.

Standard of Acceptance

- Vibro-Acoustics (Swegon NA)
- Kinetics
- BVA
- Korfund Mason
- Tecoustics

2.2 Elastomeric Mounts – Type M1

- .1 Molded neoprene mount:

- .1 one piece, molded neoprene mount, with cast-in-top threaded steel load insert, and two hold down bolt openings on the bottom plate,
- .2 load rating: up to 13 mm (0.5 in) static deflection and up to nominally 1800 kg (3960 lbs.) load,

2.3 Isolator Springs – Type S1

- .1 Open spring isolator:
 - .1 free-standing, open (un-enclosed) spring isolator, selected for static deflections as shown,
 - .2 upper load plate and leveling assembly, and bottom load plate with non-skid noise isolation pad and bolt holes for fastening to the floor,
 - .3 load rating: up to 50 mm (2 in) static deflection and up to nominally 8000 kg (17,600 lbs.) load,
 - .4 ratio of lateral spring stiffness to vertical spring stiffness: 1.0 or greater,
 - .5 overload capacity: 50% minimum,
 - .6 springs coated in a colour-coded corrosion protection finish and tested with a 1000 hour salt spray rating to ASTM B117.

2.4 Isolation Hangers – Type H1

- .1 Spring isolation hanger:
 - .1 open (un-enclosed) spring isolator for connection to upper and lower hanger rods, selected for static deflections as shown,
 - .2 a stamped or welded hanger bracket mount with elastomeric washer isolating the spring,
 - .3 bracket and spring: polyester powder coat finish,
 - .4 swivel arrangement to permit hanger box or rod to move through 30° of arc without metal to metal contact,
 - .5 load rating: 10 mm (0.4 in) to 50 mm (2 in) static deflection and up to nominally 1450 kg (3190 lbs.) load,
 - .6 ratio of lateral spring stiffness to vertical spring stiffness: 1.0 or greater,
 - .7 overload capacity: 50% minimum.,

2.5 Isolation Hangers – Type H2

- .1 Spring isolation hanger with elastomer-in-shear insert:
 - .1 Same as type H1 except as follows.
 - .2 includes a neoprene elastomer-in-shear insert on the upper load connection, in series to the spring,
 - .3 load rating: up to 100 mm (4 in) static deflection and up to nominally 1700 kg (3740 lbs.) load,

2.6 Isolation Hangers – Type H3

- .1 Neoprene isolation hanger:
 - .1 neoprene isolator for connection to upper and lower hanger rods,
 - .2 a stamped hanger bracket mount with isolator and load washer, with galvanized steel finish
 - .3 bracket and spring: polyester powder coat finish,
 - .4 swivel arrangement to permit hanger box or rod to move through 30° of arc without metal to metal contact,

- .5 load rating: up to 15 mm (0.57 in) static deflection and up to nominally 900 kg (1980 lbs.) load,
- .6 ratio of lateral spring stiffness to vertical spring stiffness: 1.0 or greater,
- .7 overload capacity: 50% minimum.

2.7 Equipment Base – Type A

- .1 Vibration isolators attached directly to equipment,
- .2 No supplementary base required.

2.8 Equipment Base – Type B

- .1 Fabricated steel frame or rails (except cooling towers, evaporative fluid coolers, and evaporative condensers):
 - .1 prefabricated steel base for fans and other equipment requiring motor support,
 - .2 welded assemblies from structural sections,
 - .3 reinforced for motor and drive with;
 - (a) isolation elements attached to base brackets and
 - (b) adjustable motor slide rails.
 - .4 use height-saver isolator mounting brackets wherever possible,
 - .5 minimum vertical section of base selected on basis of motor size from following;

Motor Size Horsepower	Motor Size kW	Vertical Side mm (in)
up to 3	up to 2.2	75 (3)
7.5	5.5	100 (4)
20	15	150 (6)
50	37	200 (8)
over 50	37	250 (10)

2.9 Equipment base – Type C

- .1 Concrete filled inertia base:
 - .1 Type B base and as follows,
 - .2 full depth perimeter structural section or formed plate channel frame with;
 - (a) welded in place reinforcing rods running in both directions and
 - (b) 1 mm (20 ga) metal pans,
 - (c) base section filled with concrete, vibrated into place.
- .2 spring mount units carried by height-saver gusseted brackets welded to frame and
- .3 'T' shaped bases to support horizontal pump elbows.

3 EXECUTION

3.1 General

- .1 Install vibration isolation equipment in accordance with manufacturer's instructions and locate isolation for equipment to provide stable support under saddles, frames and projections of equipment.
- .2 Select thrust restraints for equipment mounted on vibration isolation to limit movement during start-up and normal operation.

3.2 Equipment Bases

Provide equipment bases for equipment as shown on equipment schedule drawings.

- .2 Block and shim bases level at correct operating height. Set the bottom of bases to clear housekeeping pads under full static load conditions by:
 - .1 50 mm (2 in) minimum for type A and B bases.

3.3 Equipment Vibration Isolation

Provide vibration isolators with required static deflection for motorized equipment as shown on equipment schedule drawings, except as otherwise specified herein.

- .2 Provide Type H1 isolators for in-line duct fans and fan-powered terminal boxes.
- .3 Provide vibration isolation rubber washers where isolator is bolted to floors, housekeeping pads or overhead structure.

3.4 Vibration Isolation for Service Connections to Vibration Isolated Equipment

- .1 Make ductwork connections to vibration isolated air handling equipment with flexible connections in accordance with specification section 23 33 05.
- .2 Make electrical connections to vibration isolated equipment with flexible liquid tight conduit in accordance with specification section 20 05 12.
- .3 Make pipe connections to vibration isolated equipment in accordance with specification section 20 05 16.

3.5 Vibration Isolation Piping Supports – General Requirements

- .1 Provide vibration isolators on pipe supports where piping is connected to motorized equipment that is supported on vibration isolators of any type, in accordance with the following table.

Location	Pipe Size NPS	Isolator Type	Static Deflection mm (in)
The first two pipe supports adjacent to the vibration isolated equipment	< 10	S1 or H2 [Note 1]	Equal to the equipment isolator static deflection, but not less than 20 (0.75)
The third pipe support adjacent to the vibration isolated equipment	All	S1 or H2	Equal to the equipment isolator static deflection, but not less than 20 (0.75)

Location	Pipe Size NPS	Isolator Type	Static Deflection mm (in)
The 4 th and 5 th support point from the vibration isolated equipment	≥ 6	S1 or H2	20 (0.75)
The 6 th support point from the vibration isolated equipment	≥ 10	S1 or H2	20 (0.75)
Within 15 m (50 ft) pipe-run distance of outdoor equipment	All	S1 or H2	20 (0.75)

Notes:

[1] Order springs pre-compress to suit the installed weight of the pipe filled with the operating fluid.

- .2 Provide acoustic barrier materials at pipe anchors and guides, located within pipe shafts, duct shafts, equipment and fan rooms, and up to the first anchor outside of these rooms or areas.

3.6 Thermal Expansion Supports for Pipe Risers

- .1 Unless otherwise shown for pipe riser supports to use variable or constant load pipe hangers in accordance with section 20 05 29, provide spring isolators for pipe supports to accommodate pipe thermal movement for vertical pipe (risers) as follows.

Support vertical cold- and hot-piping for riser heights that are 25 m (82 ft) or less in height on spring isolators attached to the pipe riser supports;

- .1 select springs so that the initial spring deflection is at least four (4) times the expected thermal movement at each support point,
- .2 provide the design and fabrication of brackets at the riser spring mount as well as at the pipe attachment where standard riser clamps are not sufficient, and
- .3 in accordance with specification section 20 05 29.
- .3 For support of vertical cold- and hot-piping for riser heights greater than 25 m (82 ft), refer to specification section 20 05 29.
- .4 Provide spring isolators on horizontal branch piping or the horizontal pipe mains connecting to the riser as follows:
 - .1 type S2 or H2 isolators on the first three supports on horizontal piping connecting to the pipe risers,
 - .2 spring isolators on the horizontal piping is not required where the horizontal pipe connection is within 4 m (13 ft) of a pipe riser anchor or fixed riser base support.
 - .3 select spring isolators with a static deflection of that is four (4) times the expected thermal movement of the riser pipe at the location of the horizontal pipe connection.

3.7 Pipe Movement Isolation Supports at Building Expansion Joints

- .1 Where piping crosses building expansion joint, provide spring hangers at first two support locations of piping at either side of the construction joint line.

3.8 Start-up and Set-up

- .1 After installation of connections to resiliently mounted equipment;
 - .1 remove shims and blocking and adjust mountings to level equipment,
 - .2 adjust connections, hangers, snubbers, and restraints,

- .3 ensure that there is no physical contact between isolated equipment and building structure.
- .2 On completion of installation and start-up of equipment;
 - .1 make arrangements for manufacturer/supplier of vibration isolation equipment to visit site, check the performance of the vibration isolation systems, inspect their installation, and submit written report,
 - .2 make corrections to installation in accordance with manufacturer/suppliers recommendations,
 - .3 provide notice 24 hours in advance of this site visit.

END OF SECTION

SEISMIC RESTRAINT FOR MECHANICAL SERVICES 20 05 49.13

GENERAL

1.1 Scope

- .1 Provide restraint devices to limit movement of piping, ducts, conduits, and equipment under seismic force and movement conditions and, where applicable, wind loads.
- .2 Provide engineering services for the design, selection of materials, installation instructions, and inspection of seismic restraint devices.
- .3 The requirements under this Specification section are in addition to the requirements for equipment, piping and duct supports and vibration isolation specified in other sections of Division 20.
- .4 Where specifications of materials of this section differ from those in other sections of Division 20, this section governs.

1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
 - .1 20 05 16 Flex Connections, Expansion Joints, Anchors & Guides
 - .2 20 05 29 Common Hanger and Support Requirements
 - .3 20 05 48 Vibration Isolation
 - .4 20 05 49.23 Seismic Qualifications for Mechanical Equipment
 - .5 26 05 49 Seismic Restraints for Electrical Services

1.3 Definitions

- .1 The following definitions apply for the purpose of this section.

Transverse restraint – means restraint(s) applied to limit motion perpendicular to the centerline of the pipe, duct or conduit.

Longitudinal restraint – means restraint(s) applied to limit motion parallel to the centerline of the pipe, duct or conduit.

Restraint: means a device which limits movement of an object due to imposed seismic forces acting on the object.

Brace: a restraint directly connected to an object that reacts against both tension and compression seismic loads.

Cable restraint: a restraint consisting of cables that reacts against only tension seismic forces, and that may have a small amount of slack to prevent vibration isolation short-circuiting during normal operation.

Snubber (restraint): a restraint that does not come into contact with the object under normal operating conditions.

Seismically qualify (seismically qualified): Refer to specification section 20 05 49.23.

- .2 The following abbreviations apply to this section:

- “**C_p**” the horizontal seismic force coefficient as defined in NFPA 13.
- “**K_s**” horizontal seismic force coefficient equal to 0.3 S(0.2) I_E S_p, as defined in the 2020 National Building Code of Canada and represents a multiply of gravitational acceleration.
- “**K_v**” vertical seismic force coefficient and represents a multiple of gravitational acceleration.
- “**W_p**” the weight of the component subject to a seismic force.

.3 Interpretation:

- .1 In this specification, the parameter “S_s” (spectral response acceleration at 5 Hz) in NFPA 13, ASHRAE, SMACNA and MSS SP-127 used for estimating the horizontal seismic force, has the same meaning as the parameter “S(0.2)” for the Project site-specific design spectral response acceleration value at 0.2 seconds as defined in article 4.1.8.18 of the 2020 National Building Code of Canada.

1.4 Applicable Codes and Standards

.1 Legislation

- .1 2020 National Building Code of Canada, as adopted in the jurisdiction of the Project.

.2 Installation standards and codes:

- | | | |
|----|----------------|--|
| .1 | ASHRAE D-90316 | Practical Guide to Seismic Restraint |
| .2 | ANSI/SMACNA | Seismic Restraint Manual Guidelines for Mechanical Systems, 3 rd edition. |
| .3 | MSS SP-127 | Bracing for Piping Systems: Seismic - Wind - Dynamic Design, Selection, |
| .4 | NFPA 13 | Installation of Sprinkler Systems |

.3 Product standards:

- | | | |
|-----|--------------|--|
| .1 | ACI 355.2 | Qualification of Post-Installed Mechanical Anchors in Concrete |
| .2 | ASHRAE 171 | Method of Testing Seismic Restraint Devices for HVAC&R Equipment |
| .3 | ASTM A492 | Standard Specification for Stainless Steel Rope Wire |
| .4 | ASTM A1023 | Standard Specification for Stranded Carbon Steel Wire Ropes for General Purpose |
| .5 | ICC-ES AC01 | Expansion Anchors in Masonry Elements |
| .6 | ICC-ES AC106 | Predrilled Fasteners (Screws) in Masonry |
| .7 | ICC-ES AC156 | Acceptance Criteria for Seismic Certification by Shake-Table Testing of Non-structural Components |
| .8 | ICC-ES AC193 | Mechanical Anchors in Concrete Elements |
| .9 | ICC-ES AC308 | Post-Installed Adhesive Anchors in Concrete Elements |
| .10 | MSS SP-58 | Pipe Hangers and Supports – Materials, Design, Manufacture, Selection, Application, and Installation |

.4 Other documents:

- | | | |
|----|--------|--|
| .1 | ASCE 7 | American Society of Civil Engineers, Minimum Design Loads and Associated Criteria for Buildings and Other Structures |
|----|--------|--|

1.5 Seismic Analysis, Design and Inspection Services

- .1 Provide the services of a professional engineer, licensed in the province or territory of the Work and who specializes in seismic restraint of building services and equipment (the "Seismic Engineer"), for the design of seismic restraints and to provide inspection services of the completed installation.
- .2 Seismic Engineer design services;
 - .1 Provide the design of seismic restraint systems, including seismic restraint calculations for all connections of equipment to the structure.
 - .2 Provide design drawings showing locations of restraints and details of construction and attachment of restraints. Mark-ups of Consultant drawing or Contractor installation drawings may be used for this purpose.
 - .3 Analysis of dead loads, seismic loads and capacity of materials utilized for connections to equipment and structure. Analysis to detail anchoring methods, bolt diameter, embedment and/or welded length. Design seismic restraint devices to accept, without failure, the seismic forces acting on the equipment or components and their support and restraint attachments to the building structure.
- .3 Seismic Engineer inspection services;
 - .1 At periods during installation and at completion of the installation of the seismic restraint devices, the Seismic Engineer shall inspect the installation, identify and report deficiencies (if any) which are observed, and re-inspect the installation after deficiencies have been corrected.
 - .2 Seismic Engineer to submit periodic inspection reports and a final inspection report after all work is completed and deficiencies have been corrected, confirming the installation conforms to the seismic design requirements. Prepare and submit any required declarations or similar document to this effect where required by local legislation.
- .4 Shop drawings of custom restraints, supporting calculations, and reports shall be sealed by the Seismic Engineer.
- .5 Prepare and submit reports of inspections of the installation and a final general review report of the completed seismic installation.

1.6 Manufacturer's Services – Seismic Restraints

- .1 Manufacturer of seismic control equipment are responsible for:
 - .1 determining seismic restraint sizes and locations,
 - .2 provide calculations and supply materials for restraint of vibration isolated and non-isolated equipment,
 - .3 provide installation instructions, drawings and trained field supervision to ensure proper installation and performance including welding details,
 - .4 field inspection of manufactured support systems including roof curbs and other rooftop equipment supports at time of installation.

1.7 Contractor Design Services – Pipe Risers

- .1 Notwithstanding the requirements of section 20 05 29, engineered design services for pipe riser supports are required for all pipe risers. These design services may be provided by the Contractor, the Seismic Engineer, or by a seismic restraint manufacturer.
- .2 Pipe riser supports design responsibilities include:
 - .1 complete engineering design of pipe riser support system including design and selection of pipe riser anchors, riser guides and riser isolators,

- .2 provide calculations and supply materials for support of pipe risers to accommodate dead loads, dynamic loads and static seismic loads.
- .3 provide installation instructions, drawings and trained field supervision to ensure proper installation and performance including welding details.

1.8 Design Criteria

- .1 Design seismic restraint systems to conform to the provincial or territorial building code requirements for seismic forces and movement as applicable for the place of the Work. Seismic restraint methods as described in ASHRAE D-90316, SMACNA seismic guideline and MSS SP-127 are acceptable as the baseline requirement.
- .2 Base the design of seismic restraints on actual equipment data (dimensions, weight, center of gravity, etc.) obtained from submittals or the manufacturers of the equipment.
- .3 Testing and calculations of seismic restraints shall include both shear and tensile loads as well as one test or analysis at 45° to the weakest mode.
- .4 Site design parameters shall be obtained for the existing building.
- .5 Building seismic force coefficient data;
 - .1 seismic horizontal force coefficients " K_s " and seismic vertical uplift force coefficient " K_v " for building service are listed in Schedule A attached to the end of this Section. These coefficients are the maximum values independent of the type of equipment or service being restrained. It is permitted to calculate a lower K_s coefficient where the C_p , A_r and R_p values, as defined in the building code specific to the actual equipment or service being restrained, are used.
 - .2 seismic force coefficient " C_p " for fire protection piping is listed in Table 3 of Schedule A attached to the end of this Section.
- .6 Seismic force calculation (except fire protection piping);
 - .1 the horizontal seismic force " V_p " applied to a component is:
$$V_p = K_s \times W_p,$$
 - .2 the vertical seismic force " V_{pv} " applied to a component is:
$$V_{pv} = K_v \times W_p$$
- .7 Seismic force calculation for fire protection piping, including automatic sprinklers constructed in accordance with NFPA 13 and fire standpipes constructed in accordance with NFPA 14;
 - .1 the horizontal seismic force applied to a component is
$$F_p = C_p \times W_p \times 1.15,$$
 - .2 the vertical seismic force applied to a component is equal to 15% of the horizontal seismic force F_p .
- .8 For suspended equipment, the building elevation height is measured to the level of the floor above the suspended equipment.
- .9 For vibration isolated equipment, where the clearance distance (air gap) between the equipment support frame and the restraint (e.g. snubber or integral limit stop) exceeds 6 mm (1/4 in.), the seismic horizontal force V_p is to be increased by 100%.
- .10 Where adhesive anchors for concrete are used, the seismic force for the restrained equipment is to be increased by multiplying the horizontal seismic force coefficient specified in Schedule A of this Specification section by the " R_p " equipment category as defined in article 4.1.8.18 of the National Building Code of Canada specific to the equipment being restrained.

$$K_{s,adhesives} = K_s \times R_{p,applicable\ equipment}$$

- .11 Where concrete inserts are used, the seismic force for the restrained equipment is to be increased by multiplying the horizontal seismic force coefficient specified in Schedule A of this Specification section by the "R_p" equipment category as defined in article 4.1.8.18 of the National Building Code of Canada specific to the equipment being restrained and divided by the value of 1.5.

$$K_{s,inserts} = K_s \times \frac{R_{p,applicable\ equipment}}{1.5}$$

Seismic Qualification of Equipment

- .1 Refer to Specification section 20 05 49.23.

1.10 Submittals

- .1 Submit shop drawings in accordance with Division 1 and as follows.
- .2 Submittals for design of seismic restraint systems shall be sealed by a Professional Engineer licensed in the province or territory of the jurisdiction of the Project.
- .3 Seismic restraints:
- .1 Provide test certificates for each seismic restraint device, identifying maximum tested load capacities.
 - .2 Provide calculations for each piece of restrained equipment, lengths of braced piping, ductwork and conduit, including seismic forces, restraint selection, and selection data.
 - .3 Provide seismic data in spreadsheet format for each piece of equipment and include the following information:
 - (a) Equipment ID,
 - (b) Building floor level,
 - (c) Horizontal seismic force factor K_v,
 - (d) Equipment weight,
 - (e) Horizontal seismic force,-
 - (f) Vertical uplift seismic force (where applicable),
 - (g) Design condition (worst case) overturning moment,
 - (h) Number of restraint fastenings,
 - (i) Pull-out tension for worst case restraint,
 - (j) Compression for worst case restraint (vibration isolated equipment),
 - (k) Horizontal shear load per fastener,
 - (l) Worst case simultaneous tension and shear loads at each restraint and snubber,
 - (m) Pull-out tension load rating per fastener,
 - (n) Horizontal shear rating per fastener.
 - .4 Provide drawings for each type of restraint assembly, including details for connections to building structure, and associated bill of materials, and (where applicable) full welding details of field welds to structural elements.
 - .5 For building connections in concrete, provide concrete anchor sizes and nominal and effective embedment depth.
 - .6 Provide floorplan layout drawings indicating location of each restraint, identifying each restraint type in a manner to identify the restraint detail.

- .7 Provide layout and construction details for reinforced housekeeping pads based on actual equipment to be restrained and selected concrete anchors. Shop drawings to include:
 - (a) minimum housekeeping pad plan dimensions and height, including reinforcement,
 - (b) details for securing the housekeeping pad to the structural floor slab,
 - (c) dimensioned position of restraint devices or combination isolator/restraint devices,
 - (d) minimum distance from concrete anchors to edge of housekeeping pad.
- .4 Calculations and designs shall be sealed by a Professional Engineer licensed in the province or territory of the jurisdiction of the project.
- .5 Pipe riser support system:
 - .1 Provide engineered layout drawings of pipe supports including anchors, guides, and isolators, with supporting load calculation including dead loads, dynamic loads and static seismic loads, and reaction loads at building connection.
 - .2 Include:
 - (a) riser drawing indicating location of each support element for each for each piping system,
 - (b) installation instructions for presetting of pipe guides and isolators,
 - (c) riser clamp products or fabrication details of pipe brackets,
 - (d) riser clamping details as applicable for each riser pipe material.

1.11 Quality Assurance

- .1 Without limiting Contractors responsibility for quality assurance of the Work, the following minimum quality control processes are required.
- .2 Pre-Construction meeting;
 - .1 Request and arrange a meeting with the Seismic Engineer and Consultant to review seismic restraint approach, prior to any restraint installation. Obtain approval from the Consultant before commencing work.
- .3 Initial installation and review;
 - .1 Install the first three transverse and three longitudinal braces for each fire protection systems, one (1) building service piping system, and one (1) ductwork system.
 - .2 Request and arrange for a review of the installation by the Seismic Engineer and Consultant. Obtain approval of the installation before commencing remainder of the work.
- .4 Provide services of the manufacturer's technical representative to conduct site inspections of the Work in progress, and to conduct a final inspection of the Work. Provide a copy of the final inspection report to the Consultant for review. For clarity, these inspections are separate from those performed by the Seismic Engineer.
- .5 Provide services by the Seismic Engineer to conduct periodic reviews of the work in progress, and final review of the completed seismic restraint installation, before any ceilings are installed or work is otherwise concealed.
- .6 All deficiencies identified by the Seismic Engineer, manufacturer, or Consultant are to be rectified before equipment or services are concealed.

2 PRODUCTS

2.1 General

- .1 Seismic restraint materials to be provided by manufacturers specializing in the field of seismic restraint.

Standard of Acceptance

- Vibro-Acoustics (Swegon North America)
 - Kinetics Noise Control Inc.
 - B.V.A. Systems
 - Korfund (VMC)
 - Tecoustics
 - Hilti
 - nVent
- .2 Manufactured seismic restraints, anchors and related materials to be tested in accordance with ICC ES AC156 for loads meeting or exceeding the applied seismic forces of the Work.
- .3 Demonstrate conformity of seismic restraint products by:
- .1 approved by a government agency and indicate maximum restraint ratings, or
 - .2 provided with test results verified by an independent testing laboratory which state the maximum restraint ratings.
- .4 Seismic restraints for equipment supported by vibration isolators to be either:
- .1 vibration isolators as specified in section 20 05 48 and provided with separate seismic snubbers, or
 - .2 combination vibration isolators with integral seismic snubbers.
- .5 The following product articles describe the more common type of restraint devices. Other restraint devices are permissible provided they are qualified by 3rd party testing laboratories for seismic force restraint.

2.2 Seismic Snubbers

- .1 Type "SS1" – Single-Axis/Single Direction Snubbers:
- .1 ASHRAE Type "I", designed to restrict movement in one axis,
 - .2 carbon steel construction with epoxy or electrostatic paint finish, attached to floor or housekeeping pad with minimum of two bolts, faced with minimum 6.4 mm (1/4 in.) thick neoprene pad of compounded to bridge bearing quality,
- .2 Type "SS2 / SS3" – Multi-Axis/Multi-Direction Snubber Assemblies:
- .1 ASHRAE Type "G" and "F", designed to restrict movement in two (2) lateral ("SS2") or three (3) axis ("SS3"),
 - .2 interlocking steel construction, attached to equipment structure and equipment, maximum of 6 mm (1/4 in) seismic movement,
 - .3 minimum 6 mm (1/4 in) thick resilient neoprene pads compounded to bridge bearing specifications, to prevent metal-to-metal impact,
 - .4 minimum two bolt attachments to the floor,

2.3 Seismic Restraint Brackets

- .1 Type "SRB" – Rigid Equipment Restraint Brackets:
- .1 suitable for connection to equipment bases and tank bases,
 - .2 carbon steel "L" sections with epoxy or electrostatic paint finish, for fastening to both the floor structure/housekeeping pad and the equipment base,
 - .3 structure bolt opening equipped with neoprene bushing, compounded to bridge bearing quality,
 - .4 minimum two bolt fastening to equipment base using screws,

- .5 suitable for equipment direct contact to floor with or without isolation pads,

2.4 Seismic Vibration Isolators

- .1 Type “2-S” – All Direction Neoprene Isolator:
 - .1 ASHRAE Type “E”, designed to restrict movement in all directions with no metal-to-metal contact.
 - .2 molded, oil resistant neoprene compounded to bridge bearing quality, with encapsulated cast-in-place top steel load plate, and steel base plate with anchor holes,
- .2 Type “3-S” – Restrained Spring Isolator – Constant Load:
 - .1 ASHRAE Type “B”, designed to restrict movement in all directions,
 - .2 colour coded seismic-controlled spring isolator, single or multiple spring coils, with minimum 6 mm (¼ in.) neoprene pad,
 - .3 removable coil spring element without having to disturb supported equipment,
 - .4 lateral stiffness greater than 1.2 times rated vertical stiffness,
 - .5 minimum 50% overload capacity,
 - .6 non-welded spring elements: epoxy coated, with a minimum 1000-hour rating when tested in accordance with ASTM B-117,
 - .7 steel housing design to limit lateral and vertical movement of the supported equipment,
 - .8 neoprene snubber, to limit maximum equipment movement in any direction to 6 mm (¼ in.),
 - .9 location of snubbers designed to minimize prying action on floor bolts,
 - .10 adaptor base suitable sized for larger anchors, when required to suit anchorage capacity.
- .3 Type “4-S” – Restrained Spring Isolator – Variable Load:
 - .1 colour coded seismic-controlled spring isolator, single or multiple spring coils, with minimum 6 mm (¼ in) neoprene pad mounted under spring(s),
 - .2 removable coil spring element without having to disturb supported equipment,
 - .3 lateral stiffness greater than 1.2 times rated vertical stiffness,
 - .4 minimum 50% overload capacity,
 - .5 non-welded spring elements: epoxy coated, with a minimum 1000-hour rating when tested in accordance with ASTM B-117,
 - .6 steel housing design to limit lateral and vertical movement of the supported equipment,
 - .7 top load plate with adjustable and leveling bolts,
 - .8 adjustable vertical restraints to allow unloading of water-bearing equipment,
 - .9 isolation washers,
 - .10 bottom load plate with anchor holes,
 - .11 hot dipped galvanized for outdoor installations,
 - .12 neoprene snubber compounded to bridge veering quality, to limit maximum equipment movement in any direction to 6 mm (¼ in),
 - .13 adaptor base suitable sized for larger anchors, when required to suit anchorage capacity.

2.5 Restrains and Braces for Distribution Services

- .1 Type “SCR” – Cable Restraints:

- .1 manufactured system consisting of cable, building attachment, and vertical hanger rod reinforcement assembly,
- .2 field-built assemblies are not acceptable,
- .3 steel wire strand cables:
 - (a) galvanized steel aircraft cable to ASTM A1023, or stainless steel to ASTM A492
 - (b) sized for seismic load with a safety factor of 2,
 - (c) arranged for restraint in both longitudinal and transverse directions under tension loads only,
 - (d) connector strength rating equal to 90% of cable breaking strength rating.
- .4 building and equipment attachment brackets:
 - (a) carbon steel assemblies, designed to permit rotation to the final installation angle, or 45° bent steel plates with holes to allow attachment of cable loops,
 - (b) protective loop thimbles at contact with connectors,
 - (c) rope connections: overlap wire "U" clips with at least two (2) bolt fasteners, or, tool-less wedge insert lock connectors,
 - (d) selected to exceed the cable working design load by 50%,
 - (e) single sided "C" beam clamps are not acceptable.
 - (f) fasteners to building structure designed to withstand simultaneous shear and tension loads, including prying action due to the bracket.
- .2 Type "SSB" – Solid Braces:
 - .1 factory-built or field assembled solid braces, consisting of structural-shapes, building attachment, and vertical hanger rod reinforcement assembly.
 - .2 sized for seismic load with a safety factor of 2,
 - .3 arranged for restraint in both longitudinal and transverse directions.
 - .4 building and equipment attachment brackets:
 - (a) carbon steel assemblies, designed to permit rotation to the final installation angle, or 45° bent steel plates with holes to allow attachment of cable loops,
 - (b) selected to exceed the working design load by 50%,
 - (c) single sided "C" beam clamps are not acceptable.
 - (d) fasteners to building structure designed to withstand simultaneous shear and tension loads, including prying action due to the bracket.
- .3 Vibration isolators for suspended pipes and ducts:
 - .1 applies where vibration isolators are specified for pipes or ducts in Specification section 20 05 48.
 - .2 type "H2" spring hanger in accordance with Specification section 20 05 48 and with two (2) travel-limit stops of neoprene washers with integral steel inserts which are located:
 - (a) on the top of the isolator housing, with an air gap of 6 mm (1/4 in.) between the neoprene washer and the structure connection point,
 - (b) on the underside of the isolator housing, supported by a nut on the hanger rod, and provided with an air gap of 6 mm (1/4 in.) between the underside of the isolator housing and the top of the neoprene washer.
- .4 Bracing of vertical hanger rods for SCR restraints and SRB braces:
 - .1 hanger rods braced to avoid potential for buckling;
 - (a) structural steel angle or formed channel brace selected to prevent support rod buckling,
 - (b) brace attached to support rod with a series of adjustable clips, without the use of hand-tools.

- .2 hanger rods are not required where two SRB braces are provided at each seismic restraint location, and are installed at 180° opposition to each other.

2.6 Seismic Pipe Riser Support System for Piping Subject to Thermal Expansion

- .1 Application: for piping subject to thermal expansion including HVAC water systems, steam, domestic hot and cold water.
 - .1 not applicable to: drainage and vent piping systems, compressed gas and vacuum systems.
- .2 Complete engineered riser support system by support manufacturer.
- .3 Pipe riser anchors:
 - .1 outboard-mounted all-direction pipe anchors, designed for load bearing of pipe by means of pipe riser clamps or pipe support brackets,
 - .2 carbon-steel interlocking plates with bridge bearing quality neoprene pads, and painted finish,
 - .3 top-side loading plate with threaded UNC tapped mounting hole, for attachment by bolting to pipe riser clamp or welded to pipe bracket,
 - .4 variants for mechanical anchoring to concrete floor or field-welding to structural steel framing,
 - .5 one pair of guides per guide location.

Standard of Acceptance

- Vibro-Acoustics - fig. PRA, PRA-S

- .4 Pipe riser guides:
 - .1 outboard-mounted pipe guides, designed for load bearing of pipe by means of pipe riser clamps or pipe support brackets,
 - .2 carbon-steel sliding guides with EPDM lateral bushings and bridge bearing quality neoprene end pads, and painted finish,
 - .3 top-side loading plate with threaded UNC tapped mounting hole, for attachment by bolting to pipe riser clamp or welded to pipe bracket,
 - .4 one pair of guides per guide location.

Standard of Acceptance

- Vibro-Acoustics - fig. PRG, PRG-S

- .5 Pipe riser isolators:
 - .1 open spring assembly, with neoprene base and equipment loading plate, and mounting bolt hole for attachment by bolting to pipe riser clamp or welded to pipe bracket.
 - .2 springs selected for four times the riser expansion or contraction at the supported location, to not exceed a maximum 25% load change between installed and operating condition.

Standard of Acceptance

- Vibro-Acoustics - fig. FST series

- .6 Pipe riser clamps:
 - .1 Carbon steel pipe:
 - (a) NPS 1-1/2 and under – carbon steel riser clamps, ANSI/MSS SP-58 type 8.

Standard of Acceptance

- Anvil - fig. 261

- (b) NPS 2 to 24 – 4 or 6 bolt carbon steel riser clamps, ANSI/MSS SP-58 type 42.

Standard of Acceptance

- Anvil - fig. 40

.2 Stainless steel pipe:

- (a) NPS ½ to NPS 12 – T304 stainless steel, ANSI/MSS SP-58 type 8.
- (b) special pattern with extended ears and 4 bolts to allow bearing on pipe riser anchors, guides and isolators.

Standard of Acceptance

- Anvil - fig. 261SS special.

.3 Copper tube:

- (a) NPS ½ to NPS 4 – carbon steel with copper plated finish, ANSI/MSS SP-58 type 8.
- (b) special pattern with extended ears and 4 bolts to allow bearing on pipe riser anchors, guides and isolators.

Standard of Acceptance

- Anvil - fig. CT-121 special.

.7 Pipe brackets:

- .1 purpose engineered, carbon steel structural shapes with reinforcing gussets, for full welding attachment to pipe and to load plates on pipe anchors, guides or isolators.
- .2 painted finish.

2.7 Seismic Pipe Riser Supports – Piping not Subject to Thermal Expansion

- .1 Use pipe riser clamps and guides in accordance with Specification section 20 05 29, except select components to have a load capacity equal to at least two times the combined dead weight, dynamic load and seismic load.

2.8 Mechanical Anchors

.1 General:

- .1 Post-installed mechanical anchors in concrete to be seismically qualified for installation in cracked concrete in accordance with ACI 355.2 by testing for seismic tension and shear loads in cracked concrete in accordance with ICC-EC AC193, and qualified by an ICC-ES seismic evaluation report.
- .2 Anchors installed in concrete masonry units to be seismically qualified in accordance with TMS 402/602 by testing for seismic tension and shear loads in accordance with ICC-ES AC01 or AC106, and be qualified by an ICC-ES seismic evaluation report.
- .3 Anchors to be selected for concurrent shear and tension loads with a safety factor not less than 2.0 times estimated load.

.2 Undercut anchors for post-concrete installation:

- .1 zinc-plated carbon steel bolt, nut, washer and cone-shape bearing-bell, with tungsten-tipped cutting radial edges, to create bearing force by keying into concrete,

- (a) for outdoor use, all materials are to be stainless steel.
- .2 special undercut stop-drill bit and installation setting tool,
- .3 marking system to indicate when the anchor is completely installed,
- .4 designed for pre-setting of anchors and/or fastening of anchors through the equipment attachment opening,

Standard of Acceptance

- Hilti - fig. HDA (indoor), HDA-R (outdoor)
- .3 Expansion wedge anchors for post-concrete or masonry unit installation:
- .1 zinc-plated carbon steel bolt, nut, washer, expanding segments and wedge mandrel, to create restraint force by friction and keying against/into adjacent concrete,
 - (a) for outdoor use, all materials are to be stainless steel.
 - .2 torque- loading to determine complete installation,

Standard of Acceptance

- Hilti - fig. KB-TZ2 (concrete and masonry)
 - Hilti - fig. HSL-3 (concrete only)
- .4 Screw anchors for masonry units:
- .1 Zinc-plated carbon steel masonry screw with hex washer head, to create restraint force by keying into concrete masonry units.
 - (a) for outdoor use, all materials to be stainless steel.

Standard of Acceptance

- Hilti - fig. KH-EZ series.
- .5 Housekeeping pad anchors:
- .1 for installation prior to pouring of the housekeeping pad and post-installation of the structural floor,
 - .2 tapered ductile iron body, with openings sized for two runs of Ø10mm (#3) reinforcing bar, and body NC threaded receiver for connection to undercut or expanding wedge anchors,
 - .3 two pieces of Ø10mm (#3) reinforcing bar, of sufficient length to tie into housekeeping pad reinforcement,
 - .4 undercut or expanding wedge anchor for connection to the structural floor slab.

Standard of Acceptance

- Mason Industries - fig. HPA

2.9 Adhesive Anchors

- .1 Adhesive anchors for post-concrete installation:
- .1 seismically qualified for installation in cracked concrete in accordance with ACI 355.2 by testing for seismic tension and shear loads in cracked concrete in accordance with ICC-EC AC308.
 - .2 to have an ICC-ES seismic evaluation report, and be suitable for installation in cracked and uncracked normal- and light-weight concrete.

- .3 anchors to be selected for concurrent shear and tension loads with a safety factor not less than 2.0 times estimated load.
- .4 injectable, two-component hybrid adhesive, matching threaded rod and accessories.

Standard of Acceptance

- Hilti - fig. HIT-HY 200

3 EXECUTION

3.1 General Requirements

- .1 Design and construct seismic restraints to;
 - .1 keep equipment and distribution services in place during and following seismic events,
 - .2 resist vertical loading simultaneously with transverse or longitudinal seismic loading.
- .2 Give special consideration to design for adjacent connections, insulation treatment, thermal movement, vibration isolation, and relation to building seismic joints.
- .3 Select restraint fastening systems so that full restraint will be provided assuming one failed fastener.
- .4 Install seismic restraint devices in accordance with manufacturer's instructions and Seismic Engineer's installation shop drawings.
- .5 Secure each transverse or longitudinal brace to the building structure, and not any other building service.
- .6 Restraint installation:
 - .1 install cable restraints with slack not exceeding a deflection of 12 mm (1/2 in.) measured at its midpoint, where equipment being restrained is supported on/by vibration isolators or for piping which is subject to thermal expansion,
 - .2 install cable restraints snug in all other applications,
 - .3 use solid braces only in rigidly supported situations,
 - .4 brace hanger rods forming a part of a seismic restraint to accept resulting compressive loads,
 - .5 install transverse and longitudinal braces at angles between 45 and 60° measured from the horizontal, unless the seismic bracing details by the Seismic Engineer states otherwise.
- .7 Concrete or masonry walls may be used as transverse duct restraints (but not pipe restraints), provide the wall is not a fire separation requiring the duct to be installed with a fire damper, and the annual space on any side of the duct does not exceed 12 mm (1/2 in.). Where the annual space exceeds this value, provide separate braces or use angle channels to secure the duct to the wall.
 - .1 drywall partitions, including demountable partitions, are not to be used for restraint.
- .8 Trapeze support and racks piping systems may have the rack braced (transverse and longitudinally) provided each pipe supported by the rack is restrained to the rack, while allowing thermal expansion as necessary.

3.2 Use of Pre-Engineered Bracing Details for Distribution Services

- .1 Use of pre-engineered restraint and bracing details in accordance with SMACNA (for ducts, piping and conduit) or MSS-SP-127 (for piping) is permitted. Where the installation of these services exceeds the limits of these documents, provide specific engineering restraint devices and systems.
 - .1 for SMACNA details, refer to the seismic hazard level ("SHL") by floor level in Schedule A of this Specification Section.

- .2 Restrain fire protection automatic sprinkler systems and fire standpipe systems in accordance with NFPA 13.
- .3 Provide cable restraints or bracing for transverse and longitudinal seismic restraints at spacing and locations as specified in the above referenced standards.
- .4 Exemptions for seismic restraints for distribution services (pipes, ducts, conduit) described in ASHRAE, SMACNA or MSS SP-127 are limited to the explicit exemptions described herein.

3.3 Exemptions for Duct Seismic Restraints

- .1 Except as required in paragraph .2 below, the following ductwork is not required to have seismic restraints where all the following conditions are met;
 - .1 the building is not a post-disaster building,
 - .2 ducts and duct supports are constructed to SMACNA duct construction standards,
 - .3 the extent of the free movement of the duct under seismic forces will not cause the duct to come into contact with other building services or building elements,
 - .4 HVAC ducts having a cross-sectional area of 0.56 m² (6 ft²) or less or have a linear weight for ducts and any insulation of 248 N/m (17 lb/ft) or less,
 - .5 HVAC or process ducts supported on trapeze assemblies with rod hangers, where the duct and any insulation have a linear weight of 146 N/m (10 lb/ft) or less,
 - .6 other ducts which are not subject to items.3 or .4 above are exempt where both of the following conditions apply:
 - (a) an individual duct is supported by hangers where the support height measured from the structural support to the top of the duct is 305 mm (12 in.) or less for the entire length of the run and the hanger is attached to the duct within 50 mm (2 in.) of the top of the duct with a #10 sheetmetal screws, and
 - (b) where rod hangers are used, the rod hanger at the connection to the support structure are provided with a swivel in accordance with Specification section 20 05 29 to prevent bending of the hanger rod. Where such a device only provides rotation of the hanger rod in one plane, it shall be installed to allow transverse movement of the hanger rod.
- .2 The above exemptions do not apply to ducts conveying toxic or flammable gases, chemical or biological exhaust, or ducts which are solely used for smoke control.

3.4 Exemptions for Pipe Seismic Restraints

- .1 Except as required in paragraph .2 below, the following piping is not required to have seismic restraints where all the following conditions are met;
 - .1 the pipe is supported by hangers where the support height measured from the structural support to the top of the pipe is 305 mm (12 in.) or less along the continuous length of the pipe,
 - .2 piping is supported on a trapeze where the support height measured from the structural support to the top surface of the trapeze is 305 mm (12 in.) or less along the continuous length of the pipe,
 - .3 the rod hanger at the connection to the support structure is provided with a swivel in accordance with Specification section 20 05 29 to prevent bending of the hanger rod. Where such a device only provides rotation of the hanger rod in one plane, it shall be installed to allow transverse movement of the hanger rod, and
 - .4 the extent of the free movement of the piping under seismic forces will not cause the pipe to come into contact with other building services or building elements.
- .2 The above exemptions do not apply to fire protection piping and piping conveying fuel oil, natural gas, propane gas and liquid, medical gases and compressed gases.

3.5 Building Structural Connections

- .1 Select building connection devices based on seismic loads for actual provided equipment.
- .2 For connection to concrete structures:
 - .1 Select building structure anchors as follows:
 - (a) post-installed undercut anchors or wedge-expansion anchors,
 - (b) concrete inserts may be used in new construction but only where complete seismic design is completed and seismic forces are adjusted to suit,
 - .2 Spacing between anchors: not less than 3 x the effective embedment of the greatest embedment length.
- .3 Where adhesive anchors or concrete inserts are used, the anchors are sized for an increased seismic force as described in article "Design Criteria".
- .4 For connection to steel structures:
 - .1 use double sided beam clamp, loaded to the centerline of the beam web, or
 - .2 where permitted by the building structural engineer, specifically designed welded or bolted connection may be used.
 - .3 the use of single sided "C" type beam clamps is not permitted for the connection to the building steel structure for hanger rods and seismic restraints.

3.6 Duct Restraints General Requirements

- .1 Use cable restraints or braces. Do not mix cable restraints and rigid bar restraints on the same duct system.
- .2 Use cable restraints for ductwork suspended on vibration isolators. Provide a small amount of slack in the cable to prevent vibration short-circuiting, with the slack not exceeding a lateral displacement of 12 mm (1/2 in.) at the center point of the cable.
- .3 Provide reinforcement of hanging rods to prevent buckling of the rod.

3.7 Piping Restraints General Requirements

- .1 Use cable restraints for piping subject to thermal expansion, including but not limited to chilled water, heating water, steam and glycol heating/cooling water.
- .2 Use cable restraints for piping supported on vibration isolation hangers or supports.
- .3 Use cable restraints or braces for all other piping.
- .4 Thermal expansion pipe anchors and guides on piping systems may be used as both a transverse and longitudinal seismic restraint where they are designed for concurrent thermal and seismic loadings.
- .5 Provide reinforcement of hanging rods to prevent buckling of the rod.
- .6 Where clevis hangers are used, provide a brace for the clevis cross bolt consisting of Schedule 40 pipe of the smallest size to fit over the clevis cross bolt, of a length to provide a 6 mm (1/4 in.) total gap between the reinforcement and the clevis frame.
- .7 For trapeze hangers, provide U-bolts over piping to limit lateral and vertical movement, but allow approximately 6 mm (1/4 in.) total clearance to allow pipe thermal expansion movement.
- .8 Attach restraints to pipe hangers and trapezes. For existing piping, restraints may be attached to the pipe using pipe clamp assemblies manufactured for this purpose.
- .9 Where pre-engineering restraints in accordance with SMACNA or MSS SP-127 are used, the spacing for transverse and longitudinal restraints are to be reduced to 50% of the stated spans in these documents for the following piping systems:

- .1 steel piping with threaded joints,
- .2 plastic piping including but not limited to PVC, CPVC, PP, and PVDF,
- .3 fiberglass-reinforced pipe,
- .4 cast iron drainage piping with no-hub connectors,
- .5 glass drainage piping.

3.8 Piping Movement Control at Equipment Connections

- .1 Provide flexible connectors at piping connections to equipment in accordance with Specification section 20 05 16 except/and as follows.
 - .1 The following table for equipment connectors takes precedence over the requirements of Specification section 20 05 16.

Equipment Type	Limits	Connector Type
Steam, heating and cooling coils, and humidifiers	All	Flexible Metal Hose, Corrugated Connector
Hot water reheat coils, Fan Coil units	All	Flexible Metal Hose, Flexible Non-Metallic Hose
Other equipment not specifically listed	NPS 2 and smaller	Flexible Metal Hose
	NPS 2-1/2 and larger	Corrugated Connector

- .2 Provide seismic restraints at ends of piping where connected to equipment, to limit pipe movement so that it does not cause the flexible connector devices at the equipment to exceed their lateral movement rating;
 - .1 For pipe drops to equipment, provide a pipe guide on the pipe immediately above the flexible connector device, with clearance of not more than the lateral deflection rating of the flexible connector. Line the pipe guide with 6 mm (1/4 in.) neoprene pads of bridge bearing quality. Support the guide from the floor level,
 - .2 for horizontal connections to equipment such as coils, reheat coils, duct mounted humidifiers, provide cable restraints on the rigid piping within 300 mm (12 in.) of the connection to the flexible hose,
 - .3 this requirement applies to piping that is otherwise exempt from seismic restraints.

3.9 Piping Connections to Duct Mounted Coils

- .1 This article applies to heating or cooling piping connections to the following equipment ("inline equipment"):
 - .1 duct-mounted reheat coils,
 - .2 terminal units with reheat coils,
 - .3 duct-mounted humidifiers,
 - .4 fan-coil heating and/or cooling units.
- .2 Provide seismic restraints at ends of runout piping connections to inline equipment:
 - .1 use cable restraints or rigid braces as applicable to the restraint method used for the piping systems,

- .2 where the associated portion of the piping system is otherwise exempt from seismic restraint, use cable restraints,
- .3 locate the cable restraint or rigid brace within 300 mm (12 in.) of the flexible hose connector to the inline equipment,
- .4 seismically restrain the inline equipment, whether or not the associated ductwork is provided with such restraints. For terminal units and fan coil units, use cable restraints. For duct-mounted reheat coils or humidifiers, use cable restraints on ductwork within 3 m (10 ft) of each side of the coil or humidifier for.
 - (a) where the associated ductwork is not restrained, arrange cable restraints at four corners of the inline equipment / ductwork to provide both lateral and longitudinal restraints.

3.10 Piping Risers Restraints

- .1 Use pipe anchors and guides for seismic restraints of vertical pipe risers. Do not use separate cable restraints or braces.
- .2 For horizontal seismic forces acting on vertical pipe risers, use the seismic force coefficient "Ks" value at the floor location of the pipe anchor or guide (as applicable), and the restrained weight is to include 50% of the pipe and fluid content weight between the anchor or guide and the next anchor or guide, in both vertical directions.
- .3 For piping subject to thermal expansion:
 - .1 provide fully engineered pipe riser support system,
 - .2 for steel pipe;
 - (a) provide an anchor at the location shown,
 - (b) construct the anchor assembly using heavy-duty pipe riser clamps or pipe brackets with full-welded connections to the pipe, and full-welded or bolted connections to the anchor. Use mechanical anchors to bolt the pipe anchor to concrete floor, and weld pipe anchors to steel framing.
 - (c) unless otherwise shown, use a heavy-duty pipe riser clamp with a load capacity not less than two times the combined dead weight of pipe and water, dynamic load and seismic loads.
 - .3 for copper tube,
 - (a) attach a copper sleeve that matches the OD of the tube and fully braze the sleeve to the tube.
 - (b) alternatively, use a slip-on flange over the tube and fully-braze the flange to the tube,
 - (c) position the sleeve or flange immediately above and bearing on a pipe riser clamp, which is bolted to the riser anchor.
 - .4 based on engineered support design, provide intermediate isolator supports.
- .4 For piping not subject to thermal expansion;
 - .1 provide pipe guides and riser clamps for piping not subject to thermal expansion in accordance with Specification section 20 05 29,
- .5 For all piping;
 - .1 for cast iron DWV pipe, plastic DWV pipe, and glass DWV pipe, provide a guide at each floor level.
 - .2 for all other piping, provide guide or riser clamp at every other floor but not to exceed 7.6 m (25 ft) spacing, unless engineering design determines other spacing dimensions,

3.11 Conduit Restraints

- .1 Conduits for mechanical wiring are to be restrained in accordance with the requirements of section 26 05 49.

3.12 Floor Mounted Equipment Restraints

- .1 Anchor floor mounted equipment with anchor bolts, minimum four bolts for rectangular equipment bases, and three bolts for circular equipment bases.
 - .1 friction due to gravity loads shall not be considered to provide resistance to seismic forces.
- .2 For non-isolated equipment, secure equipment directly using equipment base supports or use SRB brackets. Alternatively, use type SS1 or SS2 snubbers where equipment is not subject to overturning moments. Use type SS3 snubbers where equipment is subject to overturning moments;
 - .1 for type SS1 snubbers, provide a minimum of eight (8) snubbers for each piece of equipment, with two units placed on each corner of the equipment base frame.
 - .2 for type SS2 and SS3 snubbers, provide a minimum of four (4) snubbers for each piece of equipment, with one unit placed on each face of the equipment base frame.
- .3 For round equipment bases, such as expansion tanks with floor-support ring without mounting flanges, use type SS3 snubbers or purpose-constructed clamps to positively attach to the equipment base and anchored to the floor. Welding to the equipment base is permitted only where the equipment manufacturer information permits this method of attachment.
- .4 Provide resilient neoprene bushings and washers between equipment and anchor bolts where equipment is secured rigidly to floor or housekeeping pad.
- .5 Install snubber devices only after equipment is installed and operating, to ensure no metal-to-metal contact. Adjust snubbers so that any clearance gaps do not exceed 6 mm (1/4 in.).
- .6 For floor mounted equipment with vibration isolators;
 - .1 select basic vibration isolator in accordance with Section 20 05 48.
 - .2 select seismic restraint for each piece of equipment of either:
 - (a) integrated seismic vibration restraint type 2-S, 3-S or 4-S, or
 - (b) vibration isolator in accordance with Section 20 05 48 combined with seismic snubbers SS1, SS2 or SS3 as applicable to suit overturning moment.
 - .3 Do not mix type of restraint on the same piece of equipment.
 - .4 Where the equipment is not provided with a structural base to transfer seismic forces, provide a structural-shape or formed steel channel base or a Type C inertia base as a complete steel frames suitably cross braced in both horizontal directions to withstand seismic induced shear force and bending moments.

3.13 Suspended Equipment Restraints

- .1 For isolated equipment, select basic vibration isolator in accordance with Section 20 05 48.
- .2 Provide restraints for equipment independent of restraints provided on connecting ductwork or piping.
- .3 Provide reinforcement of hanger rods to prevent buckling.
- .4 Provide SCR type longitudinal and transverse restraints at each corner of the equipment (total of eight (8) cables). Alternatively, a single SCR cable can be installed at each corner of the equipment, positioned at 45° to both transverse and longitudinal direction and sized for concurrent transverse and longitudinal loads.

3.14 Equipment Restraints - Surface Wall-Mounted Equipment and Panels

- .1 Application: for non-rotating mechanical equipment, electrical panels, control panels, motor controllers, and other electrical distribution equipment.

- .2 Attach equipment to horizontal galvanized steel channels and fasten with bolts equipped with neoprene isolation grommet washers. Channels to extend past the side of the equipment to allow anchoring to wall. Select bolts for concurrent shear dead-weight without deduction for uplift load, and tension restraint load.
- .3 Attach channels to concrete or masonry walls with not less than four (4) anchors with each anchor having a not less than a 1.5 safety factor.

3.15 Equipment Restraints - Recessed Wall-Mounted Equipment

- .1 Application: for non-rotating mechanical equipment, electrical panels, control panels, motor controllers, and other electrical distribution equipment.
- .2 Mount recessed equipment through the top, bottom and sides of the equipment housing to adjacent block wall or wall studs.

3.16 Inspection, Testing, Adjustment and Reporting

- .1 For equipment supported on vibration isolators, field measure air gaps on each restraint and if necessary adjust the restraint so that the clearance air gap does not exceed 6 mm (1/4 in.). Provide a written report identifying the results of each test and adjustment, to the Seismic Engineer and Consultant for review.
- .2 Arrange for the seismic restraint manufacturer to inspect and report on the installation at completion of the work. Make corrections of deficiencies identified by the manufacturer. This work is to be performed prior to the final field review by the Seismic Engineer.
- .3 Arrange for Seismic Engineer to conduct a final inspection prior to substantial performance of the Work. Make corrections of deficiencies identified by Seismic Engineer. This work is to be performed prior to the final field review by Consultant.
- .4 Make corrections of deficiencies identified by Consultant.
- .5 Submit the following reports prior to application for substantial performance of the Work, or where applicable, ready-for-takeover of the Work:
 - .1 Seismic Engineer periodic and final inspection reports,
 - .2 seismic restraint manufacturer inspection reports,
 - .3 Seismic Engineer declaration of general review.

END OF SECTION

SEISMIC QUALIFICATION FOR MECHANICAL EQUIPMENT 20 05 49.23

Scope

- .1 Provide seismic qualification (certification) of specified mechanical equipment where applicable methods and method of qualification is specified in other technical Specification sections of Divisions 20 to 25.

1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
 - .1 20 05 49.13 Seismic Restraint for Mechanical Services

1.3 Definitions

- .1 The following definitions apply for the purpose of this section.

Hazardous liquids – means any liquid which is subject to the Transportation of Dangerous Goods Act (Canada) including but not limited to flammable liquids and combustible liquids.

Seismic Qualification: equipment which has been evaluated to withstand design lateral and vertical seismic induced forces:

Attachment seismic qualification (Level I qualification) - means the equipment is evaluated at the equipment's attachment point to the building structure to retain the position of the equipment during a design seismic event.

Structural seismic qualification (Level II qualification) - means the equipment's internal structural elements and components have been evaluated to remain in place and not be dislodged during a design seismic event and includes Level I qualification. Also referred to as the Equipment Force Resisting System ("EFRS").

Functional seismic qualification (Level III qualification) - means the equipment is evaluated to continue its functional operation after being subjected to a design seismic event and includes a Level I and II qualification.
- .2 Refer to Specification section 20 05 49.13 for other applicable definitions and abbreviations.

1.4 Interpretation:

- .1 In this specification, for shake table testing the parameter " S_{DS} " (5% damped spectral response acceleration parameter at short periods) used in ASCE7, ICC-ES AC156, AHRI 1271, NFPA 13, ASHRAE, SMACNA and MSS SP-127 for estimating the horizontal seismic force, has the same meaning as the parameter $[S(0.2)][F_a S_a(0.2)]$ for the Project site-specific design spectral response acceleration value at 0.2 seconds as defined in article 4.1.8.18 of the 2020 National Building Code of Canada.

1.5 Applicable Codes and Standards

- .1 Legislation
 - .1 Provincial building code applicable to the place of the Work.
- .2 Product standards:
 - .1 AHRI 1271 Standard for Seismic Qualification of HVACR Equipment (SI units)

- .2 ICC- ES AC156 Acceptance Criteria for Seismic Certification by Shake-Table Testing of Non-structural Components
- .3 Other documents:
 - .1 ASCE 7-10 American Society of Civil Engineers: Minimum Design Loads and Associated Criteria for Buildings and Other Structures
 - .2 NEMA BI 50010-2024: Seismic Certification Criteria for Nonstructural Electrical Components for Commercial Building Code Applications

1.6 Seismic Qualification Design Criteria

- .1 Common site specific design parameters to be obtained for the existing building.
- .2 Seismic force calculations for use in analysis and in shake table tests are to comply with the following:
 - .1 calculate lateral seismic forces in accordance with the building code at the place of the Work, or in its absence the 2020 National Building Code of Canada ("NBC"):

$$V_p = 0.3 S(0.2) I_E C_p \frac{A_r}{R_p} \left(1 + 2 \frac{h_x}{h_n} \right) W_p$$
 - .2 the NBC equipment specific parameters "Ar", "Rp", and "Cp" are found in Schedule "A at the end of this section.
 - .3 the NBC parameter "hx/hn" ratio for the location of the equipment in the building is to be take as a value of 1.0 except where otherwise specified.
- .3 For shake table testing, the force calculation parameters in ASCE7 are to be interpreted relative to the 2020 NBC as follows:
 - .1 the ASCE7 parameter "SDS" is taken as being equivalent to "S(0.2)" where S(0.2) is as defined in the NBC and is the maximum of S(0.2,X) and S(0.5,X),
 - .2 the ASCE7 parameter "ap" is equivalent to the NBC "Ar" parameter.
 - .3 the ASCE7 parameter "Rp" is equivalent to the NBC "Rp" parameter.
 - .4 the ASCE 7 Component importance factor "Ip" is to be read as the NBC Building Importance Factor "IE".
 - .5 the ASCE7 parameter "z/h" is to be read as the NBC parameter "hx/hn",
 - .6 the ASCE7:2022 parameter "Ω0" and "Rpμ" has no equivalent in the NBC and is not to be used and therefore the ASCE7 reduction credit in the seismic force transmitted to the equipment due to building structure ductility and overstrength factor shall not be used,
 - .7 the NBC equipment specific parameter "Cp" has no equivalent in ASCE7 but is to be included in the force calculation,
- .4 The shake table test force-time response parameters are in accordance with the following table and as follows:
 - .1 parameters for test acceleration values A_{FLX-H}, A_{RIg-H}, A_{FLX-V}, and A_{RGD-V} are as defined in ICC-ES AC156.

Location	Test Criteria	Design S(T,X) (g) [Note 1]	h_x/h_n (z/h)	Horizontal Acceleration		Vertical Acceleration	
				AFLX-H	ARIG-H	AFLX-V	ARIG-V
Top of Building	ICC-ES AC156	[●]	1.0	[●]	[●]	[●]	[●]
Grade Level and Basements	ICC-ES AC156	[●]	0.0	[●]	[●]	[●]	[●]

Notes:

[1] Has the same meaning as ASCE7 parameter S_{DS} .

1.7 Method for Seismic Qualification of Equipment

- .1 Refer to each applicable equipment Specification section for the equipment-specific seismic qualification level and certification method. This information is summarized in Schedule A at the end of this section. Where a conflict or inconsistency exists between Schedule A and the requirements of each technical specification section, the requirements in the technical section specifications shall take precedence.
- .2 For hazardous liquid atmospheric storage tanks, certify equipment for Functional seismic qualification (Level III) by static analysis with sloshing effect or by dynamic analysis, in accordance with ASCE7.
- .3 Where seismic qualification is by shake table test, equipment product line may be qualified by extrapolation or interpolation analysis from a suitable range of shake table tested sample products of the same model by either:
 - .1 in accordance with ICC ES AC156 for equipment within the scope of that standard, or
 - .2 with equipment manufacturer's supporting calculations for such equipment which are prepared by an engineer licensed in the jurisdiction of the Project.

1.8 Prequalified Equipment

- .1 Evidence of seismic qualification by analysis or shake table testing as specified herein by the following means is acceptable as evidence of complying with this specification.
- .2 By analysis:
 - .1 qualification calculations for static or dynamic analysis shall be performed and sealed by a professional engineer licensed in the jurisdiction of the manufactured product or the jurisdiction of the Work when the product is manufactured in Canada,
 - .2 where equipment is manufactured outside of Canada, the qualification calculations for static or dynamic analysis shall be either:
 - (a) performed and sealed by a professional engineer licensed in the jurisdiction of the Work, or
 - (b) performed by the equipment manufacturer or their designate and the calculations reviewed by a professional engineer licensed in the jurisdiction of the Work who will also prepare a sealed review report attesting that the reviewed calculation methods and results demonstrate the equipment is designed for the applicable seismic forces.
- .3 By shake table testing:
 - .1 shake table test report in accordance with AHRI 1271 from a testing laboratory accredited under ISO/IEC 17025 to the requirements of ICC ES AC156,
 - .2 shake table test report in accordance with NEMA BI 50010 from a testing laboratory accredited under ISO/IEC 17025 to the requirements of ICC ES AC156,
 - .3 shake table test report published by ICC-ES AC156,

- .4 equipment which is pre-approved and listed on the California Department of Health Care Access and Information "Special Seismic Certification Preapproval (OSP)" program.
- .5 in all cases, the horizontal acceleration factor " F_p/W_p " is equal to or greater than the Project horizontal acceleration ratio " $V_p/W_p = K_s$ " as stated in Specification section 20 05 49.13.

1.9 Submittals

- .1 Submit applicable supporting qualification documents with the equipment shop drawings:
 - .1 accredited testing laboratory shake table test report,
 - .2 California HCAI OSP listing including data for design horizontal seismic forces (shake table test), or
 - .3 manufacturer's analysis calculation report sealed by a professional engineer as specified herein.

2 PRODUCTS

- .1 Not Used

3 EXECUTION

3.1 Schedules

- .1 The following appended equipment schedules form part of this specification section.
 - .1 Schedule A: Summary of Equipment Seismic Qualification Requirements
- .2 Legend for Schedule A:

Seismic Force Calculations

C_p , A_r , R_p and A_x have the meanings defined in article 4.1.8.18 of the building code.

Equipment Types

Control Panel - an energized control panel which may include motor controllers.

Unit – a complete piece of equipment and which may include control panels

Unit / CP – Requirements for a Unit (excluding a control panel) and separate requirements for the Control Panel

Evaluation Method

SA - Static Analysis

DA - Dynamic Analysis

STT - Shake Table Test

"AA" & "BB" Different equipment requires different evaluation methods

"AA", "BB", "CC" Different evaluation methods may be used.

"AA" / "BB" The first equipment type listed required method "AA" evaluation and the second equipment type listed requires method "BB" evaluation.

[Excel file: 20 05 49-023 - Seismic Qualification for equipment list](#)

END OF SECTION

IDENTIFICATION FOR MECHANICAL SERVICES

20 05 53

1 GENERAL

1.1 Scope

- .1 Provide identification nameplates, labeling for piping, ductwork, equipment, and valves, and specialty signage.

1.2 Applicable Codes and Standards

- .1 Installation codes and standards:
 - .1 ANSI Z535.1 Standards for Safety Signs and Labels
 - .2 ASME A13.1 Scheme for the Identification of Piping Systems
 - .3 CSA Z7396.1 Medical Gas Pipeline Systems – Part 1: Pipelines for Medical Gases, Medical Vacuum, Medical Support Gases, and Anaesthetic Gas Scavenging Systems

1.3 Submittals

- .1 Shop drawings:
 - .1 Submit product data sheets for materials specified herein.

2 PRODUCTS

2.1 General

- .1 Manufactured identification systems:
 - .1 resistant to general chemical, and ultraviolet stabilized for outdoor use,
 - .2 minimum operating temperature: -25°C (-12°F),
 - .3 maximum operating temperature: 121°C (250°F).
 - .4 language: English

Standard of Acceptance

- Brady - identification tapes, bands, and markers.
- Seton - Setmark Pipe Markers.
- Smillie McAdams Summerlin.
- Craftmark Identification Systems.
- Primark

2.2 Engraved Equipment Identification Nameplates

- .1 Laminated nameplates:
 - .1 laminated two-layer coloured plastic plates, with engraved lettering,
 - .2 minimum size: 90 mm x 40 mm x 2.5 mm (3 in x 1½ in x ¼ in),
 - .3 letter height:
 - (a) ID and name: 20 mm (¾ in.) minimum
 - (b) power source: 10 mm (⅜ in) minimum,
 - .4 provided with Class 128 barcode and tag file,

.5 nameplate colours:

(a) nameplate and letter colours are dependent on type of electrical power supply to equipment.

Power Source	Background Colour	Letter Colour
Normal or None	White	Black
Life-Safety/ Emergency	Red	White
Stand-by (non-life safety)	Orange	White
UPS	Blue	White

Piping Identification - Medical Gas Systems

.1 Self-adhesive plastic marking tape:

.1 text with integral flow direction arrow markers,

(a) reversing text may be used,

.2 text and field colour: to CSA Z7396.1,

.3 tape width: sized to suit pipe O.D. and to overlap itself a minimum 19 mm (3/4 in),

.4 text height and marker length:

Pipe/Tube NPS	Marker Length mm (in)	Text Height mm (in)
≤ 1-1/4	200 (8)	13 (0.5)
1.5 to 2	200 (8)	19 (0.75)
2.5 to 6	300 (12)	32 (1.25)

.2 Coil-wrap pipe markers are not permitted.

2.4 Piping Identification – Piping Systems other than Medical Gas Systems

.1 General:

.1 conform to ASME A13.1 and as shown in Schedule A at the end of this Section for marking colours and global harmonization system (GHS) hazard identification symbols.

.2 text height:

Pipe/Tube NPS	Marker Length mm (in)	Text Height mm (in)
≤ 1-1/4	200 (8)	13 (0.5)
1.5 to 2	200 (8)	19 (0.75)
2.5 to 6	300 (12)	32 (1.25)
8 to 10	600 (24)	65 (2.5)
>10	800 (32)	90 (3.5)

Flexible coil-wrap manufactured markers:

- .1 PVC plastic coated markers with integral printing, or plastic cover with field applied self-adhesive markers,
- .2 reversing text with integral arrow markers,
- .3 application method:
 - (a) NPS ½ to NPS 6: full wrap of pipe
 - (b) NPS 8 and over: partial pipe wrap with perforations for securing with nylon tie-wraps, tie-wraps included.

Self-adhesive polyester pipe name marking tape:

- .1 reversing text with integral flow direction arrow markers,
- .2 tape height: 65 mm (2.5 in) minimum.
- .4 Self-adhesive vinyl flow direction marking bands:
 - .1 colour band tape with flow direction arrows,
 - .2 colours: as specified for pipe name markers.
 - .3 tape width: 50 mm (2 in)
 - .4 tape length: wrapped around pipe or covering with ends overlapping one pipe diameter but not less than 25mm (1 in).
 - .5 flow arrow: 20 mm (¾ in) minimum high

2.5 Buried Piping

- .1 Stretchable polyethylene or metallized ribbon, labeled with name of service, with service name at maximum 800 mm intervals.

2.6 Ductwork Identification

- .1 Punched stencils in PVC or card material, suitable for application of field painting.
- .2 Letter height: 50 mm (2 in).
- .3 Letter paint colour: black.

2.7 Valve Identification

- .1 Engraved plastic laminate tags:
 - .1 text for valves:
 - (a) piping system fluid service, area location description, following by a series number
 - (b) where a valve is shown on drawings to be normally closed, include "Normally Closed"
 - .2 text for steam traps: abbreviation for steam pressure (e.g. "S70") as shown, followed by a series number,
 - .3 tag background colour and test colour: same as for pipe markers in accordance with Schedule A at the end of this section.
 - .4 brass or stainless steel chain.

Medical Pipeline Valve Lockout Tags

- .1 Printed vinyl lock-out valve tags with brass grommets:
 - .1 text:
 - (a) 1st line: "Medical Gas Valve"

(b) 2nd line: “Normally Closed” or “Normally Open)” as applicable.

2.9 Miscellaneous Identification

- .1 Self-adhesive polyester marking labels with global harmonized system (GHS) hazard pictograms.
 - .1 red border on white field,
 - .2 symbol height: 100 mm (4 in) minimum.

2.10 Signage

- .1 Rigid plastic signs, UV stabilized and suitable for indoor and outdoor installation, for surface mounting.
- .2 Graphic symbols:
 - .1 graphic image in accordance with WHIMS and ISO 7010,
 - .2 sign dimensions:
 - (a) indoors: 300 x 300 mm (12 in. x 12 in.)
 - (b) outdoors: 450 x 450 mm (18 in. x 18 in.)
- .3 Colours:
 - .1 Field and text colours in accordance with ANSI Z535.1

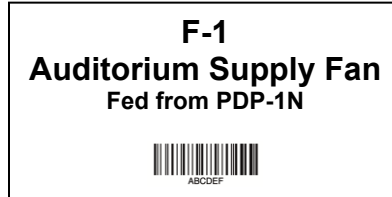
Information Type	Background Colour	Letter Colour	Primary Notification Text
General information	Blue	White	NOTICE
General Safety, Exiting	Green	White	---
Caution	Yellow	Black	CAUTION
Warning	Orange	Black	WARNING
Danger	Red	White	DANGER
Biological	Fluorescent Orange	Black	BIOHAZARD

3 EXECUTION

3.1 Equipment Identification

- .1 Where required:
 - .1 provided for equipment identified with number designations shown in equipment schedules, drawings, specifications, and/or equipment selection sheets.
 - .2 marked with equipment ID, service name, and power source using wording and numbering used in contract documents.
 - .3 for clarity, equipment identification nameplates are in addition to manufacturers plates.
- .2 Locate nameplates to be easily read, and fasten securely with mechanical fasteners. For pressure vessels, secure nameplates to equipment with high-tensile epoxy adhesive.
- .3 Do not paint over equipment manufacturer or field installed nameplates.

- .4 Provide metal standoffs on insulated equipment.
- .5 Examples:
 - .1 at equipment (fan, pump, etc.), illustrated for Normal Power:



- .2 at motor starter, adjustable frequency drive, and separate local disconnect, illustrated for Emergency Power:



3.2 Piping Identification - General

- .1 Except where otherwise specified herein, provide manufactured pipe markers of the following types based on area of the building:

self-adhesive type:

- (a) indoor uninsulated piping,
- (b) indoor insulated piping with PVC or smooth metal jackets,
- .2 flexible coil-wrap:
 - (a) outdoor piping,
 - (b) indoor insulated piping with any type of jacket.
- .3 Install self-adhesive markers on cleaned and prepared surfaces free of dirt and oil.
- .2 Install pipe markers in the following locations:
 - .1 maximum every 15 m (50 ft) along length of pipe, except for natural gas and fuel oil,
 - .2 maximum every 6 m (20 ft) along length of pipe for natural gas and fuel oil,
 - .3 within 1 m (3 ft) of each side of barriers, floors and walls,
 - .4 within 1 m (3 ft) of and behind access doors ,
 - .5 within 1 m (3 ft) of piping termination point.
- .3 Marker colours and hazard identification:

Provide pipe markers with the colour coding and hazard identification symbols in accordance with Schedule A at the end of this section.

3.3 Piping Identification - Medical Gas Systems

- .1 Provided identification markings on medical gas systems:
 - .1 maximum every 6 m (20 ft) along length of pipe,

- .2 before and after barriers, floors and walls,
- .3 at each valve,
- .4 behind access doors,
- .5 inlet and outlet points including vents.
- .2 Marker colours and hazard identification:
 - .1 Provide pipe markers with the colour coding and hazard identification symbols in accordance with Schedule A at the end of this section.

3.4 Piping Identification - Buried Piping

- .1 Provide tracer tape along entire length of pipe at a depth of:
 - .1 600 mm (2 ft) mm below top of grade for water piping,
 - .2 150 mm (6 in) above top of natural gas, propane, or fuel oil piping, and medical gas piping.
- .2 This tape is in addition to any required electrical tracing wire that may be required under other Specification sections or by legislation.

3.5 Valve Lockout Tags – Medical Gas Systems

- .1 Provide valve lockout tags at each valve which is not located in a zone control panel. Tags to be provided as Normally Open or Normally Closed as shown on drawings.

3.6 Ductwork identification

- .1 Paint stenciled letters showing;
 - .1 duct service,
 - .2 fan number, and
 - .3 arrows showing direction of flow,
- .2 Paint stencil markings at the following locations:
 - .1 exposed ducts at 15 m (50 ft) intervals in service rooms,
 - .2 exposed ducts at wall and floor penetrations in other than service rooms,
 - .3 concealed ducts above drywall-ceilings next to access doors, and
 - .4 concealed ducts above removable tile ceilings at wall and floor penetrations, and at 15 m (50 ft) intervals.
- .3 Stencil indication on prepared surfaces, and locate on both sides of any penetration.

Hazard warning labels:

- .1 provide hazard marking symbols on ductwork and associated equipment in accordance with Schedule B at the end of this Section.
- .2 install labels adjacent to ductwork identification system, and on designated equipment adjacent to equipment identification nameplate and on each access opening into the equipment.

3.7 Valve Identification

- .1 Provide valves with a numbered tag showing valve type and size, attached to valve stem or wheel handle with chain.
 - .1 Valve identification is not required at the following valves:
 - (a) inside fire hose cabinets,

- (b) radiation heating units, unit heaters, or fixture stops,
- (c) plumbing fixture service stops,
- (d) within 4 m (12 ft) and in sight of equipment, fixtures, or apparatus that the valve controls provided there is no branch piping between the valve and equipment served,
- (e) existing valves that are not provided under this project.

.2 Identification information – manual valves:

- .1 each valve tag to indicate fluid service, sequential valve number (unique for each service) including supply or return, location identifier, and normal operating position
- .2 examples (colour coding shown for illustration):

Domestic Cold Water
Riser C/1
No. 12

Natural Gas
Boiler Plant
No. 2
Normally Closed

.3 Identification information – automatic control valves:

- .1 provide valve tags for all automatic control valves except as follows:
 - (a) within sight of equipment that the valve controls.
- .2 each valve tag to indicate fluid service, control function, control valve identification number,
- .3 examples (colour coding shown for illustration):

Chilled Water
Constant Pressure
Differential Valve
CV-3

- .4 Provide a tag schedule for each system, designating valve numbers, fluid service, function, valve size, and location of each tagged item and normal operating position of each valve. Submit copies in original file format (Excel, Word) on two (2) removable mass storage devices.

3.8 Schedules

- .1 The following Schedules form part of this specification section.
 - .1 Schedule A: Piping Marker Colours and Hazard Labels
 - .2 Schedule B: Ductwork and Equipment Hazard Labels

Schedule A – Piping Marker Colours and Hazard Labels

Fluid Service Category	Piping Services	Background Colour	Lettering Colour	GHS Hazard Symbol
Water	Potable (city) water, Non-potable water, Treated City Water, Sanitary, Storm Drainage, Chilled water, Condenser water, Cooling water, Heating water, Glycol heating or cooling water, Brine water, Boiler feedwater, Steam condensate	Green	White	None
Vapour from Water	Steam, Steam Vents	White	Black	None
Fire Protection Fluids	Sprinklers, Standpipe, Foam, Gaseous	Red	White	None
Combustible Liquids	Heating oil, Diesel, Lubrication oil, Hydraulic oil	Brown	White	None
Flammable Fluids	Natural Gas, Propane	Yellow	Black	None
	Gasoline	Yellow	Black	  
Compressed Air	Compressed Air, Instrument Air, Laboratory Air	Blue	White	None
Compressed Gases	Nitrogen, Helium, Carbon Dioxide	Grey	White	
Other Gases	Vacuum, Laboratory Vacuum, Plumbing Vents	Grey	White	None

Fluid Service Category	Piping Services	Background Colour	Lettering Colour	GHS Hazard Symbol
Oxidizing Fluids	Chlorine	Yellow	Black	
Toxic and Corrosive Fluids	HVAC chemical treatment, Acid Drain, Acid Vent Decontamination Drain and Tank	Orange	Black	 
Radioactive Fluids	Isotope Drain, Isotope Vent	Orange	Black	 (ISO 7010)

Schedule B – Ductwork and Equipment Hazard Labels

Duct System	Equipment	GHS Hazard Labels
Chemical Fume Hood Exhaust	Exhaust Fans	 
Level 1 or 2 Biological Laboratory Exhaust	Exhaust Fans	
Level 3 or 4 Biological Containment Laboratory	Exhaust HEPA Filter Housing	
Hazardous Pharmaceutical Sterile Room Exhaust	Exhaust HEPA Filter Housing	
Isolation (medical) Room Exhaust Decontamination Room Exhaust	Exhaust Fans	
Flammable Storage Exhaust	Exhaust Fans	
Perchloric Acid Exhaust	Exhaust Fans	

END OF SECTION

COMMON REQUIREMENTS FOR MECHANICAL INSULATION 20 07 11

1 GENERAL

Scope

- .1 Common requirements for insulation of mechanical services provided under Division 20 to 25 of the Work. The requirements of this specification section apply to separate specification sections for insulation of ductwork, equipment and piping.

1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
 - .1 20 05 29 Common Hanger and Support Requirements for Piping
 - .2 20 07 13 Duct Insulation
 - .3 20 07 16 Equipment Insulation
 - .4 20 07 19 Piping Insulation

1.3 Definitions and Abbreviations

- .1 The following definitions apply to this section.
 - .1 **Ambient:** as applied to temperatures means the interior or outdoor air temperature at time of installation.
 - .2 **Coating:** light-consistency compound for indoor applications used in conjunction with reinforcing membrane, to provide either a breathable or vapour barrier finish to insulation.
 - .3 **Cold services:** means cold ductwork, equipment and/or equipment.
 - (a) **Cold ductwork:** mechanical ductwork with a service temperature greater than 1°C and up to and including 16°C (34°F to 61°F).
 - (b) **Cold equipment:** mechanical equipment with a service temperature of 16°C (61°F) or less,
 - (c) **Cold piping:** mechanical piping with a service temperature of 16°C (61°F) or less,
 - .4 **Concealed (services):** mechanical services that are located: in the space above opaque suspended ceilings; within trenches not located in service rooms; within pipe and/or duct shafts; or in non-accessible chases and wall cavities.
 - .5 **Conditioned air:** air supplied from air handling units that heats, cools, dehumidifies, or humidifies the air.
 - .6 **Conditioned space:** an enclosed space or room that is heating, cooled, dehumidified and/or humidified.
 - .7 **Dual temperature services:** means dual temperature ductwork, piping and/or equipment that operates, at different times, at both hot and cold temperatures.
 - (a) **Dual temperature ductwork:** mechanical ductwork that operates at temperatures greater than 1°C and up to and including 38°C (34°F to 100°F), at different times or at different locations in the duct system and includes cooling systems with terminal reheat.
 - (b) **Dual temperature equipment:** means mechanical equipment that operate, at different times, at cold equipment temperatures and at hot equipment temperatures.

- (c) **Dual temperature piping:** mechanical piping that operate, at different times, at cold piping temperatures and at hot piping temperatures.
- .8 **Ductwork:** includes ducts, fans, air handling equipment casings, and plenums.
- .9 **Exposed (services):** mechanical services that are located in areas that are not "concealed" as defined above for concealed services. For greater certainty, the following locations are exposed services:
 - (a) services in tunnels,
 - (b) services in space beneath raised floors.
 - (c) trenches located in service rooms.
- .10 **Finish covering:** a field-applied protective layer for insulation that provides an aesthetic finish but that may also provide mechanical-impact protection, weather-protective, moisture and/or vapour barrier protection.
- .11 **Hot services:** means hot ductwork, piping and/or equipment.
 - (a) **Hot ductwork:** mechanical ductwork with a service temperature greater than 28°C and up to and including 65°C (80 to 150°F) and does not have any mechanical cooling.
 - (b) **Hot equipment:** mechanical equipment with a service temperature 38°C (100°F) and greater.
 - (c) **Hot piping:** mechanical piping at service temperatures as shown in Schedule A1 of specification section 20 07 19.
- .12 **Jacket:** a factory-applied material used to contain insulation and may function as a vapour barrier. Jacketed insulation may also be further protected by covering with a finish covering.
 - (a) **All Service Jacket (ASJ)** – an insulation covering suitable for hot services and functions as a vapour barrier on cold services, typically constructed of laminated white kraft paper (outside surface) reinforced with fibreglass and bounded to an inner aluminium foil substrate.
 - (b) **Foil Scrim Kraft (FSK)** – an insulation covering suitable for hot services and functions as a vapour barrier on cold services, typically constructed of a laminate aluminium foil (outside surface) reinforced with fibreglass and bounded to an inner kraft paper layer.
 - (c) **Polypropylene Scrim Kraft (PSK)** - an insulation covering suitable for hot services and functions as a vapour barrier on cold services, typically constructed of a laminate polypropylene layer (outside surface) reinforced with fibreglass and bounded to an inner kraft paper layer.
- .13 **Mastic:** heavy-consistency waterproof compound for outdoor applications, used in conjunction with reinforcing membrane that remains adhesive and generally pliable with age, to provide either a breathable or vapour barrier finish for outdoor insulation.
- .14 **Mechanical services:** equipment, piping, ductwork and related accessories provided under Division 20 to 25 of the Work.
- .15 **Outdoor (services):** mechanical services located outside of the building envelope including services located beneath overhangs, located in unconditioned soffits, or exposed to any outdoor condition including temperature, sun exposure, or precipitation.
- .16 **Pure water:** water that has been treated with filtration equipment, including but not limited to reverse osmosis, deionization, ultra-filtration, ultra-violet, distillation or any combination of such or similar equipment, to achieve water quality significantly free of impurities.
- .17 **Service temperature:** the highest (for hot mechanical services) or the lowest (for cold mechanical services) gas or vapour design operating temperature, or the liquid supply operating temperature.
- .18 **Surface temperature:** for the purpose of this specification, has the same meaning as service temperature.

- .19 **Unconditioned (space):** rooms or spaces that are not conditioned spaces, and includes ceiling spaces which are not part of a ceiling return air plenum system.
- .20 **Wet area:** spaces subject to high humidity or where mechanical services may be exposed to direct contact with water, including not limited to: pools, shower rooms, tub rooms, medical device reprocessing, dishwashers, sterilizers, cart-washing, vehicle washing, and emergency showers.

1.4 Applicable Codes and Standards

- .1 Installation codes and standards:
 - .1 NFPA 90-A Installation of Air-Conditioning and Ventilating Systems
 - .2 ASHRAE/IES 90.1 Energy Standard for Buildings Except Low-Rise Residential Buildings
 - .3 NFPA 255 Test of Surface Burning Characteristics of Building Materials
- .2 Product standards:
 - .1 CAN/ULC-S102 Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies
 - .2 CAN/ULC-S102.2 Standard Method of Test for Surface Burning Characteristics of Flooring, Floor Coverings, and Miscellaneous Materials and Assemblies
 - .3 CAN/ULC-S114 Standard Method of Test for Determination of Non-Combustibility in Building Materials
 - .4 ASTM B209 Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
 - .5 ASTM B240 Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
 - .6 ASTM C177 Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded Hot-Plate Apparatus
 - .7 ASTM C411 Standard Test Method for Hot Surface Performance of High Temperature Thermal Insulation
 - .8 ASTM C449 Standard Specification for Mineral Fibre Hydraulic-Setting Thermal Insulation and Finishing Materials
 - .9 ASTM C518 Standard Test Method for Steady State Thermal Transmission Properties by Means of Heat Flow Meter Apparatus
 - .10 ASTM C533 Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation
 - .11 ASTM C534 Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form
 - .12 ASTM C547 Standard Specification for Mineral Fiber Pipe Insulation
 - .13 ASTM C552 Standard Specification for Cellular Glass Thermal Insulation
 - .14 ASTM C553 Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications
 - .15 ASTM C591 Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation
 - .16 ASTM C612 Standard Specification for Mineral Fiber Block and Board Thermal Insulation

- | | | |
|-----|----------------------|---|
| .17 | ASTM C795 | Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel |
| .18 | ASTM C892 | Standard Specification for High-Temperature Fiber Blanket Thermal Insulation |
| .19 | ASTM C1126 (Gr.1) | Standard Specification for Faced and Unfaced Rigid Cellular Phenolic Thermal Insulation |
| .20 | ASTM C1139 | Standard Specification for Fibrous Glass Thermal Insulation and Sound Absorbing Blanket and Board for Military Applications |
| .21 | ASTM C1290 | Standard Specification for Flexible Fibrous Glass Blanket Insulation Used to Externally Insulate HVAC Ducts |
| .22 | ASTM C1393 | Standard Specification for Perpendicularly Oriented Mineral Fiber Roll and Sheet Thermal Insulation for Pipes and Tanks |
| .23 | ASTM E84 | Standard Test Method for Surface Burning Characteristics of Building Materials |
| .24 | CGSB 51-GP-52MA | Vapour Barrier, Jacket and Facing Material for Pipe, Duct, and Equipment Thermal Insulation. |
| .25 | CGSB 51.53-95
and | Poly(Vinyl Chloride) Jacket Sheeting, for Insulated Pipes Vessels Round Ducts. |

1.5 Qualified Tradespersons

- .1 Work to be performed by a recognized specialist firm with an established reputation in this field.
 - Custom Insulation Systems
 - White & Greer Co Ltd
 - Thermax Environmental Inc.
 - ICON Insulation Inc.

1.6 Submittals

- .1 Submit manufacturer catalogue cut-sheets for the following materials in one bound submission;
 - .1 insulation,
 - .2 coatings, mastics, and sealants,
 - .3 reinforcing membranes,
 - .4 finish covering materials,
 - .5 PVC fitting covers.
- .2 Submit an installation detail drawing indicating how insulation, coatings and vapour barriers are applied in general, and specifically for pipe fittings and equipment insulation.

1.7 Quality

- .1 Manufacturers and products are listed in this section to establish quality and manufacturing standards. Products from other manufacturers with explicitly similar characteristics may be acceptable but must be submitted as an alternative product submission.

2 PRODUCTS

2.1 General Requirements

- .1 Adhesives, coatings, finish coverings, lagging, sealers, and tapes:
 - .1 maximum flame spread rating of 25 to CAN/ULC-S102/102.2 or ASTM 84.
 - .2 maximum smoke developed rating of 50 to CAN/ULC-S102/102.2 or ASTM 84.
 - .3 exception: vapor barrier mastics on mechanical services located outside of the building.

2.2 Adhesives, Fasteners, and Tape

- .1 Contact bond cement:
 - .1 for quick setting for metal surfaces.
 - .2 Volatile Organic Content: maximum 80 g/L.

Standard of Acceptance

- Bakor - fig. 220-05
- Foster – fig. Drion 85-75

- .2 Adhesive for flexible closed cell foam insulation:
 - .1 Volatile Organic Content: maximum 80 g/L.

Standard of Acceptance

- Armacell - Armaflex 520 BLV
- Armacell - Armaflex. Low VOC Spray Contact Adhesive

- .3 Lap seal adhesive:
 - .1 for joints and lap sealing of vapour barriers.
 - .2 Volatile Organic Content: maximum 250 g/L.

Standard of Acceptance

- Bakor - fig. 220-05
- Childers - fig. CHIL-STIX FRN CP-82

- .4 Fibrous insulation adhesive:
 - .1 Volatile Organic Content: maximum 250 g/L

Standard of Acceptance

- Childers - fig. CHIL-STIX FRN CP-82
- Foster - fig. 85-70

- .5 Vapour barrier tape:
 - .1 colour matched and foil faced
 - .2 listed to UL 181A.

Standard of Acceptance

- Johns Manville - fig. Zeston Z-Tape

- MacTac Canada Ltd – fig. Vinyl Scrim or Foil Scrim Kraft
- Compac Corp.
- Fattal Canvas Inc. - fig. Insultape

.6 Weld pins, studs, clips and washers:

- .1 Galvanized steel or copper plated steel, stainless steel or aluminium to match ductwork material.
- .2 Attachment method:
 - (a) welded for outdoor ducts,
 - (b) welded for indoor ducts,
 - (c) self-adhesive base may be used for vertical surfaces of rectangular ducts.

Standard of Acceptance

- Midwest - fig. Fasteners
- Jordahl - fig. Studwelding

.7 Staples:

- .1 Monel, flare type, minimum size 12 mm (½ in).

.8 Tie wire:

- .1 1.6 mm (16 ga) stainless steel with twisted ends.

.9 Caulking for sheetmetal finish covers (outdoor use only)

- .1 fast-drying, aluminum colour finish, flexible butyl elastomer based vapour barrier sealant.

Standard of Acceptance.

- Foster - fig. 95-44

2.3 Coatings and Reinforcing Membranes

.1 Reinforcing membrane:

- .1 synthetic fibre:
 - (a) Leno weave,
 - (b) indoor and outdoor use.

Standard of Acceptance

- Foster - fig. Mast-A-Fab

.2 glass-fibre fabric:

- (a) indoor use.

Standard of Acceptance

- Childers - fig. Chil-Glas #5/#10

.3 glass-fibre fabric for use with elastomeric closed cell foam:

- (a) indoor use.

Standard of Acceptance

- Childers - fig. Chil-Glass #10

.2 Breather coating - Indoors:

- .1 for breather coatings and lagging adhesive,
- .2 Volatile Organic Content: maximum 50 g/L
- .3 white in colour,

Standard of Acceptance

- Childers- fig. CP-50A HV2
- Foster - fig. 30-36

.3 Breather mastic - Outdoors:

- .1 for breather coatings and lagging adhesive,
- .2 abrasion resistive, flexible,
- .3 UV stabile,
- .4 grey in colour.

Standard of Acceptance

- Childers - fig. Vi-Cryl CP-10/11
- Foster - fig. 35-00 / 45-00
- Bakor - fig. 120-10

.4 Vapor barrier coatings - Indoors:

- .1 Volatile Organic Content: maximum 50 g/L.
- .2 for vapor barrier coatings and lagging adhesive except for elastomeric closed cell foam,
 - (a) permeance rating 0.02 perms maximum,
 - (b) white in colour

Standard of Acceptance

- Childers - fig. Chil Perm CP-34/35
- Foster - fig. 30-80, 30-90

.5 Vapor barrier mastic - Outdoors:

- .1 for vapor barrier coatings and lagging adhesive,
- .2 asphalt cutback,
- .3 permeance rating 0.02 perms maximum,
- .4 grey in colour.
- .5 for outdoor use only.

Standard of Acceptance

- Childers - fig. Chil-Pruf CP-22
- Foster - fig. 60-25/60-26

.6 Vapour barrier coatings – elastomeric foam insulation:

- .1 for indoor and outdoor use,
- .2 water bases sealer/finishing coat, water and UV resistant.
- .3 white in colour.

Standard of Acceptance

- Armacell - fig. ArmaFlex WB Finish

2.4 Insulation Finishing Cement

- .1 Mineral fibre, hydraulic-setting insulation cement, to ASTM C449
- .2 Temperature rating: 650°C (1200°F)

Standard of Acceptance

- Johns Manville - fig. CalCoat-127
- Ramco Insulation - fig. Ramcote 1200 (PKI Quick Cote)

2.5 Field Applied Coverings

- .1 Fabric finish covering:
 - .1 plain weave cotton fabric at 220 g/m² (6 oz/sq yd), treated with fire retardant lagging adhesive, or
 - .2 re-wettable fiberglass lagging fabric with water activated self-adhesive.
 - .3 suitable for field painting.

Standard of Acceptance

- Fattal - fig. Thermocanvas
- Clairmont - fig. Diplag 60
- Newtex - fig. Zetex Rewettable

- .2 PVC finish covering:
 - .1 PVC sheeting, or pre-cut and rolled sheeting to suit OD of pipe and insulation, with UV inhibitor for white colour product,
 - (a) minimum thickness:
 - i) indoors: 0.5 mm (20 mil-in.),
 - ii) outdoors: 0.8 mm (30 mil-in.),
 - (b) maximum operating temperature: 66°C (150°F) at the material,
 - (c) listed to CAN/ULC-S102/S102.2 or ASTM E84,
 - .2 PVC fitting covering with integral insulation inserts:
 - (a) minimum 0.5 mm (20 mil-in) thickness,
 - (b) pre-molded fitting covers, one or two piece,
 - (c) maximum operating temperature: 66°C (150°F) at the material,
 - (d) self-sealing longitudinal joints or field applied sealer adhesive,
 - (e) listed to CAN/ULC-S102/S102.2 or ASTM E84,

colour: white

- .4 foam-glass or glass-fibre insulation molded insert, including for elbows, tees, valves, end-caps, and mechanical pipe couplings,
- .5 multiple layers where required for thicker pipe insulation thicknesses.
- .6 pressure sensitive, colour matching vinyl tape.

Standard of Acceptance

- Johns Manville - fig. Zeston 2000
- Proto PVC - fig. LoSMOKE
- ACWIL Insulations
- Sure Fit Systems

.3 Metal finish covering:

- .1 straight pipe, duct or plenum:
 - (a) stucco embossed aluminum 3105 or 3003 to ASTM B-209, not less than 0.45 mm (0.016 in) thick sheet, with integral 3 mil polyfilm moisture barrier on the interior surface, lock-forming quality,
 - (b) stainless steel type 304 to ASTM A-240, not less than 0.25 mm (0.010 in) thick sheet, lock-forming quality;
 - i) stucco embossed,
 - ii) 0.19 mm (3/16 in) corrugated.
- .2 fittings:
 - (a) custom made swaged ring or lobster back covers on bends and die shaped fitting covers over pipe fittings, round duct fittings, valves, strainers, flanges, and grooved couplings.
- .3 bands:
 - (a) 12 mm (½ in) wide stainless steel with mechanical fasteners.

Standard of Acceptance

- Alcan Canada Products - fig. Thermaclad Type 1
- Childers Products Inc. - fig. Fab Straps

.4 Protective finish for elastomeric cellular foam insulation

- .1 indoors and outdoors:

Standard of Acceptance

- Armaflex WB Finish

2.6 Insulation

- .1 Refer to specification sections for duct, equipment, and piping insulation.

3 EXECUTION

3.1 General Requirements

- .1 Apply insulation after pressure and leakage testing is completed and accepted, and heat tracing (if any) is installed.
- .2 Surfaces to be clean and dry before application of insulation.

- .3 Store and use adhesives, mastics, and insulation cements at ambient temperatures and conditions recommended by the product manufacturers.
- .4 Do not apply insulation on chrome plated surfaces of piping, valves, fittings, and equipment.
- .5 Cut and bevel insulation around nameplates and pressure vessel certification stamps, seals or similar markings.
- .6 Neatly finish insulation at supports, protrusions, and interruptions.
- .7 Where insulation media is exposed, seal the insulation with reinforced vapor barrier or breather coating or mastic.

3.2 Installation of Insulation

- .1 Refer to specification sections for duct, equipment, and piping insulation.

3.3 Sealing of Insulation – General Requirements

- .1 The following requirements apply to all mechanical insulation unless otherwise specified in each mechanical service insulation specification section. Refer to separate specifications for specific sealing requirements for ductwork, equipment and piping insulation.
- .2 Apply sealer coatings and mastic in accordance with the following:
 - .1 use breather coating/mastics for hot services:
 - .2 use vapour barrier coating/mastic for cold and dual temperature services:
 - .3 only use mastics on outdoor installations.
 - .4 apply mastics and coatings when ambient temperature is above 4°C (40°F), unless manufacturer's instructions permit colder ambient installation conditions.
- .3 Maintain integrity of vapour barrier through sleeves, around fittings and at hangers and supports.

3.4 Insulation Finish Coverings

- .1 Where required to be provided by other mechanical insulation specification sections, install protective finish coverings in accordance with the following.
- .2 Install protective finish coverings on insulation after breather and vapor barrier sealing is completed.
- .3 For hot services that are exposed in wet areas, secure and seal coverings in accordance with the requirements for cold and dual temperature services.
- .4 Cut finish covering materials to allow 50 mm to 100 mm (2 in to 4 in) overlaps onto adjacent sheets. On vertical services, arrange circumferential overlaps to be on the lower end of each cover section.
- .5 PVC finish covering:
 - .1 Adhesives and sealers to be compatible with PVC material.
 - .2 Hot services;
 - (a) secure sheeting with colour matched tape around circumference, at least two places per section of sheet, and by stapling longitudinal and circumferential edges,
 - (b) except in wet areas, do not seal major joint edges with vapour barrier tape,
 - (c) seal PVC fitting covers at throat and heel seams by stapling and secure over adjacent insulation covers by banding or taping ends to adjacent finish covering with colour matched tape.

- (d) Install PVC covers in accordance with the requirements for cold and dual temperature services.
- .3 Cold and dual temperature services:
 - (a) seal longitudinal edges with vapor barrier coating adhesive or colour matched vapour barrier tape for the full length and depth of the overlap,
 - (b) seal circumferential butt edges of PVC fitting covers with reinforced vapour barrier coating adhesive extending over adjacent pipe insulation section with an overlap of at least 50 mm (2 in),
 - (c) seal PVC fitting covers at throat and heel seams by solvent bonding and secured over insulation with reinforced vapor barrier coating overlapping adjacent service insulation a minimum of 50 mm (2 in),
 - (d) neatly finish exposed edges with vapour barrier sealant/mastic.
- .6 Metal finish covering:
 - .1 use stucco embossed metal finish covers on round surfaces with diameter of 2.4 m (8 ft) and smaller; refer to applicable duct, equipment and piping specification sections for metal type.
 - .2 use corrugated stainless steel metal finish covers on flat surfaces, and on round surfaces with diameters greater than 2.4 m (8 ft).
 - .3 apply metal finish coverings over mechanical services, with a 60 mm (2-1/2 in) overlap,
 - .4 use lock-on systems or secure sheeting with bands 450 mm (18 in) apart.
 - (a) make-up curved surfaces with custom made swaged ring or lobster back covers.
 - .5 for indoor mechanical services;
 - (a) seal cover joints for cold and dual temperature services with clear or colour-matched calking.
 - (b) on outdoor mechanical services;
 - (c) seal cover joints for cold and dual temperature services with clear or colour-matched calking to permit expansion of metal finish covers.
- .7 Fabric finish covering:
 - .1 Cotton lagging:
 - (a) apply cotton lagging with minimum two coatings of breather or vapor barrier coating adhesive as applicable to the piping system, and finish to provide a smooth surface free of wrinkles and sags.
 - (b) where cotton lagging with appropriate coating is used this satisfies the requirements of a sealer coating for cold and dual temperature services.
 - .2 Fiberglass lagging:
 - (a) apply re-wettable fiberglass lagging in accordance with manufacturer instructions, and finish to provide a smooth surface free of wrinkles and sags.
 - (b) for cold and dual temperature services, apply a finish coat of vapour barrier sealer.
 - (c) where re-wettable fiberglass lagging is used this satisfies the requirements of a breather coating for hot piping systems,

3.5 Mechanical Damage Protection - Indoors

- .1 Protect visible pipe insulation extending up through a floor sleeve at the floor line with 1.2 mm (18 ga) thick stainless steel protection shield approximately 100 mm (4 in) high, secured to floor slab. Conceal fastenings by use of a floor plate.
- .2 For piping systems using finishes, this protection cover is in addition to the specified pipe finish cover.

3.6 Field Quality Control

- .1 The Consultant reserves the right to have protective finish coverings removed on up to 1% of all cold service and dual temperature service surfaces, fittings, flanges, couplings, valves, and ductwork/pipeline accessories to review the installation of the insulation, at no additional cost.
- .2 If insulation sealing is found to be incorrect at any one sampled location, remove the protective finish on all fittings, flanges, couplings, valves, and pipeline accessories for review, at no additional cost.
- .3 Repair defective insulation sealing and replace protective coverings at no additional cost.

End of Section

DUCTWORK INSULATION

20 07 13

1 GENERAL

Scope

- .1 Provide insulation, coatings, finish coverings and mechanical protection for ducts, casing, plenums, fans and associated equipment.
- .2 insulation is not required on factory insulated casings and/or over acoustically lined ductwork except as otherwise shown.
- .3 Conform to specification section 20 07 11 for common requirements for mechanical insulation.

1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
 - .1 20 07 11 Common Requirements for Mechanical Insulation
 - .2 23 31 13 Metal Ducts

1.3 Definitions and Abbreviations

- .1 Refer to Specification section 20 07 11 and as otherwise specified herein.

1.4 Applicable Codes and Standards

- .1 Refer to Specification section 20 07 11.

1.5 Submittals

- .1 Comply with the requirements of Specification section 20 07 11 except/and as specified herein.
- .2 Submit shop drawing details for construction of insulation for outdoor ducts, including details for
 - .1 sloping of insulation,
 - .2 installation of vapour barrier/breather coats, and protective finish covering details,
 - .3 reinforcing sheeting for larger ducts.

2 PRODUCTS

2.1 General Requirements

- .1 Insulation, adhesives, coatings, finish coverings, lagging, sealers, and tapes:
 - .1 maximum flame spread rating of 25 to CAN/ULC-S102/102.2 or ASTM 84,
 - .2 maximum smoke developed rating of 50 to CAN/ULC-S102/102.2 or ASTM 84,
 - .3 exception: vapor barrier mastics on mechanical services located outside of the building.

2.2 Ductwork Insulation

- .1 Type D-1 (glass-fibre roll blanket):
 - .1 flexible glass-fibre blanket, formaldehyde-free to ASTM C1290,
 - .2 density: 12 kg/m³ (0.75 pcf),

- .3 service temperature with jacketed: up to 65°C (150°F),
- .4 foil skim kraft ("FSK") jacket of aluminium foil reinforced with glass fibre yarn, and laminated to kraft paper,
- .5 vapour transmission: maximum 0.02 perms to ASTM E96 Procedure A,
- .6 listed to CAN/ULC-S102/S102.2 or ASTM E84,
- .7 minimum RSI values at a mean temperature of 24°C (75°F) at the pre-installed nominal insulation thickness:

Nominal Thickness mm (in)	RSI m ² ·°C/W	Nominal Thickness mm (in)	RSI m ² ·°C/W
25 (1)	0.53	55 (2.2)	1.06
40 (1.5)	0.74	110 (4.4)	2.11

Standard of Acceptance

- Johns Manville - Microlite FSK Duct Wrap
- Owens Corning - SOFTR Duct Wrap
- Knauf Fibreglass - Atmosphere Duct Wrap

- .8 Same as above except provided with a PSK (polypropylene-scrim-draft) vapour barrier jacket.

Standard of Acceptance

- Johns Manville - Microlite Black PSK

.2 Type D-2 (rigid glass fibre board):

- .1 rigid glass-fibre insulation board to ASTM C612,
- .2 density:
 - (a) indoors: 48 kg/m³ (3.0 lb./ft³),
 - (b) outdoors: 96 kg/m³ (6.0 lb./ft³),
- .3 service temperature:
 - (a) unfaced board: up to 232°C (450°F),
 - (b) faced board: up to 65°C (150°F),
- .4 foil skim kraft ("FSK") jacket of aluminium foil reinforced with glass fibre yarn, and laminated to kraft paper,
- .5 vapor transmission: maximum 0.02 perms,
- .6 listed to CAN/ULC-S102/S102.2 or ASTM E84,
- .7 minimum RSI values at a mean temperature of 24°C (75°F) at the specified insulation thickness:

Nominal Thickness mm (in)	RSI m ² ·°C/W	Nominal Thickness mm (in)	RSI m ² ·°C/W
25 (1)	0.76	50 (2)	1.51

40 (1-1/2)	1.14	75 (3)	2.27
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Standard of Acceptance

- ° Johns Manville - Manville 814 Spin-Glas
- ° Owens Corning - 703 Board
- ° Knauf Fiberglass - Insulating Board

.3 Type D-3 (mineral fibre board, high temperature)

- .1 rigid-board, mineral fibre to ASTM C411,
- .2 density: 145 kg/m³ (9.1 lb./ft³),
- .3 service temperature: up to 700°C (1292°F),
- .4 listed to CAN/ULC-S102/S102.2 or ASTM E84,
- .5 not to exceed a maximum thermal conductivity at the following meant insulation temperatures:

Mean Temperature °C	Conductivity W/(m·°C)	Mean Temperature °C	Conductivity W/(m·°C)
100	0.044	700	0.158

Standard of Acceptance

- ° Roxul - ProRox SL 980

3 EXECUTION

3.1 Applicable Systems to be Insulated

- .1 Insulate ductwork, plenums, casings and equipment in accordance with the following, and of the insulation type and thickness in accordance with Schedule 1 at the end of this specification section.
- .2 Externally insulate casings and equipment:
 - .1 air handling units producing conditioned supply air,
 - .2 air handling units conveying exhaust air downstream of heat recovery devices,
 - .3 free-standing supply air fans (not enclosed in a casing or plenum).
- .3 Externally insulate ductwork and plenums:
 - .1 cold and dual temperature ductwork conveying conditioned supply air including downstream of reheat coils,
 - .2 hot ductwork conveying conditioned supply air up to the space served but not within the space itself,
 - .3 unconditioned supply air ducts and plenums located in unheated spaces,
 - .4 return air and exhaust air ducts and plenums in unheated spaces,
 - .5 outside air intake ducts and plenums,
 - .6 exhaust air plenums at point of discharge to outside of building,
 - .7 exhaust air ducts and plenums downstream of heat recovery devices,

- .8 exhaust air ducts between exhaust air damper and point of discharge to outside of building,
- .9 mixed air plenums and ducts;
 - (a) for recirculating type ventilation systems without cooling coils, terminate outside air intake insulation 300 mm (12 in) downstream of mixing plenum,
- .10 150 mm (6 in) entering and leaving length overlap of acoustically lined ductwork,
- .11 sheet metal blank-off plates behind unused sections of air intake louvers.
- .4 Externally insulate ductwork located outdoors:
 - .1 conditioned supply ducts,
 - .2 return ducts,
 - .3 general and process exhaust ducts between building and rooftop exhaust fan,
 - (a) excluding outdoor fan discharge duct,
 - .4 kitchen exhaust ducts between building and rooftop exhaust fan, with more than 3 m (10 ft) length of duct on roof,
 - (a) excluding outdoor fan discharge duct.
- .5 External insulation is not required on:
 - .1 casings, ducts or plenums which have been lined with acoustic insulation, except as described above,
 - .2 ducts, plenums, casings and freestanding supply fans conveying unconditioned air,
 - .3 portions of intake ducts or plenums, unit casings and conditioned air plenums which are of double wall insulated construction,
 - .4 factory insulated flexible connectors (ducts),
 - .5 factory insulated air handling units,
 - .6 for non-recirculating make-up air type ventilation systems with a supply air temperature less than 27°C (80°F),
 - (a) terminate casing insulation 300 mm (12 in) downstream of heating coil or heating unit, and
 - (b) insulation is not required on the supply ductwork.

3.2 Installation of Rigid Insulation - Indoors

- .1 Attach insulation fastener pins, studs and clips to all surfaces of ducts, casings, plenums and fans, at approximately 300 mm (12 in) centers, each direction, but not less than two (2) rows per duct. Attachment method:
 - .1 welded type for outdoor ducts,
 - .2 welded type for indoor ducts,
 - .3 self-adhesive base type may be used for vertical surfaces of rectangular ducts.
- .2 Install rigid board insulation with joints staggered and tightly butted and no visible gaps. Install horizontal boards to overlapping over vertical boards.
- .3 Secure rigid insulation by impaling on insulation fastener pins, apply speed washers and cut off excess pin length flush with speed washer. Cover washers with vapour barrier tape extending at least 50 mm (2 in) beyond the washer.

- .4 Where space restrictions do not permit the use of mechanical fasteners, secure the insulation with 100% coverage of contact adhesive along with stainless steel banding on 300 mm (12 in) centers, with a band within 50 mm (2 in) of each duct corner.
- .5 Neatly finish insulation at supports, protrusions, and interruptions.
- .6 Apply colour matched vapour barrier tape neatly and firmly to all joints, including outside and inside corner joints, and at any exposed ends of insulation and cuts or damage to the insulation jacket. Alternatively, apply two heavy coats of applicable sealer coat and with reinforcing membrane. Extend tape or coating at least 50 mm (2 in) on each side of joint, exposed ends of insulation or repairs to insulation jacket.

3.3 Installation of Flexible Insulation – Indoors

- .1 On rectangular ducts 600 mm (24 in) and wider, and round ducts 450 mm (18 in) and wider, attach mechanical fastener pins, studs and clips to the bottom exterior surface of the duct at approximately 300 mm (12 in) centers, each direction, but not less than two (2) rows per duct. For round ductwork, the bottom of the duct is measured as being half the circumference of the duct.
- .2 Except for flexible connectors, cut flexible insulation to required circumferential length and pull-out to final installed thickness in accordance with manufacturer instructions, and to overlap insulation 50 mm (2 in) on each lap joint, and tightly butt end edges together.
- .3 For flexible connectors, apply insulation to bare (uninsulated) supply flexible connectors as follows:
 - .1 remove insulation to create a minimum 50 mm (2 in.) wide lap for both the longitudinal joint and the circumferential joint,
 - .2 cut insulation to width to provide a slightly compressed longitudinal butt joint; do not pull out insulation,
 - .3 secure longitudinal and circumferential joints with staples through the laps, and then apply vapour barrier tape over joints to create a vapour barrier seal,
 - .4 secure the ends of the insulation with vapour barrier tape to the rigid duct insulation,
 - .5 secure the ends of the insulation at the diffuser or grill with a Nylon tie-wrap over the diffuser/grille spigot and recover with vapour barrier tape to fully seal end of insulation to the diffuser/grille.
- .4 Secure flexible insulation by:
 - .1 impaling on mechanical fastener pins and secure with speed washers, and either;
 - (a) secure insulation with stainless steel wire or stainless steel banding on 300 mm (12 in) centers, or by stapling laps, or
 - (b) secure insulation with 100% insulation adhesive coverage.
- .5 Cut off excess pin length flush with speed washer. Cover washers with vapour barrier tape extending at least 50 mm (2 in) beyond the washer.
- .6 Neatly finish insulation at supports, protrusions, and interruptions.
- .7 Apply colour matched vapour barrier tape neatly and firmly to all joints, including outside and inside corner joints, and at any exposed ends of insulation and cuts or damage to the insulation jacket. Alternatively, apply two heavy coats of applicable sealer coat and with reinforcing membrane. Extend tape or coating at least 50 mm (2 in) on each side of joint, exposed ends of insulation or repairs to insulation jacket.

3.4 Insulation of Fittings, Flanges and Accessories

- .1 Cut and miter rigid insulation at elbows and fittings and attach to ductwork with mechanical fasteners as specified for ducts, and in addition secure insulation with 50% coverage of adhesive.

- .2 At junctions between external insulation and acoustically lined ducts, overlap external insulation 300 mm (12 in) over acoustically lined ducts.
- .3 Insulate flanges, support angles and standing seams with 100 mm (4 in) wide overlapping strips of insulation matching adjacent ductwork and of same thickness, and seal with two coats of breather mastic with reinforcing membrane.

3.5 Sealing Insulation - Hot Ductwork

- .1 Seal hot ductwork insulation in accordance with specification section 20 07 11 and/except as specified herein.
- .2 Indoor installation (except wet areas):
 - .1 apply vapour barrier tape to butt joints, overlapping by at least 50 mm (2 in) each side,
 - .2 do not tape longitudinal lap seams except as required to secure the insulation.
- .3 Indoor installations – wet areas:
 - .1 apply vapour barrier tape to:
 - (a) all longitudinal lap seams and butt edges,
 - (b) 100% coverage of insulation at pipe joints, fittings, couplings, etc.
 - (c) over insulation fasteners including pins/washers and staples.
- .4 Outdoor installation:
 - .1 apply two coats of breather mastic with reinforcing membrane to all corners, lap edges and butt edges, overlapping joint by minimum 50 mm (2 in) each side, and to all insulation that does not have a factory installed jacket,
 - .2 cover mechanical fastener penetrations including staples with two coats breather mastic with reinforcing membrane.

3.6 Sealing Insulation - Cold and Dual Temperature Ductwork

- .1 Seal cold and dual temperature ductwork insulation in accordance with specification section 20 07 11 and/except as specified herein.
- .2 Indoor installation (except wet areas):
 - .1 tightly seal insulation lap seams and butt joints, using factory lap seams or field-fabricated lap seams and butt strips,

apply vapor barrier coating with reinforcing membrane to all corners, lap edges and butt edges, overlapping joint by minimum 50 mm (2 in) each side,

- .3 cover insulation pin/washer fastener penetrations including staples with vapour barrier coating with reinforcing membrane, overlapping the fasteners by a minimum of 50 mm (2 in) in all directions.
- .3 Indoor installation – wet areas:
 - .1 tightly seal ductwork located within wet areas in accordance with the requirements for outdoor installation except use vapour barrier coatings.
- .4 Outdoor installation:
 - .1 apply two coats of vapour barrier mastic with reinforcing membrane to all corners, lap edges and butt edges, overlapping joint by minimum 50 mm (2 in) each side, and to all insulation that does not have a factory installed jacket,

- .2 cover mechanical fastener penetrations including staples with two coats vapour barrier mastic with reinforcing membrane, overlapping the fasteners by a minimum of 50 mm (2 in) in all directions.

3.7 Insulation Finish Covering

- .1 Provide insulation protective finish coverings selected in accordance with Schedule 2 at the end of this specification section and installed in accordance with specification section 20 07 11 and/except as specified herein.

3.8 Mechanical Damage Protection - Indoors

- .1 Protect exposed insulated ductwork from floor level up to a height of 1200 mm (4 ft) above the floor with 0.9 mm (20 ga.) galvanized steel jacket, with riveted longitudinal seams and mechanically fastened to the floor with countersunk stainless steel screws.
- .2 Where waterproof floor sleeves are required, the floor sleeve may be combined with this requirement.

3.9 Insulating and Finishes Tables

- .1 The insulating and finishing tables follow:
 - .1 Schedule 1 - Ductwork, Insulation Type and Thickness
 - .2 Schedule 2 - Ductwork Insulation Protective Finishes.

**Schedule 1:
Ductwork Insulation Type and Thickness**

Duct Air Service Temperature	Location	Equipment Description	Insulation Type	Insulation Thickness mm (in) [Note 1]
5°C to 65°C (40 to 150°F)	Indoors	Air handling unit casings and plenums, Free standing supply fans	D-2	50 (2)
		Rectangular ducts and plenums – exposed or concealed	D-2	25 (1)
		Rectangular ducts - concealed	D-1	25 (1)
		Round and Oval ducts - exposed		
	Unconditioned Space	Rectangular ducts and plenums	D2	40 (1-1/2)
			D1	55 (2.2)
		Round and Oval ducts	D1	55 (2.2)
	Outdoors	Rectangular and Oval – Supply, Return	D-2	75 (3)
		Round and Oval – Supply, Return	D-1	110 (4.4) [Note 2, 3]
		Rectangular – Process and General Exhaust	D-2	1 (25)
		Round – Process and General Exhaust	D-1	1.5 (40)

.... continued on next page

Table 1: (continued)
Ductwork Insulation Type and Thickness

Duct Air Service Temperature	Location	Equipment Description	Insulation Type	Insulation Thickness mm (in) [Note 1]
-40 to +40°C (-40 to 104°F)	Indoors	Plenums and Casings – Air Intakes	D2	Two layers 50 (2)
-10 to +40°C (14 to 104°F)	Indoors	Plenums and Casings – Exhaust	D2	50 (2)
5 to 16°C	Indoors	Drain Pans	D2	1 (25)

Notes:

[1] Type D-1 flexible duct insulation thickness is “out of box” before installation.

[2] Insulation thickness may be provided by two layers, so that the total insulation thickness “out of the box” is equal to or greater than the specified thickness.

[3] Flexible duct may be used only on the rounded sides of flat oval ducts.

Schedule 2:
Ductwork Insulation Protective Finish Coverings

Location	Exposed/ Concealed	System/ Space	Protective Finish Covering
Indoors	Concealed	All	None
	Exposed	Service Rooms	Metal
		Public Spaces	Metal
Outdoors	Any	All	Metal

End of Section

EQUIPMENT INSULATION 20 07 16

1 GENERAL

Scope

- .1 Provide insulation, coatings, finish coverings and mechanical protection for heating and cooling equipment.
- .2 Insulation is not required on factory insulated equipment.
- .3 Conform to specification section 20 07 11 for common requirements for mechanical insulation.

1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
 - .1 20 07 11 Common Requirements for Mechanical Insulation

1.3 Definitions and Abbreviations

- .1 Refer to Specification section 20 07 11 and as otherwise specified herein.

1.4 Applicable Codes and Standards

- .1 Refer to Specification section 20 07 11.

1.5 Submittals

- .1 Comply with the requirements of Specification section 20 07 11 except/and as specified herein.

2 PRODUCTS

2.1 General Requirements

- .1 Insulation, adhesives, coatings, finish coverings, lagging, sealers, and tapes:
 - .1 maximum flame spread rating of 25 to CAN/ULC-S102/102.2 or ASTM 84,
 - .2 maximum smoke developed rating of 50 to CAN/ULC-S102/102.2 or ASTM 84,
 - .3 exception: vapor barrier mastics on mechanical services located outside of the building.

2.2 Equipment Insulation

- .1 Type E-1 (glass fibre, semi-rigid roll):
 - .1 glass fibre semi-rigid roll insulation for tanks and pipes, to ASTM C1393 or ASTM C177,
 - .2 glass-fibre oriented to maintain uniform thickness when installed on round surfaces,
 - .3 density: 40 kg/m³ (2.5 lb/ft³),
 - .4 nominal pipe size: NPS 14 and larger,
 - .5 service temperature, jacketed: up to 65°C (150°F),
 - .6 jacket: integral all-service-jacket (ASJ) of white kraft paper bonded to aluminum foil substrate reinforced with tri-directional fiber-glass scrim.
 - .7 vapor transmission: maximum 0.02 perms to ASTM E96,

- .8 listed to CAN/ULC-S102/S102.2 or ASTM E84,
- .9 not to exceed a maximum thermal conductivity at the following mean insulation temperatures:

Mean Temperature °C	Conductivity W/(m·°C)	Mean Temperature °C	Conductivity W/(m·°C)
24	0.035	93	0.046

Standard of Acceptance

- Johns Manville - Micro-Flex Pipe and Tank Wrap
- Owens Corning - Fiberglas Pipe and Tank
- Knauf Fibreglass - KwikFlex Pipe and Tank

.2 Type E-2 (glass fibre, rigid board):

- .1 rigid glass-fibre insulation board to ASTM C612,
- .2 density:
 - (a) indoors: 48 kg/m³ (3.0 lb/ft³),
 - (b) outdoors: 96 kg/m³ (6.0 lb/ft³),
- .3 service temperature:
 - (a) unfaced board: up to 232°C (450°F),
 - (b) faced board: up to 65°C (150°F),
- .4 jacket: integral foil skim-kraft (FSK) jacket of aluminium foil reinforced with glass fibre yarn, and laminated to kraft paper,
- .5 vapor transmission: maximum 0.02 perms,
- .6 listed to CAN/ULC-S102/S102.2 or ASTM E84,
- .7 minimum RSI values at a mean temperature of 24°C (75°F) at the specified insulation thickness:

Nominal Thickness mm (in)	RSI m·°C/W	Nominal Thickness mm (in)	RSI m·°C/W
25 (1)	0.76	50 (2)	1.51
40 (1-1/2)	1.14	75 (3)	2.27

Standard of Acceptance

- Johns Manville - Manville 814 Spin-Glas
- Owens Corning - 703 Board
- Knauf Fiberglass - Insulating Board

.3 Type E-3 (mineral fibre, roll)

- .1 mineral wool, roll insulation for tanks and pipes, to ASTM C553,
- .2 density: 90 kg/m³ (5.6 lb/cu ft),
- .3 service temperature: up to 650°C (1200°F),
- .4 listed to CAN/ULC-S102/S102.2 or ASTM E84,

.5 not to exceed a maximum thermal conductivity at the following mean insulation temperatures:

Mean Temperature °C	Conductivity W/(m·°C)	Mean Temperature °C	Conductivity W/(m·°C)
149	0.053	315	0.090

Standard of Acceptance

- ° Roxul - ProRox MA 960NA
- ° Johns Manville - MinWool-1200 Pipe and Tank

.4 Type E-4 (mineral fibre, semi-rigid roll):

- .1 mineral wool, semi-rigid roll for tanks and pipes, to ASTM C547,
- .2 density: 90 kg/m³ (5.6 lb/cu ft),
- .3 service temperature: up to 650°C (1200°F),
- .4 listed to CAN/ULC-S102/S102.2 or ASTM E84,
- .5 non-combustible to CAN/ULC-S114 or does not flame, glow, smolder or smoke when tested to ASTM C411.
- .6 not to exceed a maximum thermal conductivity at the following mean insulation temperatures:

Mean Temperature °C	Conductivity W/(m·°C)	Mean Temperature °C	Conductivity W/(m·°C)
149	0.053	315	0.090

Standard of Acceptance

- ° Johns Manville - MinWool-1200 Field-Formed

.5 Type E-5 (mineral fibre board):

- .1 rigid-board, mineral fibre to ASTM C612,
- .2 density: 95 - 100 kg/m³ (6 - 6.2 lb/ft³),
- .3 service temperature: up to 650°C (1200°F),
- .4 listed to CAN/ULC-S102/S102.2 or ASTM E84,
- .5 non-combustible to CAN/ULC-S114 or does not flame, glow, smolder or smoke when tested to ASTM C411.
- .6 not to exceed a maximum thermal conductivity at the following mean insulation temperatures:

Mean Temperature °C	Conductivity W/(m·°C)	Mean Temperature °C	Conductivity W/(m·°C)
100	0.045	600	0.175

Standard of Acceptance

- ° Roxul - ProRox SL 960

- Johns Manville - MinWool-1200 Industrial Board

.6 Type E-6 (molded mineral fibre):

- .1 factory molded mineral fibre to ASTM C547,
- .2 density: 128 kg/m³ (8.0 lb/ft³),
- .3 equivalent nominal pipe size: NPS 44 and smaller,
- .4 service temperature: up to 650°C (1200°F),
- .5 listed to CAN/ULC-S102/S102.2 or ASTM E84,
- .6 not to exceed a maximum thermal conductivity at the following mean insulation temperatures:

Mean Temperature °C	Conductivity W/(m·°C)	Mean Temperature °C	Conductivity W/(m·°C)
38	0.036	149	0.049

Standard of Acceptance

- Roxul - ProRox PS 960
- Johns Manville - MinWool-1200
- Industrial Fiber-Tek - IFT 1200 Pipe

.7 Type E-8 (elastomeric foam plastic):

- .1 flexible elastomeric closed cell foam, to ASTM C534,
- .2 service temperature: -183°C (-297°F) to 82°C (183°F),
- .3 maximum thickness: 25 mm (1 in),
- .4 manufacturer specific sealer/adhesive,
- .5 listed to CAN/ULC-S102/S102.2 or ASTM E84,
- .6 not to exceed a maximum thermal conductivity at 25 mm (1 in) thickness at the following mean insulation temperatures:

Mean Temperature °C	Conductivity W/(m·°C)	Mean Temperature °C	Conductivity W/(m·°C)
24	0.035	32	0.037

Standard of Acceptance

- Armstrong - AP Armaflex
- Rubatex

.8 Type E-9 (calcium silicate):

- .1 fabricated pipe and fitting shapes, calcium silicate, asbestos-free, to ASTM C533 Type I,
- .2 density: 232 kg/m³ (14.5 lb/cu ft),
- .3 integral corrosion inhibitor to reduce under insulation corrosion,
- .4 nominal pipe size: NPS 4 to NPS 24,

- .5 service temperature: 20 to 649°C (70 to 1200°F),
- .6 listed to CAN/ULC-S102/S102.2 or ASTM E84,
- .7 non-combustible to CAN/ULC-S114 or does not flame, glow, smolder or smoke when tested to ASTM C411.
- .8 not to exceed a maximum thermal conductivity at the following meant insulation temperatures:

Mean Temperature °C	Conductivity W/(m·°C)	Mean Temperature °C	Conductivity W/(m·°C)
38	0.050	93	0.056

Standard of Acceptance

- ° Johns Manville - Thermo-12 Gold

- .9 Type E-10 (removable high-temperature insulated jackets):
 - .1 custom fabricated, removable/reusable high temperature insulated jackets for hot surfaces,
 - .2 suitable for indoor and outdoor use,
 - .3 process surface temperature: as shown in Schedule 1,
 - .4 maximum outer jacket touch-safe temperature protection: 95°C (203°F),
 - .5 outer jacket: silicone impregnated glass-fibre, for temperatures up to 260°C (500°F),
 - .6 insulation: mineral or fibreglass insulation suitable for system operating temperature,
 - .7 internal liner: silicone impregnated fibreglass fabric, or stainless steel knitted wire mesh,
 - .8 fasteners:
 - (a) stainless steel laced wire, for pipe sections,
 - (b) stainless steel mesh straps with buckle rings, for valves, strainers, meters and similar pipeline accessories,
 - .9 metal identification tag, referenced equipment served,
 - .10 listed to CAN/ULC-S102/S102.2 or ASTM E84,
 - .11 non-combustible to CAN/ULC-S114 or does not flame, glow, smolder or smoke when tested to ASTM C411.

Standard of Acceptance

- ° Firwin Corporation
- ° Thermohelp Canada Inc.

3 EXECUTION

3.1 Applicable Equipment

- .1 Insulate hot equipment where the highest service temperature of the equipment is 38°C (100°F) and higher in accordance with Schedule 1A and 1B at the end of this specification section.
- .2 Insulate cold and dual temperature equipment where the lowest service temperature is 16°C (61°F) or less in accordance with Schedule 2 at the end of this Section.

3.2 Insulation of Equipment – General Requirements

- .1 Place insulation with joints staggered and tightly butted so that there are no voids.

- .2 Do not use weld pins on plate-and-frame heat exchangers, deaerator vessels, condensate tanks or other manufactured vessels.
- .3 For flat surfaces, and curved surfaces with radius 250 mm (10 in) and greater:
 - .1 secure insulation with stainless steel bands at not more than 300 mm (12 in) spacing, or secure rigid board insulation with adhesive applied in strips 150 mm (6 in) wide at not more than 300 mm (12 in) centers,
 - .2 for boiler breeching, provide metal corner beads to reinforce corners and edges of rectangular breeching.
- .4 For curved surfaces with radius less than 250 mm (10 in):
 - .1 cut insulation with bevels to allow full butt joints to prevent "V" shaped gaps between pieces,
 - .2 secure insulation with stainless steel bands or wire at not more than 300 mm (12 in) spacing, and apply adhesive in strips 150 mm (6 in) wide at not more than 300 mm (12 in) centers,
- .5 For irregular surfaces of equipment, pipe couplings and flanged nozzles;
 - .1 use preformed sections, or mitred segments of rigid board and/or semi-rigid roll insulation secured with stainless wire, or wrap with roll-type insulation to thickness equal to that of adjoining insulation.
- .6 For nozzles, manholes, and access doors:
 - .1 terminate insulation with straight cut with space of 25 mm (1 in) at connection,
 - .2 seal cut of insulation with insulation coatings/mastic beveled away from flanged or union connections,
 - .3 cover flanged joint, union, manhole and access doors with removable and replaceable aluminum insulated box overlapping adjacent insulation by 50 mm (2 in) and secured with bands.
- .7 For instruments and instrument sensor risers:
 - .1 tightly fit equipment insulation to instrument riser/piping,
 - .2 in addition, for cold and dual temperature equipment, insulate the instrument sensor riser for a length equal to four (4) times the diameter of the riser pipe.
- .8 Additional Requirements for Calcium Silicate Insulation
 - .1 Apply using high temperature adhesive.
 - .2 Place insulation in double layers with joints tightly butted and staggered and fill voids and openings in assembly with insulating cement.
 - .3 Secure insulation with 1.6 mm (16 ga) stainless steel wire or bands at not more than 300 mm (12 in) on center. Use welded studs, clips, flanges or angles as anchors for wire and bands.
- .9 For equipment having a surface temperature greater than 121°C (250°F);
 - .1 apply insulation finishing cement at all exposed edges of insulation where the insulation is interrupted by valves, flanges, connections to other equipment, and equipment supports and anchors.
 - .2 apply the cement to create a neat surface finish over the end face of the insulation and overlap onto the outside surface of the insulation jacket (other than metal finish jackets) by at least 50 mm (2 in.). Avoid applying the cement to the adjoining equipment surface.

3.3 Sealing Insulation - Hot Equipment

- .1 Seal equipment insulation in accordance with specification section 20 07 11 and/except as specified herein.
- .2 Indoor installation:
 - .1 apply vapour barrier tape to butt joints, overlapping by at least 50 mm (2 in) each side,
 - .2 do not tape lap joints except as required to secure the insulation,
 - .3 sealing of indoor insulation is not required where a protection finish jacket is applied.
- .3 Outdoor installation:
 - .1 apply two coats of breather mastic complete with reinforcing membrane over the entire exposed insulation surface, regardless of final finish jacket application,
 - .2 breather mastics are not required on type E-10 insulation,
 - .3 seal type E-9 insulation with a 100% coverage of insulation finishing cement.

3.4 Sealing Insulation - Cold and Dual Temperature Equipment

- .1 Seal equipment insulation in accordance with specification section 20 07 11 and/except as specified herein.
- .2 All insulation except type E-8 for indoor and outdoor installation:
 - .1 apply two coats of vapor barrier coating/mastic complete with reinforcing membrane over equipment insulation, regardless of final finish jacket application.
 - .2 at pipe connections, cut-back insulation and seal with coating/mastic; insulate pipe flanges in accordance with requirements for piping insulation.
 - .3 at instruments and instrumentation sensor riser, cut-back and seal insulation with coating/mastic at riser, and seal sensor riser insulation.
- .3 Type E-8 insulation:
 - .1 seal transverse and butt joints for type E-8 insulation with sealer/adhesive specific to elastomeric foam insulation,

3.5 Insulation Finish Covering

- .1 Provide insulation protective finish coverings selected in accordance with Schedules 1 to 3 at the end of this specification section and installed in accordance with specification section 20 07 11 and/except as specified herein.

3.6 Insulating and Finishes Schedules

- .1 The insulating and finishing tables follow:
 - .1 Schedule 1A - Hot Equipment, Insulation Type, Thickness, and Coverings (excluding engines)
 - .2 Schedule 2 - Cold and Dual Temperature Equipment, Insulation Type, Thickness and Coverings
 - .3 Schedule 3 - Equipment Insulation Protective Finish Coverings

**Schedule 1A:
Hot Equipment Insulation Type, Thickness, and Coverings (excluding engines)**

Equipment Description	Fluid Service Temperature °C (°F)	Insulation Type	Insulation Thickness	Protective Finishing Covering [Note 1]
Shell-and-Tube Heat exchangers Flash tanks Expansion tanks	≥ 38 to ≤ 120 (≥ 100 to ≤ 248)	E-1, E-3, E-4	50 (2)	[Fabric] [St. Steel] [Aluminium]
Domestic hot water tank & heaters	≥ 38 to ≤ 120 (≥ 100 to ≤ 248)	E-1, E-3	40 (1½)	
Any other hot equipment	> 120 to ≤ 260 (> 248 to ≤ 500)	E-4, E-5	50 (2)	Fabric
			90 (3.5)	[St. Steel] [Aluminium]
	≥ 38 to ≤ 120 (≥ 100 to ≤ 248)	E-1 to E-6	25 (1)	[Fabric] [St. Steel] [Aluminium]

Notes:

[1] For exposed equipment located indoors. See Schedule 3 for other locations.

**Schedule 2:
Cold and Dual Temperature Equipment Insulation Type, Thickness, and Coverings**

Fluid Service Temperature °C (°F)	Equipment Description	Insulation Type	Insulation Thickness	Protective Finishing Covering [Note 1]
≥ 4 and ≤ 16 (≥ 39 and ≤ 61)	Heat exchangers; plate-and-frame	E-2	2 layers each 20 (3/4)	Fabric
	Domestic cold-water booster pumps, Domestic cold-water meter, Domestic cold-water backflow preventers	E-8	12 (1/2)	None
	Equipment not otherwise identified.	E-1, E-2	25 (1)	Fabric
		E-8	20 (3/4)	None
< 4 (< 39)	Refrigeration equipment: evaporator shell and heads	E-8	2 layers each 25 (1)	WB coating
	Refrigeration equipment: liquid refrigerant piping and accessories	E-8	25 (1)	None

Notes:

[1] For exposed equipment located indoors. See Schedule 3 for other locations.

**Schedule 3:
Equipment Insulation Protective Finish Coverings**

Location	Exposed/ Concealed	Equipment	Protective Finish Covering
Indoors	Concealed	Hot	None
		Radiant Panels	FSK
		Cold	Fabric
	Exposed	All	See Tables 1A, 1B, 2
Outdoors	Exposed	All	Stainless Steel

End of Section

PIPING INSULATION

20 07 19

GENERAL

1.1 Scope

- .1 Provide insulation, coatings, finishing coverings and mechanical protection of piping, valves, fittings, and pipeline accessories.
- .2 Conform to Specification section 20 07 11 for common requirements for mechanical insulation.

1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other Specification sections, the work under this section directly integrates with or refers to the following Specification sections:
 - .1 20 05 29 Common Hanger and Support Requirements for Piping
 - .2 20 07 11 Common Requirements for Mechanical Insulation

1.3 Definitions and Abbreviations

- .1 Refer to Specification section 20 07 11 and as otherwise specified herein.

1.4 Applicable Codes and Standards

- .1 Refer to Specification section 20 07 11.

1.5 Submittals

- .1 Comply with the requirements of Specification section 20 07 11 except/and as specified herein.
- .2 Submit a shop drawing illustrating the method of insulation of pipe fittings, flanges and couplings for Cold and Dual Temperature piping. Submittal to include:
 - .1 type of insulation material being used (mitered preformed piping insulation sections, insulation inserts or blanket); this may vary based on pipe size,
 - .2 for insulation inserts and blanket methods, indicate the insulation thickness and number of layers required for each pipe size, the adjacent pipe insulation thickness, and the final compressed thickness of the fitting insulation,
 - .3 method and shop details of application of vapour barrier, including details for sealing of PVC jackets.
- .3 When requested by Consultant, submit full size mock-up examples of pipe fitting insulation for Cold and Dual-Temperature piping, complete with selected vapour barrier method. Submittal to include one elbow and one Tee based on pipe size as selected by Consultant.

2 PRODUCTS

2.1 General Requirements

- .1 Insulation, adhesives, coatings, finish coverings, lagging, sealers, and tapes:
 - .1 maximum flame spread rating of 25 to CAN/ULC-S102/102.2 or ASTM 84.
 - .2 maximum smoke developed rating of 50 to CAN/ULC-S102/102.2 or ASTM 84.
 - .3 exception: vapor barrier mastics on mechanical services located outside of the building

2.2 Pipe Insulation

.1 Type P-1 (molded glass-fiber):

- .1 factory molded rigid glass-fiber to ASTM C547,
- .2 nominal pipe size: NPS 24 and smaller,
- .3 service temperature, jacketed: -18°C (0°F) to 65°C (150°F),
- .4 jacket: all-service-jacket (ASJ) of white kraft paper bonded to aluminum foil, reinforced with glass fiber yarn, and laminated to an interior kraft paper face,
- .5 vapor transmission: maximum 0.02 perms to ASTM E96,
- .6 listed to CAN/ULC-S102/S102.2 or ASTM E84,
- .7 reduced environmental impact feature of either: bio-based binders, 25% minimum recycled glass content, and/or paper-free ASJ jacket material,
- .8 not to exceed a maximum thermal conductivity at the following meant insulation temperatures:

Mean Temperature °C	Conductivity W/(m·°C)	Mean Temperature °C	Conductivity W/(m·°C)
24	0.034	93	0.040

Standard of Acceptance

- Johns Manville - fig. Micro-Lok HP (25% recycled content)
- Owens Corning - fig. Fiberglas Evolution (paper-free ASJ)
- Knauf Fiberglass - fig. Earthwool 1000 Ecosse (bio-based binders)

.2 Type P-2 (semi-rigid glass-fiber roll):

- .1 glass fiber semi-rigid roll insulation for tanks and pipes, to ASTM C1393,
- .2 glass-fiber oriented to maintain uniform thickness when installed on round surfaces,
- .3 density: 40 kg/m³ (2.5 lb./ft³),
- .4 nominal pipe size: NPS 14 and larger,
- .5 service temperature with jacket: up to 65°C (150°F),
- .6 jacket: all-service-jacket ("ASJ") of white kraft paper bonded to aluminum foil, reinforced with glass fiber yarn, and laminated to an interior kraft paper face,
- .7 vapor transmission: maximum 0.02 perms to ASTM E96,
- .8 listed to CAN/ULC-S102/S102.2 or ASTM E84,
- .9 not to exceed a maximum thermal conductivity at the following meant insulation temperatures:

Mean Temperature °C	Conductivity W/(m·°C)	Mean Temperature °C	Conductivity W/(m·°C)
24	0.035	93	0.046

Standard of Acceptance

- Johns Manville - fig. Micro-Flex Pipe and Tank Wrap
- Owens Corning - fig. Fiberglas Pipe and Tank
- Knauf Fibreglass - fig. KwikFlex Pipe and Tank

.3 Type P-3 (molded mineral fiber):

- .1 factory molded mineral fiber to ASTM C547,
- .2 density: 128 kg/m³ (8.0 lb./ft³),
- .3 nominal pipe size: NPS 30 and smaller,
- .4 service temperature: up to 650°C (1200°F),
- .5 jacket: integral foil skim-kraft (FSK) jacket of aluminium foil reinforced with glass fiber yarn, and laminated to kraft paper,
- .6 listed to CAN/ULC-S102/S102.2 or ASTM E84,
- .7 not to exceed a maximum thermal conductivity at the following meant insulation temperatures:

Mean Temperature °C	Conductivity W/(m·°C)	Mean Temperature °C	Conductivity W/(m·°C)
38	0.036	149	0.049

Standard of Acceptance

- Rockwool - fig. ProRox PS 960
- Johns Manville - fig. MinWool-1200
- Industrial Fiber-Tek - fig. IFT 1200 Pipe

.4 Type P-4 (molded mineral fiber, high temperature):

- .1 factory molded mineral fiber, high temperature, to ASTM C547,
- .2 density: 145 kg/m³ (9.1 lb./ft³),
- .3 nominal pipe size: NPS 6 and larger,
- .4 service temperature: up to 760°C (1400°F),
- .5 jacket: none,
- .6 compressive strength: 53 kPa (8 psi) at 10% compression,
- .7 listed to CAN/ULC-S102/S102.2 or ASTM E84,
- .8 not to exceed a maximum thermal conductivity at the following meant insulation temperatures:

Mean Temperature °C	Conductivity W/(m·°C)	Mean Temperature °C	Conductivity W/(m·°C)
38	0.039	149	0.049

Standard of Acceptance

- Rockwool - fig. ProRox PS 980

.5 Type P-5 (cellular glass):

- .1 fabricated pipe and fitting shapes, cellular glass to ASTM C552,

- .2 density: 120 kg/m³ (7.5 lb./ft³),
- .3 minimum compressive strength perpendicular to pipe surface: 620 kPa (90 psi),
- .4 nominal pipe size: NPS 16 and smaller,
- .5 service temperature: -268°C (-450°F) to 480°C (900°F),
- .6 minimum compressive strength perpendicular to pipe surface: 620 kPa (90 psi),
- .7 jacket: none,
- .8 listed to CAN/ULC-S102/S102.2 or ASTM E84,
- .9 not to exceed a maximum thermal conductivity at the following meant insulation temperatures:

Mean Temperature °C	Conductivity W/(m·°C)	Mean Temperature °C	Conductivity W/(m·°C)
10	0.040	24	0.042

Standard of Acceptance

- Owens Corning - fig. Foamglas

.6 Type P-6 (elastomeric foam plastic):

- .1 flexible elastomeric closed cell foam, tubular with self-sealing seams, to ASTM C534,
- .2 nominal pipe size: NPS 2 and smaller,
- .3 service temperature: -183°C (-297°F) to 82°C (183°F),
- .4 jacket: none,
- .5 manufacturer specific sealer/adhesive,
- .6 listed to CAN/ULC-S102/S102.2 or ASTM E84,
- .7 not to exceed a maximum thermal conductivity at the following meant insulation temperatures:

Mean Temperature °C	Conductivity W/(m·°C)	Mean Temperature °C	Conductivity W/(m·°C)
24	0.035	32	0.037

Standard of Acceptance

- Armacell - fig. AP Armaflex SS Pipe Insulation
- KFlex USA - fig. Insul-Tube

Type P-7 (calcium silicate):

- .1 fabricated pipe and fitting shapes, calcium silicate, asbestos-free, to ASTM C533 Type I,
- .2 density: 232 kg/m³ (14.5 lb./ft³),
- .3 minimum compressive strength perpendicular to pipe surface: 620 kPa (90 psi),
- .4 integral corrosion inhibitor to reduce under insulation corrosion,
- .5 nominal pipe size: NPS 4 to NPS 24,

- .6 service temperature: 20 to 649°C (70 to 1200°F).
- .7 jacket: none,
- .8 listed to CAN/ULC-S102/S102.2 or ASTM E84,
- .9 non-combustible to CAN/ULC-S114 or does not flame, glow, smolder or smoke when tested to ASTM C411.
- .10 not to exceed a maximum thermal conductivity at the following meant insulation temperatures:

Mean Temperature °C	Conductivity W/(m·°C)	Mean Temperature °C	Conductivity W/(m·°C)
38	0.050	93	0.056

Standard of Acceptance

- Johns Manville - fig. Thermo-12 Gold

- .8 Type P-8 (removable high-temperature insulated jackets):
 - .1 custom fabricated, removable/reusable high temperature insulated jackets for hot surfaces,
 - .2 suitable for indoor and outdoor use,
 - .3 process surface temperature: as shown in Schedule A,
 - .4 maximum outer jacket touch-safe temperature protection: 95°C (203°F),
 - .5 jacket: silicone impregnated glass-fiber, for temperatures up to 260°C (500°F),
 - .6 insulation: mineral or fiberglass insulation suitable for system operating temperature,
 - .7 internal liner: silicone impregnated fiberglass fabric, or stainless steel knitted wire mesh,
 - .8 fasteners:
 - (a) stainless steel laced wire, for pipe sections,
 - (b) stainless steel mesh straps with buckle rings, for valves, strainers, meters and similar pipeline accessories,
 - .9 metal identification tag, referenced equipment served.

Standard of Acceptance

- Firwin Corporation
- Thermohelp Canada Inc.

- .9 Type P-10 (ceramic wool)
 - .1 alkaline earth silicate fibers (AES), roll insulation for tanks and pipes, to ASTM C892,
 - .2 free of binders and lubricants,
 - .3 density: 96 kg/m³ (6 lb./ft³),
 - .4 continuous service temperature: 1000°C (1830°F),
 - .5 jacket: none,
 - .6 non-combustible,
 - .7 no requirement for labelling under the Global Harmonized System for classification labels for chemicals,

- .8 not to exceed a maximum thermal conductivity at the following mean insulation temperatures:

Mean Temperature °C	Conductivity W/(m·°C)	Mean Temperature °C	Conductivity W/(m·°C)
800	0.21	1000	0.29

Standard of Acceptance

- Morgan Thermal Ceramics - fig. Superwool Plus]]

.10 Type P-11 (pipe fitting blanket insulation):

- .1 Glass-fiber blanket, faced and unfaced,
- .2 maximum pipe service temperature limit:
 - (a) faced: 121°C (250°F),
 - (b) unfaced: 177°C (350°F),
- .3 flexible glass-fiber blanket, formaldehyde-free to ASTM C1139,
- .4 density: 16 kg/m³ (1.0 lb./ft³),
- .5 jacket: FSK or PSK jacket, unless otherwise specified as unfaced,
- .6 vapour transmission (jacketed insulation only): 0.02 perms or less,
- .7 listed to CAN/ULC-S102/S102.2,
- .8 compressed thermal conductivity: 0.058 W/m°C @ 93°C (0.40 BTU•in/(hr•ft²•°F) @ 200°F)

Standard of Acceptance

- Knauf Fibreglass - Atmosphere Duct Wrap

.11 Type P-12 (pipe fitting insulation insert)

- .1 manufactured pre-cut shaped inserts specifically formed for insulation of pipe fittings,
- .2 maximum pipe service temperature limit: 454°C (850°F),
- .3 flexible glass-fiber blanket, formaldehyde-free to ASTM C547,
- .4 density: 16 kg/m³ (1.0 lb./ft³),
- .5 service temperature: minimum -18 to 454°C (0 to 850°F),
- .6 jacket: none (unfaced),
- .7 vapour transmission: not applicable,
- .8 listed to CAN/ULC-S102/S102.2,
- .9 compressed thermal conductivity: 0.058 W/m°C @ 150°C (0.40 BTU•in/(hr•ft²•°F) @ 300°F)

Standard of Acceptance

- Johns Manville - fig. Zeston Hi-Lo Temp Insulation Inserts

2.3 Pipe Support Insulation Inserts

- .1 General:

- .1 molded or fabricated high-density molded insulation inserts for pipe supports.
- .2 Type P-21 – factory insulated shields:
 - .1 factory assembled high-density insulation insert with insulation shield,
 - .2 nominal pipe size: NPS 1/2 to NPS 30,
 - .3 service temperature: -40 to +125°C (-40 to +275°F),
 - .4 insulation:
 - (a) rigid phenolic foam insulation, to ASTM C1126, Gr.2, Type III,
 - (b) thickness: to match thickness of adjacent pipe insulation,
 - (c) nominal density:
 - i) NPS 10 and under: 60 kg/m³ (3.75 lb./ft³),
 - ii) NPS 12 to 30: 80 kg/m³ (5.0 lb./ft³),
 - (d) minimum compressive strength perpendicular to pipe surface: 620 kPa (90 psi),
 - (e) pipe circumference coverage: 360°,
 - (f) insulation length: to extend at least 38 mm (1-1/2 in.) past each end of the integrated shield.
 - (g) vapour barrier jacket: three-ply composite polyester film and aluminium foil with self-securing lap-seal, with zero perm rating,
 - (h) listed to CAN/ULC-S102/S102.2 or ASTM E84.
 - .5 insulation shield:
 - (a) Z275 (G90) coating-weight galvanized steel to ASTM A653, with formed ribs to center clevis hanger or strut,
 - (b) edges flared or hemmed to prevent damage to insulation,
 - (c) adhered to bottom of insulation insert,
 - (d) width: covering 180° arc of insulation,
 - (e) length and thickness: as required to not exceed the compression strength of the insulation insert when supporting piping filled with water based on the maximum pipe support spans as defined in MSS SP-58.
 - .6 heavy-duty insulation shield (designation P-21HD):
 - (a) as specified above for insulation shield except/and as follows,
 - (b) shield thickness: 2.75 mm (12 ga),
 - (c) with structural steel plate welded to bottom of shield.
 - .7 sliding protection shield (designation P-21SL)
 - (a) as specified above for insulation shield except/and as follows,
 - (b) secondary shield located below the primary protection shield, with PTFE layer bonded to the upper surface of the secondary shield,
 - (c) designed to allow relative movement between the primary shield and secondary shield.

Standard of Acceptance

- Buckaroos Inc. - fig. CoolDry Insulated Saddles
- Buckaroos Inc. - fig. CoolDry Heavy Duty Insulated Saddles
- Buckaroos Inc. - fig. CoolDry Sliding Insulated Saddles

- .3 Type P-22 - cellular glass:
 - .1 cellular glass to ASTM C552,

- .2 nominal pipe size: NPS 1-1/2 to NPS 24,
- .3 density: nominal 120 kg/m³ (7.5 lb./ft³),
- .4 minimum compressive strength perpendicular to pipe surface: 620 kPa (90 psi),
- .5 service temperature: -73°C to +121°C (-100°F to 250°F),
- .6 listed to CAN/ULC-S102/S102.2 or ASTM E84.

Standard of Acceptance

- ° Owens Corning - fig. Foamglas

.4 Type P-23 - calcium silicate:

- .1 calcium silicate to ASTM C533 Type I, with integral corrosion inhibitor to reduce under insulation corrosion, asbestos-free,
- .2 nominal pipe size: NPS 1-1/2 to NPS 24,
- .3 density: nominal 232 kg/m³ (14.5 lb./cu ft),
- .4 minimum compressive strength perpendicular to pipe surface: 620 kPa (90 psi),
- .5 service temperature: 20 to 649°C (70 to 1200°F),
- .6 thermal performance: 0.058 W/m/C @ 149°C (0.40 btu/hr/in/sq ft/F @ 300°F).

Standard of Acceptance

- ° Johns Manville - fig. Thermo-12 Gold

3 EXECUTION

3.1 General

- .1 Where repairs are made to existing insulated piping due to connections of new piping work, the insulation thickness for the existing piping is permitted to match the existing insulation nominal thickness, provided the extent of new insulation does not exceed a length of 1000 mm (39 in).

3.2 Applicable Systems – Hot piping

- .1 Insulate Hot piping systems including pipe, valves, fittings, and pipeline accessories in accordance with the Schedule A at the end of this Specification section.
- .2 Insulate condensate piping in accordance with the same criteria as its associated steam system.
- .3 Insulate inlet and discharge piping for safety valves or safety relief valves that is located;
 - .1 less than 2.4 m (8 ft) above a floor or work surface, or
 - .2 within 1 m (39 in) horizontally of, and less than 2.4 m (8 ft) above, an elevated work surface.

3.3 Applicable Systems - Cold and Dual Temperature Piping

- .1 Insulate Cold and Dual temperature piping systems including pipe, valves, fittings, and pipeline accessories in accordance with Schedule B at the end of this Specification section.
- .2 Insulate the following drainage services or equipment:
 - .1 storm water drainage systems in the following locations:
 - (a) roof drain bodies,

- (b) rainwater leaders (storm water piping) from roof drain bodies to the floor level below the drain body,
- (c) rainwater leaders in or above data and telecommunication rooms,
- (d) rainwater leaders in or immediately above wet areas.

.2 sanitary piping in the following locations:

horizontal sanitary drainage piping NPS 3 and larger in ceiling spaces,

- (b) sanitary drainage piping in or above wet areas,
- (c) sanitary drainage piping in or above data and telecommunication rooms,
- (d) exposed sanitary drainage piping in service tunnels,
- (e) exposed sanitary drainage piping serving spaces located in a parking garage,
- (f) and where shown on drawings.

3.4 Insulating Hot Piping

- .1 Insulate straight pipe sections by staggering adjacent longitudinal seams 1/4 turn for each butt joint.
- .2 For insulation having ASJ or FSK jackets, secure longitudinal flaps by either:
 - .1 use of press-on tacks or stapling the lap flap on 75 mm (3 in) centers, or
 - .2 by use of self-sealing lap adhesive strips, or
 - .3 with the use of colour-matched vapour barrier tape.
- .3 Secure insulation that does not have an integral ASJ or FSK jacket by use of stainless steel wire or bands at not less than 300 mm (12 in) centers, or by a continuous wire helix on the same center spacing.
- .4 For type P-2 and P-4 insulation, or where the required pipe insulation thickness is greater than 50 mm (2 in);
 - .1 provide two layers of approximately equal insulation thickness such that the total thickness is as specified,
 - .2 install straight pipe sections by staggering adjacent section longitudinal seams 1/4 turn for each section, and stagger butt joints between the first layer and second layer by at least 1/4 of the insulation section length, and
 - .3 secure the first layer of insulation with stainless steel wire or bands on 300 mm (12 in.) centers and secure the second layer with band straps on 300 mm (12 in) centers.
- .5 Secure butt joints with vapour barrier tape or insulation butt strips.
- .6 For piping service temperatures greater than 121°C (250°F);
 - .1 apply insulation finishing cement at all exposed edges of insulation where the insulation is interrupted by valves, connections to other equipment, and piping supports and anchors.

3.5 Insulating Cold and Dual Temperature Piping

- .1 Insulate straight pipe sections by staggering adjacent longitudinal seams 1/4 turn for each butt joint.
- .2 For insulation having ASJ or FSK jackets, secure longitudinal flaps by either:
 - .1 use of press-on tacks or stapling the lap flap on 75 mm (3 in) centers, or
 - .2 by use of self-sealing lap adhesive strips, or
 - .3 with the use of colour-matched vapour barrier tape.
- .3 Except for type P-6 insulation, secure insulation that does not have an integral ASJ or FSK jacket by:

- .1 use of 12 mm (1/2 in.) wide reinforced filament tape on approximately 150 mm (6 in.) centers for piping NPS 4 and smaller, and use stainless steel banding on 225 mm (9 in.) centers for piping NPS 6 and larger, and
 - (a) apply an all-service-jacket with 100% coverage of adhesive suitable for the insulation material, with longitudinal and butt seams having a 50 mm (2 in) overlap, and seal the laps with vapour barrier adhesive/ coating, or
 - (b) apply a heavy brush coat of vapour barrier coating at the rate of 1.2 L/m² (2.5 Imp.gallon per 100 ft²), embed a layer of reinforcing membrane, and then applying a second heavy brush coat of vapour barrier coating at the rate of 1.0 L/m² (2.1 Imp. gallon per 100 ft²).
- .4 For type P-2 insulation, or where the required pipe insulation thickness is greater than 50 mm (2 in);
 - .1 provide two layers of approximately equal thickness such that the total thickness is as specified,
 - .2 install straight pipe sections by staggering adjacent section longitudinal seams 1/4 turn for each section, and stagger butt joints between the first layer and second layer by at least 1/4 of the insulation section length, and
 - .3 secure the first layer of insulation with stainless steel wire on 300 mm (12 in.) centers and secure the second layer with stainless steel banding on 225 mm (9 in) centers.
- .5 For type P-6 insulation:
 - .1 secure insulation with field-applied adhesive or self-adhesive longitudinal edge seams and apply vapour barrier adhesive/sealant to butt joints.
- .6 Secure butt joints for all insulation types with vapor barrier tape, unless otherwise sealed using vapour barrier adhesives and coatings.
- .7 Expansion joints:
 - .1 provide an insulation expansion joints for straight pipe runs greater than 15 m (50 ft) and at every 15 m (50 ft) length thereafter,
 - .2 expansion joint consisting of 50 mm (2 in) wide type P-11 insulation for full depth of pipe insulation. Seal adjacent pipe insulation ends with vapor barrier coating.
- .8 Where pipe anchors are attached to chilled water piping or Dual Temperature piping;
 - .1 cover exposed ends of cut insulation with reinforced vapour barrier coating, with the fabric and coating overlapping by at least 50 mm (2 in.) onto the pipe anchor,
 - .2 insulate the pipe anchor with type P- 6 insulation (in round or equivalent sheet form) to a distance equal to 10 times the largest outside dimension of the anchor structure element, but not less than 150 mm (6 in) beyond pipe insulation outer surface.
- .9 Notwithstanding the method of securing the insulation, all seams and joints are to be provided with a vapor barrier seal as specified herein.

3.6 Insulation of Flanges and Groove Couplings

- .1 Unless otherwise specified, build-up layers of blanket insulation for flanges and groove couplings with multiple insulation layers so that the installed insulation in its compressed thickness is not less than the insulation thickness of the adjoining pipe.
 - .1 for P-11 blanket insulation, compress each layer by 25% of uncompressed thickness,
 - .2 for P-12 preformed inserts, compress each layer by 50% of uncompressed thickness.
- .2 Insulate flanges and grooved as follows:
 - .1 butt pipe-run insulation to each side of flange or grooved-joint coupling,

- .2 use oversized pre-molded insulation to build-up rigid insulation blocking on each side of flange or grooved-joint coupling to a height equal to the height of the flange or coupling, with a width dimension same as pipe insulation thickness,
- .3 apply rigid or blanket insulation layer over the top of the flange or coupling to a thickness equal to pipe insulation thickness.
- .3 Secure insulation with stainless steel wire, stainless steel bands, or vapour barrier tape.

3.7 Insulation of Pipe Fittings

- .1 Insulate pipe fittings including but not limited to elbows and tees.
- .2 Unless otherwise specified, build-up layers of insulation inserts or blanket insulation for pipe fittings with multiple insulation layers so that the installed insulation in its compressed thickness is not less than the insulation thickness of the adjoining pipe.
- .3 NPS 1½ and smaller (Type P-1 to P-4 insulation):
 - .1 miter cut insulation to create tight fit,
 - .2 where PVC covers are used, trim backside of insulation on elbows to suit cover but do not reduce total thickness less than that of adjacent pipe insulation,
 - .3 secure fitting insulation with vapour barrier tape.
- .4 NPS 2 and larger (type P-1 to P-4 insulation):
 - .1 **METHOD 1 – Mitered Rigid Insulation:**
 - (a) neatly cut rigid pre-formed pipe insulation in multiple-mitered sections to follow the curve of the pipe fitting,
 - (b) number of mitered segments to be sufficient to maintain thickness of insulation around throat of elbow or tee,
 - (c) secure insulation without an ASJ or FSK jacket with stainless steel wire,
 - (d) secure insulation with ASJ or FSK jacket with vapour barrier tape, covering all seams.
 - .2 **METHOD 2 – Preformed rigid fitting insulated fittings:**
 - (a) use matching preformed rigid fitting insulation units,
 - (b) secure fitting insulation using stainless steel wire or vapor barrier tape.
 - .3 **METHOD 3 – flexible inserts or blanket insulation:**
 - (a) for grooved joints and flanges: install a collar of oversized rigid pipe insulation over the end of the pipe-run insulation adjacent to the grooved coupling or flange, to achieve an overall insulation height equal to the adjacent coupling or flange height,
 - (b) wrap fittings with type P-11 or P-12 insulation, neatly applied in sufficient layers to build up total compressed insulation thickness to match adjacent pipe-run insulation thickness,
 - (c) where multiple insulation layers are used for Type P-11 insulation blanket, only the outer layer may have an integral vapour barrier jacket.
 - (d) secure insulation inserts by overlapping ends under the throat of the fitting and secure with vapour barrier tape,
 - (e) secure unfaced insulation blanket with stainless steel,
 - (f) secure jacketed insulation blanket with vapour barrier tape.
- .5 Where type P-5 or P-7 insulation is used;
 - .1 insulate fittings, flanges, and couplings as described above except use factory made rigid insulation fittings or fabricate mitered fittings, of the same material as the pipe-run insulation.
- .6 Where type P-6 insulation is used;

- .1 insulate fittings, flanges, and couplings as described above except using type P-6 insulation and adhere insulation to fitting, flange, or coupling with 100% coverage of adhesive,
- .2 do not adhere insulation across bolted connections - insulate on each side of connection and add additional insulation layer across connection and fix in place with bands and seal joints.

3.8 Insulation of Pipeline Accessories – Hot, Cold and Dual Temperature Piping

- .1 Insulate pipeline accessories depending on service temperature:
 - .1 valves,
 - .2 strainers,
 - .3 pressure reducing valves,
 - .4 control valves,
 - .5 meters.
- .2 Insulate pipeline accessories for Hot piping systems with service temperatures greater than 93°C (200°F) as follows:
 - .1 insulated with type P-8 removable/reusable fitted insulation covers, designed to allow free movement of valve actuator,
 - .2 insulation is not required at this service temperature range for drain valves, blowoff/blowdown valves, and drip caps or plugs.
- .3 Insulate pipeline accessories for Hot piping systems with service temperature greater than 60°C (140°F) and up to 93°C (200°F) or less, as follows:
 - .1 insulated with:
 - (a) type P-8 removable/reusable fitted insulation covers designed to allow free movement of valve actuator, or
 - (b) insulated with fitted pipe insulation segments, or oversized sections of insulation arranged to permit its removal and reinstallation, or
 - (c) tightly placed flexible insulation and covered with PVC fitting covers.]
 - .2 insulation is not required at this service temperature range for drain valves, drain caps/plugs, and for pipeline accessories NPS 1 and smaller.
- .4 Insulation of pipeline accessories is not required for Hot piping with service temperatures less than 60°C (104°F).
- .5 Insulate pipeline accessories for chilled water, liquid refrigerant, and Dual Temperature heating/cooling systems as follows:

METHOD 1 - Detachable insulated box type:

- (a) fabricate detachable insulated box to encapsulate the pipeline accessory,
- (b) materials: embossed aluminum or stainless steel enclosure, with minimum 25 mm (1 in.) thick internal insulation of board version of type P-6 insulation,

.2 METHOD 2 – Type P-6 insulation:

- (a) for accessories NPS 8 and larger,
- (b) install one layer of 25 mm (1 in) blanket version of type P-6 insulation adhered to pipeline accessories with 100% adhesive coverage,
- (c) seal all joints with manufacturers sealant, including the joint between P-6 insulation and adjacent piping insulation,

- (d) at locations requiring access, extend insulation to create a collar around bolted connection, and install a compression fit piece of insulation to cover equipment.

.3 METHOD 3 – Fitted insulation:

- (a) for accessories NPS 4 and smaller,
 - (b) insulate with fitted pipe insulation or mitered blocks with all joints sealed with two coats of vapour barrier coating complete with reinforcing membrane.
- .6 Insulate accessories for all other Cold piping systems as follows:
- .1 insulate with flexible blanket insulation, fitted pipe insulation inserts or mitered block of same material and thickness of adjacent piping and seal all joints with two coats of vapour barrier coating complete with reinforcing membrane or vapour barrier tape.
- .7 At locations requiring access including valve handles, valve actuators, drain valves, etc. cut-back insulation and seal exposed edges.

3.9 Additional Requirements for Insulation of Engine Combustion Gas Exhaust Piping

- .1 In addition to the general requirements for Hot piping insulation installation specified herein, insulate field-fabricated engine combustion gas exhaust piping systems as follows.
- .2 For type P-10 insulation as 1st layer and type P-3 insulation as the 2nd layer:
 - .1 install the 1st layer of insulation with at least 50 mm (2 in) longitudinal overlap;
 - (a) do not stretch-out the insulation.
 - (b) secure with stainless steel wire in a double helix at approximately 225 mm (9 in.) on centers and at an incline of approximately 45°,
 - .2 install the 2nd layer of insulation by compressing slightly the 1st layer and secure the 2nd layer insulation with stainless steel bands at not more than 225 mm (9 in) spacing,
- .3 For type P-7 insulation as both 1st and 2nd layers:
 - .1 do not use adhesive to attach the insulation to the equipment,
 - .2 secure both layers with stainless steel wire in a double helix at approximately 225 mm (9 in.) on centers and at an incline of approximately 45°,
- .4 Provide type P-23 (calcium silicate) high-density insulation inserts at hanger support locations where clevis hanger or trapeze hangers are used.
- .5 For straight piping runs greater than 15 m and at every 15 m length thereafter;
 - .1 provide an insulation expansion joint consisting of 50 mm (2 in) wide type P-10 insulation for full depth of both insulation layers,
 - .2 where insulation expansion joint is concealed, secure with a stainless steel cover jacket that extends at least 50 mm (2 in) on each side of the insulation expansion joint.

3.10 Additional Requirements for Insulation of Drainage Systems

- .1 In addition to the general requirements for Cold and Dual Temperature piping insulation specified herein, insulate the underside of roof drain hoppers with Type P-11 insulation except with FSK or PSK jacket and seal all joints with two coats of vapour barrier coating complete with reinforcing membrane, or, seal with vapour barrier tape.

3.11 Insulation Protection at Pipe Supports

- .1 Installation of pipe insulation saddle protection for Hot piping:
 - .1 pipe saddles provided under Specification section 20 05 29,

- .2 insulate the interior void spaces of pipe saddles, using the same material as adjacent pipe insulation,
- .3 butt insulation up to sides and end of pipe saddle and leave bottom surface of saddle exposed for direct contact with pipe support.
- .2 Installation of pipe insulation shield protection for hot and cold piping:
 - .1 pipe insulation shields are provided under Specification section 20 05 29 except where specified herein as a factory assembled insulation insert and shield.
 - .2 provide high-density insulation inserts at pipe hanger locations as specified herein and in accordance with Specification 20 05 29 subject to fluid service temperature and pipe size,
 - (a) insert length: at least 50 mm (2 in) longer than the shield length to allow application of vapour barrier sealant or tape, but not less than the following:

Pipe Size NPS	Insulation Insert Length mm (in)
1 ½ to 4	400 (16)
6	550 (22)
8 - 24	700 (28)

- (b) arc width: one-half of the pipe diameter for type P-22 and P-23 inserts,
- .3 fabricate the high-density inserts so their thickness is the same as the adjacent installed pipe-run insulation, with finished surface thickness within +3 mm/-0 mm (+1/8 in / -0 in) of adjacent pipe insulation thickness,
- .4 for cold water piping, apply insulation cover and vapour barrier sealant to fully cover and seal the high-density insert, and to overlap the adjacent pipe-run insulation by at least 50 mm (2 in) on all edges,
- .5 install the insulation shield between the finished insulation and the support pipe; the pipe support is sized for the outside dimension of pipe and insulation.

3.12 Insulation at Floor and Wall Openings

- .1 Extend pipe insulation at full required thickness through floor and wall openings for Hot, Cold and Dual Temperature piping. Vapour barrier jackets for Cold and Dual Temperature piping are to extend unbroken through the wall or floor penetration. Finish coverings for Hot piping with service temperatures not exceeding 93°C (200°F) may terminate on each side of the opening.
- .2 Reduction in insulation thickness through floor or wall openings is not permitted except by prior approval of Consultant on specific exceptional case basis;
 - .1 exception: Hot piping with service temperature not exceeding 93°C (200°F) may be reduced by one-half the required thickness stated in Schedule A1 through wall and floor penetrations, but such thickness reduction shall not extend more than 25 mm (1 in.) on each side of the opening.
- .3 For penetrations through fire rated separations, provide finishes in accordance with fire stopping manufacturer's listing requirements.
- .4 For outdoor piping passing through exterior walls or roof, terminate mastic lagging at outside face of sleeve and provide storm flashing to protect insulation, caulked to jacket and to building structure.

3.13 Sealing of Insulation – Hot Piping

- .1 Seal hot piping insulation in accordance with Specification section 20 07 11 and/except as specified herein.
- .2 Indoor installation (except wet areas):
 - .1 except where separate protective finishing jacket is used, apply vapour barrier tape to butt joints, overlapping by at least 25 mm (1 in) each side,
 - .2 where a separate protective finishing jacket is provided, no additional sealing of the insulation is required.
- .3 Indoor installations – Wet Areas:
 - .1 In Wet Areas, seal Hot piping in accordance with the requirements of chilled water piping and Dual Temperature piping in Wet Areas.
- .4 Outdoor installation:
 - .1 for outdoor piping, apply two coats of breather mastic complete with reinforcing membrane to all lap edges and butt edges, overlapping joint by minimum 50 mm (2 in) each side, and to all insulation that does not have a factory installed jacket.

3.14 Sealing of Insulation – Cold and Dual Temperature Piping Without All Service Jacket

- .1 Provide vapour barrier jackets for Cold and Dual Temperature piping insulation which does not have an all service jacket (unfaced) in accordance with Specification section 20 07 11 and/except as specified herein, where piping is installed indoors in non-Wet Areas.
- .2 For exposed or concealed Cold Piping and Dual Temperature piping insulation without an integral all service jacket (unfaced), tightly seal pipe-run insulation longitudinal seams and butt joints using of the following methods:
 - .1 apply two coats of vapour barrier coating with reinforcing membrane over all insulation and pipe fittings, or
 - .2 cover insulation and pipe fittings, flanges and couplings with sealed PVC jackets as specified herein.

3.15 Sealing of Insulation – Cold and Dual Temperature Piping Without All Service Jacket

- .1 Provide vapour barrier seals of Cold and Dual Temperature piping insulation in accordance with Specification section 20 07 11 and/except as specified herein.
- .2 For chilled water and Dual Temperature pipe-run insulation with integral all service jackets (ASJ), tightly seal pipe-run insulation longitudinal seams and butt joints in accordance with the following method types and applicable locations in Table 1 which identifies where each method is permitted or required to be used:
 - .1 **METHOD 1 – Vapour Barrier Tape:**
 - (a) with complete coverage of insulation seam and joint with colour-matched 75 mm (3 in.) wide vapour barrier tape,
 - .2 **METHOD 2 – Vapour Barrier Coating:**
 - (a) with two coats of vapor barrier coating complete with reinforcing membrane,
 - (b) coating to overlap seam or joint by at least 50 mm (2 in.) on each side.
 - .3 **METHOD 3 – Sealed PVC Jacket:**
 - (a) with sealed PVC pipe-run insulation finish cover.

In the following table 1, "Critical Environment" rooms are defined as:

- (a) Data and telecommunication rooms,

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- (b) Medical diagnostic imaging equipment rooms and technical support spaces,
- (c) Food production and handling spaces,
- (d) Pharmacy dispensing and compounding rooms,
- (e) Wet chemistry laboratories,
- (f) Animal holding and laboratories,

Table 1 Pipe-Run Insulation Joint Sealing Method Chilled Water and Dual Temperature Piping With All Service Jacket				
Piping Location	Insulation Location	Method 1 Vapour Barrier Tape	Method 2 Vapour Barrier Coating	Method 3 Sealed PVC Jacket [Note 1]
Mechanical Service Rooms	Exposed or Concealed	No	Permitted	Permitted
Tunnels	Exposed	No	Permitted	Permitted
Vertical Service Spaces (shafts)	Concealed	Permitted	Permitted	Permitted
Trenches	Exposed	No	Permitted	Permitted
	Concealed	No	Permitted	Permitted
Critical Environment rooms	Exposed or Concealed	No	Permitted	Permitted
Below raised floors	Exposed	No	Permitted	Permitted
Wet Area	Concealed	No	No	Required
	Exposed	No	No	Required
All other indoor spaces	Concealed	Permitted	Permitted	Permitted
	Exposed	No	Permitted	Permitted
Outdoors	---	No	Required [Note 2]	Permitted

Notes:

[1] Where PVC finish jacket is also specified.

[2] Required where metal finish jacket is specified.

- .5 apply seal to overlap insulation edges and butt joint by minimum 40 mm (1.5 in) each side,
 - .6 seal the butt end of the insulation with vapour barrier coating, overlapping onto the piping, at every fourth length of piping, but not to exceed 4 m (13 ft) in pipe run length,
 - .7 seal exposed ends of insulation shoulders at pipe flanges and couplings with vapour barrier coating.
- .3 Seal insulation on pipe fittings, flanges and gaskets using Method 1, 2 or 3 in article on sealing of such pipe materials.

3.16 Sealing of Insulation on Pipe Fittings, Flanges and Couplings - Cold and Dual Temperature Piping

- .1 Seal insulation on Cold and Dual Temperature pipe fittings, flanges, and couplings by one of the following methods and selected in accordance with Table 2.
- .2 **METHOD 1 – Vapour Barrier Tape:**
 - .1 with complete coverage of insulation with colour-matched 75 mm (3 in.) wide vapour barrier tape with minimum 40 mm (1-1/2 in.) wide overlaps of each pass and onto adjacent piping,
- .3 **METHOD 2 – Vapour Barrier Coating:**
 - .1 with two coats of vapor barrier coating complete with reinforcing membrane,
 - .2 coating to overlap adjacent pipe-run insulation by at least 50 mm (2 in.).
- .4 **METHOD 3 – Sealed PVC Jacket:**
 - .1 with sealed PVC fitting cover,
 - .2 for clarity, use of PVC jacket would apply for both concealed and exposed piping, whether or not the pipe-run insulation has a PVC jacket.
- .5 Where a conflict occurs between what is permitted in this Table 2 and those of Table 1, the requirements of Table 1 takes precedence.

Table 2 Sealing of Fittings, Flanges and Couplings (F/F/G) Chilled Water and Dual Temperature Piping					
Pipe Size NPS	Pipe Location	F/F/G Insulation Type	Method 1 Vapour Barrier Tape [Note 1]	Method 2 Vapour Barrier Coating	Method 3 Sealed PVC Jacket
≤ 2-1/2	Concealed	Rigid	Permitted	Permitted	Permitted
≥ 3	Concealed	Rigid, Mitered-sections	Permitted	Permitted	Permitted
≥ 3	Concealed	Flexible Blanket or Inserts	No	Permitted	Permitted
All	Exposed	Rigid, Mitered-sections	Permitted [Note 2]	Permitted [Note 3]	Permitted
All	Exposed	Flexible Blanket or Inserts	No	Permitted	Permitted
All	Wet Area, Concealed	All	No	No	Permitted
All	Wet Area, Exposed	All	No	No	Permitted
All	Outdoors	All	No	Required [Note 4]	Permitted

Notes:

- [1] Only where vapour barrier tape is permitted to seal pipe-run insulation in accordance with Table 1.
- [2] Provide separate finish jacket as specified.
- [3] May be final finish as well unless otherwise specified.
- [4] Required where metal finish jacket is specified.

[4] For exposed and concealed areas.

3.17 Sealing of Cold and Dual Temperature Piping – Miscellaneous Requirements

- .1 Cover mechanical fastener penetrations including staples with colour matched vapour barrier tape, overlapping the fasteners by a minimum of 50 mm (2 in) in all directions.
- .2 Where factory lap seams are damaged, apply colour matched vapor barrier tape along the damaged edges.

3.18 Sealing of Insulation Using PVC Jackets (“Sealed PVC Jackets”)

- .1 Applies where other requirements in this specification section requires sealed PVC jacket to provide a vapour barrier seal.
- .2 Seal overlap with PVC manufacturers adhesive sealant by applying a continuous bead of sealant between the PVC jacket layers and between the PVC jacket and adjacent pipe-run insulation or PBC jackets. Roll overlaps to provide tight contact to the adhesive sealant.
- .3 In locations other than Critical Environment rooms, Wet Areas, and Outdoors, PVC jackets may be sealed on the overlaps and onto adjacent pipe-run insulation or PVC jackets with 75 mm (3 in.) wide colour-matched vapour barrier tape.

3.19 Insulation Finish Covering

- .1 Provide insulation finish coverings selected in accordance with Schedule C at the end of this Specification section and installed in accordance with Specification section 20 07 11 and/except as specified herein.
- .2 Self-adhesive weather barrier (SAWB) coverings;
 - .1 apply SAWB in accordance with manufacturer’s instructions,
 - .2 do not place an overlap within one-eighth pipe diameter on each side of a horizontal pipe top centerline,
 - .3 for vertical piping, overlap higher layers over lower layers with an overlap not less than 100 mm (4 in).
- .3 PVC jackets:
 - .1 for Hot piping, secure PVC jackets on piping and fittings in accordance manufacturer recommendations,
 - .2 for Cold and Dual Temperature piping, seal PVC jackets on piping and fittings with either vapour barrier coating/adhesive or by use of colour-matched vapour barrier tape as specified above.
- .4 Where concealed Cold and Dual Temperature piping use PVC fitting covers to provide a vapour barrier seal at fittings, flanges and couplings, the use of PVC jackets at these locations does not require application of PVC jackets on piping runs unless otherwise required in Schedule C.

3.20 Mechanical Damage Protection - Indoors

- .1 Protect exposed pipe insulation extending up through a floor sleeve at the floor line with 1.2 mm (18 ga) stainless steel jacket approximately 200 mm (8 in) high, secured with rivets and mechanically fastened to the floor with countersunk stainless steel screws.
 - .1 Exception: where piping is protected by a housekeeping curb or pad of at least 100 mm (4 in.) high and which extends at least 150 mm (6 in.) in front of the insulated pipe.
- .2 Where waterproof floor sleeves are required, the floor sleeve may be combined with this requirement.

- .3 For clarity, where piping systems use finish covering in accordance with Schedule C of this Specification section, this mechanical damage protection cover is in addition to the specified pipe finish cover.

3.21 Standard Details

- .1 Refer to Specification section 20 05 29 for illustration of coordination of insulation with pipe supports, unless otherwise shown on drawings.

3.22 Schedules

- .1 The following appended schedules form part of this Specification section.
 - .1 Schedule A1 Hot piping Systems, Insulation Type and Thickness
(excluding engine combustion gas exhaust piping)
 - .2 Schedule B Cold and Dual Temperature Piping Systems, Insulation Type and Thickness
 - .3 Schedule C Piping Insulation Protective Finishes.

Schedule A1
Hot Piping Insulation Type and Thickness
(excluding engine combustion gas exhaust piping)

System	Fluid Nominal Temp. °C (F)	Insulation Type	Nominal Pipe Size (NPS)				
			< 1	1 to 1¼	1½ to 3	4 to <8	≥ 8
			Insulation Thickness, mm (in)				
Steam and Condensate ≤ 100 kPa (15 psi) High temperature hot water heating	94 to 121 (201 to 250)	P-1 P-3	65 (2.5) [Note 3]	65 (2.5) [Note 3]	80 (3)	80 (3)	90 (3½)
		P-2 P-4	---	---	---	---	100 (4) [Note 1, 2]
		P-7	125 (5) [Note 3]	100 (4) [Note 3]	125 (5)	125 (5)	125 (5)
Hot Water Heating Glycol Heating Pumped Condensate	61 to 93 (141 to 200)	P-1 P-3	40 (1½) [Note 3]	40 (1½) [Note 3]	50 (2)	50 (2)	50 (2)
		P-2 P-4	---	---	---	---	65 (2½) [Note 1, 2]
		P-7	65 (2½) [Note 3]	65 (2½) [Note 3]	65 (2½)	65 (2½)	65 (2½)
Hot Water Heating (Buried)	61 to 93 (141 to 200)	P-5	50 (2) [Note 3]	50 (2) [Note 3]	65 (2.5)	65 (2.5)	65 (2.5)

...continued on next page

Schedule A1 (Continued)
Hot Piping Insulation Type and Thickness
(excluding engine combustion gas exhaust piping)

System	Fluid Service Temperature °C (F)	Insulation Type	Nominal Pipe Size (NPS)				
			< 1	1 to 1¼	1½ to 3	4 to <8	≥ 8
			Insulation Thickness, mm (in)				
Low Temperature Hot Water Heating Low Temperature Glycol Heating	41 to 60 (105 to 140)	P-1 P-3	25 (1)	25 (1)	40 (1½)	40 (1½)	40 (1½)

System	Fluid Service Temperature °C (F)	Insulation Type	Nominal Pipe Size (NPS)				
			< 1	1 to 1¼	1½ to 3	4 to <8	≥ 8
			Insulation Thickness, mm (in)				
Domestic Hot Water	41 to 60 (105 to 140)	P-1 P-3	25 (1)	25 (1)	40 (1 ½)	40 (1 ½)	40 (1 ½)
Domestic Hot Water Recirculation							
Not-Potable Hot Water							
Non-Portable Hot Water Recirculation							

Notes:

[1] For NPS 14 and larger.

[2] Install in two layers of insulation to make up total thickness.

[3] For piping NPS 1-1/4 and smaller located in partitions within conditioned spaces, insulation thickness may be reduced by up to 25 mm, but final thickness shall not be less than 25 mm.

[4] For heat-traced fire protection piping only, including drum drip assemblies on dry systems.

Schedule B
Cold and Dual Temperature Piping Insulation Type and Thickness

System	Fluid Service Temperature °C (°F)	Insulation Type	Nominal Pipe Size (NPS)				
			< 1	1 to 1¼	1½ to 3	4 to <8	≥ 8
			Insulation Thickness, mm (in)				
Dual Temperature Heating/Cooling	4 to 93 (39 to 200)	P-1 P-3	40 (1½)	40 (1½)	50 (2)	50 (2)	50 (2)
		P-2	---	---	---	---	65 (2½) [Note 1, 2]
Domestic Cold Water Non-potable Water	4 to 16 (39 to 61)	P-1 P-3	25 (1)	25 (1)	40 (1½)	40 (1½)	40 (1½)
Storm and Sanitary Drainage	4 to 16 (39 to 61)	P-1	25 (1)	25 (1)	25 (1)	25 (1)	25 (1)
		P-6	15 (1/2)	20 (3/4)	25 (1) [Note 3]	---	---
Equipment Drains	4 to 16 (39 to 61)	P-6	15 (1/2)	20 (3/4)	25 (1) [Note 3]	---	---
Chilled Water (Outdoors)	4 to 16 (39 to 61)	P-3	50 (2)	50 (2)	50 (2)	75 (3)	75 (3)
Chilled Water (Buried)	4 to 16 (39 to 61)	P-5	25 (1)	25 (1)	40 (1½)	40 (1½)	40 (1½)
Refrigerant Suction	< 4 (< 39)	P-6	25 (1)	25 (1)	25 (1) [Note 3]	---	---

Notes:

[1] For NPS 14 and larger.

[2] Install in two layers of insulation to make up total thickness.

[3] Do not use on pipe size NPS 2-1/2 to 3.

Schedule C
Piping Insulation Finish Coverings

Location	Exposed/ Concealed	Piping System	Finish Covering
Indoors	Concealed	Piping with insulation types P-4, P-5, P-7, P-10	PVC
		All other piping	None (factory jacket only)
	Exposed	Wet Areas	PVC
		Fire Protection Piping	PVC (red in colour)
		All other piping	Metal
Outdoors	Any	All other piping	Stainless Steel

END OF SECTION

START-UP AND PERFORMANCE TESTING REPORTING

20 08 01

GENERAL

1.1 Scope

- .1 Provide integrated reporting of start-up and performance testing of mechanical equipment and systems.

1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
 - .1 23 05 93.13 Testing Adjusting and Balancing for HVAC
 - .2 23 05 93.23 TAB Supplement for Healthcare

1.3 Coordination

- .1 Coordinate the work of testing companies;
 - .1 schedule sufficient time so that testing and balancing can be completed before occupancy begins and coordinate with trades involved,
 - .2 keep testing and balancing firm informed of any major changes made during construction and furnish same with a set of project drawings and reviewed Shop Drawings,
 - .3 furnish balancing devices, test connections access openings, balancing probe inlets and plugs,
 - .4 clean and pre-run all equipment, filters, etc. and place all heating, ventilating and air conditioning systems into full operation and continue same during each working day of testing and balancing,
 - .5 provide labour from pertinent mechanical trades and tools, equipment and materials to make equipment and system alterations and adjustments, as required including control adjustments,
 - .6 Building Automation System technical representative to operate the BAS during air and water balancing testing,
 - .7 where required in applicable Specification sections, refrigeration machine manufacturer service representative conducts performance testing of the refrigeration equipment, and Testing and Balancing contractor to witnesses and records all test results.
 - .8 where required in applicable Specification sections, fuel-fired heating equipment manufacturer service representative, or other qualified service company technical representative, conducts performance testing of heating equipment and Testing and Balancing contractor to witnesses and records all test results.
- .2 Be responsible for systems constructed, installed and adjusted to provide optimum performance as required by design intent. Perform any re-adjusting required as the result of spot checks by the Consultant at no increase in Contract Price.

1.4 Submittals

- .1 Submit a report format template a minimum 14 days prior to start of air and water balancing on-site.
 - .1 submit proposed format of initial report,
 - .2 include a complete list of instruments and tests for which they are to be used as they relate to this project, including date of last calibration

2 PRODUCTS

2.1 Not applicable.

3 REPORT FORMAT

3.1 General

- .1 Include the following information for each test report:
 - .1 Owner Name,
 - .2 Project Name,
 - .3 Contractor Name,
 - .4 Consultant Name,
 - .5 Name of Test Report,
 - .6 Name and signature of the person submitting the report,
 - .7 Date of report.
- .2 Submit two (2) copies of test reports in hardcopy form in 3-“D” ring binders, indexed for each type of report, separately bound from the Operations and Maintenance manuals. Provide two (3) copies of the same reports in Adobe Acrobat version 7 PDF format.

4 START-UP AND PERFORMANCE REPORTS

4.1 Required reports

- .1 Provide the following Start-Up and Performance Testing reports:
 - .1 Equipment start-up report,
 - .2 Authorities inspection reports,
 - .3 Air and water balancing report,
 - .4 Controls / BMS operation report.

4.2 Equipment Start-up Report

- .1 Provide a test report in spreadsheet format which summarizes the following data for each piece of equipment which is powered or has automatic controls:
 - .1 equipment ID and name,
 - .2 motor insulation megger test - result and initialed by contractor,
 - .3 motor rotation (bump test) - result and initialed by contractor,
 - .4 equipment start-up report - status and initialed by contractor,
 - .5 manufacturer Start-Up report – status and initialed by contractor,
 - .6 test completion date.
- .2 Provide a test report in spreadsheet format which summarizes the following data for testing of piping systems, organized by each piping system:
 - .1 system name,
 - .2 system limits (if system is not tested in its entirety),

- .3 type of test (pneumatic, hydrostatic),
- .4 pressure at start of test,
- .5 pressure at end of test,
- .6 duration of test,
- .7 contractor dated and initialed,
- .8 expansion tank initial pressure,
- .9 expansion tank final pressure,
- .10 backflow preventers have been tested - status and initialed by contractor,
- .11 pressure relief valves installed – record setpoint and initialed by contractor.
- .3 Provide a test report in spreadsheet format which summarizes the following data for testing of ductwork systems, organized by each ductwork system:
 - .1 system name,
 - .2 system limits (if system is not tested in its entirety),
 - .3 test pressure,
 - .4 duration of test,
 - .5 seal Class,
 - .6 tested duct surface area,
 - .7 allowable airflow leakage rate,
 - .8 estimated leakage rate,
 - .9 contractor dated and initialed.
- .4 Equipment/System Start-Up Test Report:
 - .1 Provide a separate start-up report for each piece of the following equipment. The SMACNA “Systems Ready to Balance Check List”, where applicable, may be used for this report.
 - (a) HVAC units,
 - (b) duct Systems,
 - (c) pumps,
 - (d) boilers, and boiler auxiliaries,
 - (e) heat exchangers,
 - (f) cooling towers,
 - (g) air compressors,
 - (h) refrigeration equipment,
 - (i) hydronic piping systems,
 - (j) steam piping systems,
 - (k) sprinkler systems (to NFPA 13),
 - (l) standpipe systems (to NFPA 14).
- .5 Manufacturer’s Start-Up Test:
 - .1 Provide a separate start-up report for each piece of the following equipment, utilizing the manufacturer’s start-up check list. This report may be prepared by the manufacturer’s service representative:
 - (a) adjustable frequency drives,

(b) Building Automation Systems.

4.3 Authorities Inspection Reports

- .1 Submit copies of authorities-having-jurisdiction inspection and test reports, including:
 - .1 plumbing and drainage municipal inspector reports,
 - .2 AHJ for boiler, pressure vessels and pressure piping reports,
 - .3 AHJ for electrical safety inspection reports and, if applicable, field certification reports.
- .2 Where an AHJ inspects the work but does not issue an inspection report, provide a signed and dated written declaration of the name of the AHJ inspector, the date of their inspection, what they inspected, and any comments they provided orally or in writing (other than an inspection report).

4.4 Air and Water Balancing Reports

- .1 Provide air and water balancing reports in accordance with Specification section 20 08 05.

5 SPECIFIC EQUIPMENT PERFORMANCE TESTS

5.1 Performance data

- .1 In addition to tests specified in other Specification sections of Division 20 to 25, perform the following equipment performance tests. If contractor's standard forms provide for additional data, also submit such additional data.
 - .1 Some equipment tests may need to be performed during the alternate season testing.
 - .2 Include nameplate data and as-tested results.

6 REPORT SUBMISSIONS

6.1 Deficiencies

- .1 Immediately report to Consultant, any deficiencies in the systems or equipment performance resulting in design requirements being unobtainable.

6.2 Draft Report

- .1 On completion of the start-up, testing, adjusting and balancing of all systems, submit to the Consultant, two (2) typewritten copies of a full report on all tests, adjustments, and balancing performed.
- .2 Attachments including systems schematics with numbered terminals for referring to data above.

6.3 Spot Checks

- .1 After review of the draft report by the Consultant, Consultant has the right to require a retest of up to 25% of all air and water balancing measurements in locations as directed by the Consultant, at no cost extra to the contract.
- .2 If results indicate unusual testing inaccuracy, omissions, or incomplete balancing/adjustment, in the opinion of the Consultant, re-balance entire affected system(s) at no increase in Contract Price.

6.4 Interim Report

- .1 After completion of any retesting described above, submit three (1) typewritten copies of the interim report bound in a 3-hole "D" style binder, and two (2) removable drives (thumb drive) of the report in PDF format.
- .2 This report is required to obtain Substantial Performance of the Contract.

6.5 Final Report

- .1 Submit to Consultant the final report following completion of alternate season testing and balancing. Submit two (2) typewritten copies bound in a 3-hole "D" style binder,, and two (2) removable drives (thumb drive) of the report in PDF format.

6.6 Acceptance

- .1 The Substantial Performance of the Mechanical Work will be considered reached when the interim Start-Up and Performance Testing report is reviewed by the Consultant and in the opinion of the Consultant all systems have been satisfactorily installed, operated tested, balanced, and adjusted to meet the specified and intended performance, except for deferred seasonal-dependent work or other deferred work agreed by the Owner.
- .2 The substantial performance is not dependent upon alternate season testing.
- .3 The total performance of the Mechanical Subcontract (Contract) will not be considered reached until the alternate season testing and balancing and any other deferred Work is completed and the final report submitted and reviewed by the Consultant.

END OF SECTION

MECHANICAL COMMISSIONING

20 08 15

1 GENERAL

1.1 Scope

- .1 Provide commissioning of mechanical systems provided under Division 20.
- .2 Mechanical system installation, start-up, testing, balancing, preparation of Operating and Maintenance manuals and operator training are the responsibility of the Division 20 Contractors, with the coordination of the commissioning process the responsibility of the Contractor.

1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
 - .1 20 08 01 Start-up and Performance Testing
 - .2 20 08 05 Testing, Adjusting and Balancing

1.3 Definitions

- .1 The following definitions apply to this section.
 - .1 **Contractor** – means the general contractor or construction manager who is responsible for the management and overall execution of the Work as applicable to the type of project delivery method used.
 - .2 **Major deficiency** – an item which if not corrected renders the equipment or system unsuitable or un-safe for use by the Owner. Major deficiencies must be corrected as a condition for achieving Substantial Performance.
 - .3 **Minor deficiency** – an item which does not impact on the operation of the equipment or system and will allow the Owner to use the system safely. Minor deficiencies may be corrected before or after Substantial Performance, but will not prevent certification of Substantial Performance of the Work.

1.4 Applicable Codes and Standards

- .1 Installation codes and standards:
 - .1 ASHRAE Guide 0 The Commissioning Process
 - .2 ASHRAE Guide 1.1 HVAC&R Technical Requirements for the Commissioning Process
 - .3 ASHRAE Guide 1.3 Building Operations and Maintenance Training for the HVAC&R Commissioning Process
 - .4 ASHRAE Guide 1.5 The Commissioning Process for Smoke Control Systems

1.5 Commissioning Process

- .1 The Commissioning process develops, coordinates, and documents the following:
 - .1 equipment start-up,
 - .2 control system calibration,
 - .3 testing and balancing,
 - .4 verification and Performance Testing,

- .5 operation documentation,
- .6 operator training.
- .2 The Commissioning Program is divided into the following parts:
 - .1 Part 1: Pre-Start and Start-Up testing
 - .2 Part 2: Installation Verification testing
 - .3 Part 3: Performance Validation testing
 - .4 Part 4: Systems Operating Manuals
 - .5 Part 5: Operator Training

1.6 Work Included

- .1 Commissioning work of Division 20 includes, but is not limited to:
 - .1 testing and start-up of equipment,
 - .2 testing, adjusting and balancing of hydronic and air systems,
 - .3 cooperation with the Commissioning Authority in developing and implementation of the commissioning plan,
 - .4 providing qualified personnel for participation in implementing commissioning test procedures, including seasonal testing required after the initial testing,
 - .5 providing equipment, materials, and labor as necessary to correct construction and/or equipment deficiencies found during the commissioning process,
 - .6 providing operation and maintenance manuals, and as-built drawings to the Commissioning Authority for verification,
 - .7 providing training and demonstrations for the systems specified in this Division.
- .2 Conduct complete and thorough evaluation and documentation of the operation and performance of all components, systems, and sub-systems, including the following equipment and systems:
 - .1 air handling systems,
 - .2 hydronic distribution systems,
 - .3 air distribution and exhaust systems,
 - .4 domestic hot water systems,
 - .5 domestic cold water systems,
 - .6 fire protection systems / suppression systems,
 - .7 constant speed motor controllers and variable frequency drives,
 - .8 building automation systems,
 - .9 medical gas systems.
- .3 Commission equipment which has been pre-tendered, pre-purchased, or pre-ordered by the Owner or their Agent, and the value of which has been assigned to the Mechanical Contractor or their sub-trades and is included in the value of the Work.
- .4 Commission services to equipment, but not the equipment itself, where the supply of the equipment does not form part of the mechanical Work.
- .5 Provide the following commissioning documentation:
 - .1 recording completed Pre-start and Start-up procedures test results,

- .2 recording completed Installation Verification and Performance Validation test results,
- .3 as-built records.
- .4 operation and maintenance manuals
- .6 The final commissioning report will be prepared by the Commissioning Authority.

1.7 Excluded Work

- .1 Unless otherwise specified, equipment which is not supplied by the mechanical contractor or their sub-trades, where the value for the supply of equipment is not included as part of the Work, such as:
 - .1 Supplied by Owner (SBO) equipment,
 - .2 Equipment marked Not in Contract (NIC) or Not in Mechanical Contract (NIMC).

1.8 Submittals - Commissioning Schedule

- .1 Provide a detailed commissioning schedule for consolidation into the main construction schedule.
- .2 Include:
 - .1 equipment and systems start-up predecessors
 - .2 time periods for pre-start and start up testing, verification and validation testing for each equipment and system.

1.9 Submittals - Documentation

- .1 Identify documents including test documents, binder covers, etc. using equipment ID numbers provided on equipment schedules.
- .2 Scan original signed test reports, including verification and performance test reports, manufacturers service reports, etc. in Adobe Acrobat *.pdf version 8 format. For original document chapters, provide Adobe chapter referencing.
- .3 Submit three (3) copies of each completed and accepted Verification and Functional Performance Test reports, both preliminary and final issues.
- .4 Collate final, accepted and signed test results in separate binders as follows:
 - .1 Fire Protection
 - .2 Plumbing and Drainage
 - .3 HVAC Systems
 - .4 Building Management Systems
- .5 Provide three (3) CD-R or DVD-R copies of commissioning documentation.

1.10 Substantial Performance

- .1 Application for Substantial Performance of the Work is precedent on the Work being ready for Owner's use which includes completion of the following commissioning elements:
 - .1 start-up and testing, including TAB reports,
 - .2 commissioning Verification testing including submission of completed records,
 - .3 commissioning Performance Validation testing including submission of completed records, except for alternate season tests,
 - .4 commissioning Controls Validation testing,
 - .5 training of Owner's operations personnel,

- .6 as-built documentation issued for Consultant's review,
- .7 Operations and Maintenance manuals which have been reviewed by the Consultant and accepted by the Owner.

2 PRODUCTS

2.1 Test Equipment

- .1 Furnish tools and equipment required during the commissioning process.
- .2 Utilities (water, gas, fuel oil, electrical power) are provided by the Owner
- .3 Provide any proprietary test equipment and software required by equipment manufacturer for programming and / or start-up, whether specified or not.
- .4 Manufacturer provides test equipment, demonstrate its use, and assists in the commissioning process as needed.
- .5 Turn-over proprietary test equipment to the Owner upon completion of the commissioning process, where such requirement is specified in the relevant equipment specification sections.

3 EXECUTION

3.1 General

- .1 Perform commissioning in accordance with ASHRAE Guide 0, Guide 1.1 except/and as specified herein.
- .2 Complete all phases of work so that the systems can be started, tested, balanced, and owner's acceptance procedures be undertaken in a timely manner such that only one acceptance test is conducted at any one time.
- .3 Participate and assist in the development of the Commissioning Plan and schedule by the Contractor, by providing necessary information pertaining to the equipment and installation. Provide commissioning schedule information to be incorporated into the overall Construction Plan schedule.
- .4 Acceptance procedures may begin prior to completion of a system and/or sub-system. Start of acceptance procedures before system completion does not relieve the Contractor from completing those systems in accordance with the commissioning and construction schedule.

3.2 Participants

- .1 Commissioning Team consists of multiple parties with separate responsibilities.
- .2 Owner:
 - .1 establishes acceptance criteria,
 - .2 provides operations staff to receive training, and to witness any or all tests at their discretion,
 - .3 final acceptance of commissioning results.
- .3 Design Consultant:
 - .1 responsible for the construction review activities in accordance with local building code requirements,
 - .2 may participate in development and / or review of commissioning procedures,
 - .3 reviews commissioning test results,
- .4 Commissioning Authority:
 - .1 develops commissioning plan and procedures,

- .2 coordinates Owner's commissioning team members who witnesses tests,
- .3 selectively witnesses commissioning tests on an audit basis to confirm compliance by the Contractor to the Commissioning Plan,
- .4 reviews commissioning test results and makes recommendations to the Owner for acceptance.
- .5 Contractor:
 - .1 coordinates and manages commissioning activities,
 - .2 develops and integrates commissioning activities into the construction schedule,
 - .3 ensures commissioning procedures are completed and documented, and commissioning records including any required attachments are submitted.
- .6 Mechanical trades subcontractors:
 - .1 Provide the services of qualified technician(s) who are familiar with the construction and operation of the system, to start-up and debug equipment and systems within the Division 20 scope of Work. Include for labour, materials, and subsistence costs for these same technicians to assist the Commissioning Authority in completing the commissioning program.
 - .2 Provide access to the contract plans, shop drawings, and equipment cut sheets of all installed equipment.
 - .3 Ensure the qualified technician(s) are available and present during commissioning testing to complete the tests, make adjustments and to assist in problem resolutions.
 - .4 Should any equipment or system experience performance problems and/or reconstruction or replacement of components is required, include for additional technician time for subsequent retesting of systems until required system performance is achieved.
 - .5 The Commissioning Authority reserves the right to approve proposed technicians with regard to the technical skill level required for each type of equipment and/or system, and a willingness by the individual(s) to work within the Commissioning Group.
- .7 Controls subcontractor, in addition to the requirements described above:
 - .1 Provide test reports using own documentation formats, for wiring tests, loop testing, loop tuning, and sequence functional tests.
 - .2 Provide details of the control system, schematics, and a narrative description of control sequences of operation.
- .8 Electrical subcontractor:
 - .1 provide a foreman electrician familiar with the electrical interlocks, interfaces with emergency power supply, and interfaces with alarm and life-safety systems. Provide access to the contract plans, and all as-built schematics of sub-systems, interfaces and interlocks.
- .9 Equipment suppliers:
 - .1 provide the services of manufacturers' service personnel to provide assistance with pre-start and initial start-up of the equipment, as required.

3.3 Commissioning Meetings

- .1 Participate in periodic commissioning team meetings, and trade commissioning meetings.
- .2 Pre-construction:
 - .1 participate in a pre-construction meeting of commissioning team members, to familiarize parties with the commissioning process, and to ensure that the responsibilities of each party are clearly understood.
- .3 Construction and Post-Construction:

- .1 participate in commissioning meetings as scheduled by the Contractor.
- .2 participate in trade commissioning meetings as required, in addition to the regular commissioning team meetings,
- .3 identify to the commissioning group problems relating to the commissioning schedule, identification of start-up issues, etc., and participate in the resolution of these problems.

3.4 Commissioning Procedures

- .1 The Owner's designated Commissioning Authority provides the commissioning procedures (checklists, etc.) for use by the Contractor and trade subcontractors.
- .2 Each commissioning procedure tests the equipment and systems, and consists of the following elements:
 - .1 Document sign-off
 - .2 Pre-start and Initial test
 - .3 Installation Verification - Equipment
 - .4 Installation Verification - Systems
 - .5 Performance Validation
 - .6 Controls Validation
 - .7 Appendices.
- .3 Document Sign-Off:
 - .1 each completed procedure is signed off by the following parties:
 - (a) Contractor, for testing,
 - (b) Commissioning Consultant, for review and witnessing,
 - (c) Owner, for test acceptance.
- .4 Pre-Start and Initial Test:
 - .1 Checklists included: confirmation of authorities inspections, pre-start safety checks (where applicable), system cleaning and pressure testing, and confirmation of availability of supporting systems.
- .5 Installation Verification - Equipment
 - .1 Checklists to verify the installation of equipment, including: design specification requirements, drawing requirements, manufacturer installation requirements, and other experience-related items.
 - .2 Use of pre-printed manufacturer installation and start-up checklists are permitted and encouraged; however, the commissioning procedure checklists may contain supplemental items.
- .6 Installation Verification - System:
 - .1 Checklists to verify the installation of the system associated with the equipment.
- .7 Performance Validation:
 - .1 Specific test procedures and record documentation requirements for performance measurements of the various systems.
- .8 Controls Validation:
 - .1 Step-by-step testing methodologies to prove the functional operation of control systems, for normal and abnormal operating conditions, and alarm conditions.

.9 Appendices:

- .1 Collate test reports from authorities having jurisdiction, manufacturer start-up and test reports, balancing reports, etc.

3.5 Commissioning Test Methodology

- .1 Step 1: complete the pre-start, start-up and testing, and adjusting and balancing tests. On completion of this phase, complete the related documentation and submit to the Commissioning Authority and Consultant.
- .2 Steps 2 and 3: on completion of Step 1, conduct the Verification and Validation testing of the operating systems. Identify deficiencies and correct. After the deficiencies have been corrected, notify the Commissioning Authority and agree on dates to demonstrate the commissioned systems.
- .3 Step 4: where the Commissioning Authority identifies systems which require witness demonstration, repeat Steps 2 and 3. These demonstrations may be coordinated with training demonstrations of Owner's operations staff.
- .4 On completion of systems which do not require witness demonstration, finalize the report and submit to the Commissioning Authority and the Consultant for review.
- .5 On completion of systems which have been witness demonstrated, the Commissioning Authority is to sign-off the completed document, before they are issued for review.

3.6 Commissioning Implementation

- .1 Conduct operating tests and checks to verify that all components, equipment, systems, and interfaces between systems, operate in accordance with contract documents.
- .2 Demonstrate and verify operating modes, interlocks, specified control sequences, specific responses to abnormal or emergency conditions, and verification of the proper response of the Building Automation System.
- .3 Validate the results of the TAB report.
- .4 Roles and Responsibilities:

Organized by:	Contractor
Test sheets provided by:	Commissioning Authority
Testing conducted by:	Div. 20 trade subcontractors
Testing recorded by:	Div. 20 trade subcontractors
Tests witnessed by:	Commissioning Authority (selected tests) Design Consultant (selected tests)
Reports reviewed by:	Contractor Commissioning Authority Design Consultant Owner
Reports Accepted by:	Owner

3.7 Operating Checks

- .1 The Commissioning Authority witnesses selected equipment and system tests on an audit basis.
- .2 Set the system equipment into operating mode to be tested including but not limited to:
 - .1 Normal shut-down

- .2 Normal auto position
- .3 Normal manual position
- .4 Unoccupied cycle
- .5 Emergency power operation, including transition states.
- .6 Alarm conditions
- .3 Inspect and verify the position of each device and interlock identified on the checklist.
- .4 Repeat the above tests for each operating cycle that applies to the system being tested.
- .5 Check the operating condition of the following elements during all modes of operation of the system:
 - .1 Safety interlocks
 - .2 Alarms
 - .3 Smoke control and smoke venting interlocks
 - .4 Life safety systems
- .6 For failed test items, provide appropriate comments to the checklist data sheet and classify whether it is a "Major" or "Minor" deficiency.
 - .1 The Consultant retains the right to make the final decision regarding classifications of deficiencies.
- .7 Verify the operational control of the systems through the Building Management System as follows:
 - .1 TAB airflow rates and calibrate terminal boxes in all modes of operation
 - .2 Equipment operation in both heating and cooling modes.
 - .3 Minimum outdoor air intake positions, air-side economizer cycles, and multi-set outdoor air damper positions as required for each operating sequence and mode.
 - .4 Building pressurization and other specialty programs
- .8 Verify the proper responses of instrumentation and control devices (actuators) as follows:
 - .1 For each controller or sensor, record the indicated monitoring and control system reading, and the test instrument reading.
 - .2 If the initial test indicates that the test reading is outside of the control range of the installed device, check the calibration of the installed device and adjust as required. Re-test the deficient device and record the results on the checklist data sheets.
- .9 The Commissioning Authority witnesses the field verification of the final TAB report as follows:
 - .1 Select, at random, 10% of the report data for verification.
 - .2 The TAB contractor will be provided advance notice of the date of retesting, but not the equipment to be tested.
 - .3 The TAB contractor uses the same equipment and instruments used for collecting the original data.
- .10 Test failure is defined as:
 - .1 For all readings other than sound, a deviation of more than 10 percent from the TAB report results.
 - .2 For sound pressure readings, a deviation of 2 dB at any bandwidth, not including differences in background noise readings.

- .3 A failure rate greater than 10% of the selected items (1% of all TAB test results) will result in rejection of the final TAB report.

.11 Acceptance

- .1 The final reports will be reviewed by the Commissioning Authority and the Consultant, to determine if verification is complete and the operating systems are functioning in accordance with the contract documents.
- .2 The Commissioning Authority, in conjunction with the Consultant, reviews and makes final classification of all noted deficiencies. Correct deficiencies classified as "Major" before acceptance of the Verification stage.
- .3 The Owner will make the final acceptance of test results.

3.8 Performance Validation Testing

- .1 Conduct performance tests and checks to validate that equipment and system components are providing the required heating and cooling performance (capacity), including but not limited to:
 - .1 Capability of the Chilled water system to deliver the required flow rate, and water temperature at design conditions.
 - .2 Capability of the hydronic and domestic water heating systems to deliver the required flow rate, and temperature.
 - .3 Capacity of electric heating systems at design temperatures.
 - .4 Confirm the ability of the HVAC systems to deliver the required cooling/heating services, at the design supply air temperature, required static pressure, and proper outside air ventilation rate.
- .2 Special testing requirements:
 - .1 Test water chillers in accordance with ARI 590 and 591, at design conditions for full load ratings, and IPLV ratings.

3.9 Problem Resolution

- .1 In the event that additional work is required to either correct systems, misapplied equipment, and/or deficient performance under varying load conditions, assist the Owner and Commissioning Authority in developing an acceptable resolution to the problem, including the resources of equipment suppliers.
- .2 The Owner has final approval over any additional work required to achieve the required level of performance.
- .3 Complete corrective work in a timely fashion to permit the completion of the commissioning process.

3.10 Acceptance

- .1 Any identified deficiencies will be reviewed by the Consultant in conjunction with the Contractor to determine if correction of the deficiency is as a result of a defect in the equipment or installation.
- .2 If it is determined the performance deficiency is as a result of a defect in the equipment or its installation, rectify the deficiency and repeat the performance test until the required performance levels are achieved.
- .3 If it is determined the equipment or system has been constructed in accordance with the contract documents, the Owner will decide whether to accept the performance as is, or, direct the installation contractor to make changes to the system as required to obtain performance levels which meet the design intent, and retest the system.

3.11 Seasonal Commissioning

- .1 Commence initial performance validation testing commissioning at the completion of the installation and verification testing phase. Conduct performance testing, which is weather dependent, as applicable to current seasonal conditions. Complete performance testing on non-weather dependent systems in accordance with the agreed commissioning plan schedule.
- .2 For out-of-season system performance testing, conduct initial performance tests to demonstrate off-peak load performance. Schedule peak load performance testing over the succeeding nine (9) months to ensure all equipment is tested at peak load prior to the expiry of the warranty period.
- .3 Test heating equipment/systems during winter design extremes.
- .4 Test cooling systems during summer design extremes with a fully occupied building.
- .5 Alternatively, provide temporary equipment (load banks, etc.) to simulate full load conditions. Submit proposed methodology for review by the Commissioning Authority and Consultant.

3.12 Additional Commissioning

- .1 Additional commissioning activities may be required after completion of system performance testing. Include in the tender cost a reasonable reserve to complete this work, including assistance from manufacturers' service technicians.

3.13 Systems Operating Manuals

- .1 Provide Operating and Maintenance Manuals in accordance with the requirements of section 20 01 01.
- .2 The Systems Operating Manuals (SOM) are in addition to the Operating and Maintenance Manuals (OMM) required under Section 20 01 01.
 - .1 Provided by Commissioning Authority and/or Consultant.

3.14 Training

- .1 Perform training in accordance with ASHRAE Guideline 1.3 except/and as specified herein.
- .2 Equipment Training:
 - .1 Provide equipment training in accordance with Section 20 01 01. The manufacturer's representative training will emphasize operating instructions and preventative maintenance.
- .3 Systems Training:
 - .1 Systems training is not in the scope of Work for Division 20.

END OF SECTION

CLOSEOUT REQUIREMENTS FOR MECHANICAL WORK

20 77 19.20

GENERAL

1.1 Scope

- .1 Provide documentation deliverables at completion of the Work for the following milestone events:
 - .1 Occupancy permit (where applicable) (Form OP1M),
 - .2 Substantial Performance of the Work (Form SP1M),
 - .3 Ready for take-over by Owner (Form RFT1M),
 - .4 Total Performance of the Work (Form TP1M).

1.2 Definitions

- .1 The following definitions apply to this section.
 - .1 **Occupancy permit** – means either: (i) a permit issued by a regulatory authority to allow the Owner to occupy the building subject to the building permit, or (ii) a building permit close-out procedure where documentation must be submitted to the building authority for that purpose.

1.3 General

- .1 The prerequisites and submittal of supporting documentation for the aforementioned milestone events may be combined as a single submission at one point in time for the following combination of events:
 - .1 Occupancy Permit, and Substantial Performance.
- .2 Where a prerequisite is listed in more than one milestone event, it shall be included in the earliest-occurring milestone event unless expressly specified otherwise.

1.4 Occupancy Permit

- .1 Submit the reviewed final record of the Testing of Integrated Life Safety and Fire Protection Commissioning report two weeks prior to application for occupancy permit, where such a report is required.
- .2 Complete the Occupancy Permit Checklist and submit with required documentation to support the Owner's application for occupancy.

1.5 Substantial Performance

- .1 Complete the Substantial Performance Checklist and submit with required documentation when applying for Substantial Performance of the Work.
- .2 Where the work is sub-divided into separate scopes of Work, each requiring a separate Substantial Performance application, provide a separate checklist for each application.
- .3 Within five working days of the Consultant's review report which indicates that Substantial Performance of the Work has been achieved, provide a detailed schedule for completion and/or correction of the Work of all items described in the Contractors' and the Consultants' deficiency list.

1.6 Ready-for-Takeover by Owner

- .1 The basic prerequisites to attaining Ready-for-Takeover of the Work are described in the General Conditions and Supplementary General Conditions of the Contract.
- .2 Complete the Ready-for-Takeover Checklist and submit with required documentation when applying for Ready-For Takeover of the Work.

1.7 Total Performance

- .1 Complete the Total Performance Checklist and submit with required documentation when applying for Total Performance of the Work.

Form OP1M: OCCUPANCY PERMIT CHECKLIST	
Project Name:	
Contract:	
Contract Scope:	
Application Date:	
Signed:	

The following requirements are completed and documentation included in this application. Where documentation has been issued directly to the Owner, a copy of the transmittal is enclosed.

- ☐ Building department inspection reports.
- ☐ AHJ pressure piping inspection reports (if applicable).
- ☐ AHJ fuel system inspection reports (if applicable).
- ☐ AHJ electrical systems inspection reports.
- ☐ Sprinkler installation certification report to NFPA 13.
- ☐ Standpipe installation certification report to NFPA 14.
- ☐ Fire pump installation and test certificate to NFPA 20.
- ☐ Integrated Fire Protection and Life Safety test report to ULC-S1001.
- ☐ Medical gas inspection report and certificate.
- ☐ Air and Water Balancing reports (Interim) for ventilation and heating.

Consultant Review	
Status:	☐ Reviewed ☐ Incomplete or deficient - resubmit
Signed:	
Date:	

Form SP1M: SUBSTANTIAL PERFORMANCE APPLICATION CHECKLIST	
Project Name:	
Contract:	
Contract Scope:	
Application Date:	
Signed:	

The following requirements are completed and documentation included in this application. Where documentation has been issued directly to the Owner, a copy of the transmittal is enclosed.

- ☐ Occupancy permit has been issued by the AHJ (where applicable).
- ☐ Systems have been started-up, tested, and demonstrated to Owner or Consultant.
- ☐ First submission TAB reports have been submitted to Consultant.
- ☐ Acoustic survey report submitted to Consultant (if specified).
- ☐ Vibration survey report submitted to Consultant (if specified).
- ☐ Controls / BMS operation report submitted to Consultant (if specified).
- ☐ Equipment, pipeline, and valve identification completed
- ☐ Spare parts and replacement parts turned over to Owner, transmittal attached.

Consultant Review	
Status:	☐ Reviewed ☐ Incomplete or deficient - resubmit
Signed:	
Date:	

Form RFT1M: READY-FOR-TAKEOVER APPLICATION CHECKLIST	
Project Name:	
Contract:	
Contract Scope:	
Application Date:	
Signed:	

The following requirements are completed and documentation included in this application. Where documentation has been issued directly to the Owner, a copy of the transmittal is enclosed.

- ☐ Substantial Performance has been certified or verified.
- ☐ Occupancy permit has been issued by the AHJ (where applicable).
- ☐ Final cleaning and waste removal completed.
- ☐ Delivery to Owner of Operating and Maintenance documents for systems being taken-over by Owner.
- ☐ Submit copies of up-to-date as-built drawings.
- ☐ Final start-up, testing and balancing reports completed and submitted to Owner, including any items requiring corrections identified by Consultant.
- ☐ The portions of the building being turned over to the Owner can be secured by Owner.
- ☐ Demonstration and training are completed, or Contractor and Owner has agreed to a schedule to provide such training to be completed within one month after the date of Ready-for-Takeover.
- ☐ All commissioning activities except for those activities that are identified or otherwise agreed by the Owner to be deferred commission activities which may be completed after Ready-for-Takeover of the Work.
- ☐ Integrated systems testing of fire protection and life safety systems.
- ☐ All warranties have been submitted to the Owner.
- ☐ A comprehensive list of items to be completed or corrected is provided to Owner and Consultant and included in the application for Ready-for-Takeover, and includes a schedule of when such work will be completed.

Consultant Review	
Status:	☐ Reviewed ☐ Incomplete or deficient - resubmit
Signed:	
Date:	

Form TP1M: TOTAL PERFORMANCE APPLICATION CHECKLIST	
Project Name:	
Contract:	
Contract Scope:	
Application Date:	
Signed:	

The following requirements are completed and included in this application. Where documentation has been issued directly to the Owner, a copy of the transmittal is enclosed.

- ☐ All final Operating and Maintenance documents have been delivered to Owner.
- ☐ All final up-to-date as-built drawings have been delivered to Owner.
- ☐ Any follow-up testing and balancing reports, including alternate season testing reports, have been submitted to Owner.
- ☐ All demonstration and training are completed.
- ☐ All commissioning activities are completed, including deferred alternate season commissioning activities.
- ☐ All known deficiencies have been corrected, including latent deficiencies reported by the Owner.
- ☐ All inspections and tests required to be performed by Contractor or manufacturer's prior to expiry of the warranty period have been completed, and documentation for those inspections and tests are included in this application.

Consultant Review	
Status:	☐ Reviewed ☐ Incomplete or deficient - resubmit
Signed:	
Date:	

End of Section

COMMON WORK RESULTS FOR FIRE SUPPRESSION

21 05 01

GENERAL

1.2 Scope

- .1 Fire suppression work includes;
 - .1 Wet Pipe Sprinkler System,
- .2 Piping materials specified herein are limited to design pressures not exceeding 2000 kPa (300 psi).

1.3 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
 - .1 20 05 24 Welding and Brazing
 - .2 20 05 29 Common Hanger and Support Requirements for Piping

1.4 Applicable Codes and Standards

- .1 Installation codes and standards:
 - .1 Fire suppression work to conform to standards of the National Fire Prevention Association (NFPA) and relevant sections of the provincial Building Code applicable to the location of the Work.
 - .2 CSA B64.10 Selection and Installation of Backflow Preventers / Maintenance and Field Testing of Backflow Preventers
- .2 Product standards:
 - .1 ANSI B1.20.1 Pipe Threads, General Purpose (inch)
 - .2 ASME B16.1 Cast Iron Pipe Flanges And Flanged Fittings
 - .3 ASME B16.3 Malleable Iron Threaded Fittings.
 - .4 ASME B16.4 Cast Iron Threaded Fittings, Class 125 and 250
 - .5 ASME B16.5 Pipe Flanges and Flanged Fittings
 - .6 ASME B16.9 Factory Made Wrought Steel Buttwelding Fittings
 - .7 ASME B16.11 Forged Steel Fittings, Socket-Welding and Threaded
 - .8 ASME B16.15 Cast Bronze Threaded Fittings, Classes 125 and 250
 - .9 ASME B16.18 Cast Copper Alloy Solder Joint Pressure Fittings
 - .10 ASME B16.21 Nonmetallic Flat Gaskets for Pipe Flanges.
 - .11 ASME B16.22 Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
 - .12 ASME B16.24 Cast Copper Alloy Pipe Flanges and Flanged Fittings; Class 150, 300, 400, 600, 900, 1500, & 2500.
 - .13 ASME B16.39 Malleable Iron Threaded Pipe Unions: Classes 150, 250 and 300.
 - .14 ASME B18.2.1 Square and Hex Bolts and Screws,
 - .15 ASME B18.2.2 Square and Hex Nuts
 - .16 ASTM A53 Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

.17	ASTM A135	Standard Specification for Electric-Resistance-Welded Steel Pipe
.18	ASTM A194	Standard Specification for Carbon and Alloy Steel Nuts and Bolts for High-Pressure or High-Temperature Service, or Both.
.19	ASTM A795	Specification for Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire suppression Use
.20	CSA B64.4	Backflow Preventers, Reduced Pressure Principle Type (RP)
.21	ULC-B65.5	Backflow Preventers, Double Check Valve Type (DCVA)
.22	CSA B242	Groove and Shoulder Type Mechanical Pipe Couplings
.23	UL 203	Pipe Hanger Equipment for Fire suppression Service
.24	UL 393	Indicating Pressure Gauges for Fire Protection Service
.25	UL 1468	Standard for Direct Acting Pressure Reducing and Pressure Restricting Valves
.26	UL 1739	Standard for Pilot-Operated Pressure-Control Valves for Fire-Protection Service
.27	ULC/ORD-C203	Pipe Hanger Equipment for Fire suppression Service
.28	ULC/ORD-C213	Rubber Gasketed Fittings for Fire suppression Service
.29	ULC/ORD-C213B	Welded Outlet Fittings
.30	ULC-S548	Alarm Initiating and Supervisory Devices for Water Type Extinguishing Systems

1.5 Qualified Tradesmen

- .1 Work to be performed by qualified and recognized firm with an established reputation in this field, using tradesmen holding certificates of competency.

1.6 Water Supply Test Results

Provide water flow test on municipal water service in proximity to building connection, in accordance with NFPA 14 and NFPA 291. Flow test must be conducted within one (1) year prior to system design. Submit record of test including static pressure, and residual pressure and flow.

- .1 Obtain municipal approval and pay fees associated with testing.

1.7 Design Criteria

- .1 Pressure piping design conditions and applicable codes are specified herein. Where different operating and design pressures are shown on drawings, the drawings govern.
- .2 System design criteria are described in the relevant Division 21 system specifications.
- .3 Where a "Class" is indicated on drawings, this refers to Class as defined in the applicable ASME B16 series of product standards. Notwithstanding the maximum allowable pressure-temperature ratings defined for each ASME Class designation, the applicable Class designation by floor level shown on the drawings may identify lower maximum allowable design pressures applicable to any Class rating.

2 PRODUCTS

2.1 Carbon Steel Pipe

- .1 Piping materials:
 - .1 to ASTM A53 Grade B, seamless or electric-resistant-welded (ERW),

- .2 to ASTM A135 Grade B, ERW,
- .3 to ASTM A795. Grade B, ERW.
- .2 Pipe wall thickness: as specified in each applicable fire suppression specification section.
- .3 Piping to be hot-dipped galvanized where required in each system specification section in Division 21.

Steel Pipe Joints and Fittings

- .1 Threaded fittings:
 - .1 end connections: NPT thread to ANSI B1.20.1.
 - .2 fittings:
 - (a) Class 125 cast iron to ASME B16.4,
 - (b) Class 150 and Class 300, malleable iron to ASME B16.3.
 - .3 unions: Class 150 and Class 300, malleable iron body with ground joint and bronze face to ASME B16.39.
 - .4 threaded joint compound: pulverized lead paste or Teflon pipe tape sealant.

Standard of Acceptance

- Masters Pro-Dope
 - Masters Orange or White Tape.
- .2 Welding fittings:
 - .1 butt weld fittings:
 - (a) forged to ASME B16.9,
 - (b) wall thickness to match pipe,
 - (c) long radius elbows.
 - .2 welding outlet fittings:
 - (a) forged to ASTM A105,
 - (b) dimensions and pressure ratings to MSS SP-97, Standard Class for buttwelding branch connection and Class 3000 for threaded or socket welded branch connection,
 - (c) NPT ends to ASME B1.20.1.
 - .3 special welding outlet fittings for fire protection:
 - (a) weld-on branch outlet fittings for groove-end and threaded-end connections for fire protection services,
 - (b) listed to ULC/ORD-C213B for fire protection service,
 - (c) forged from materials meeting ASTM A53 Gr. B.,
 - (d) pressure rating: 2067 kPa (300 psi) for fire protection water,
 - .4 socket welded fittings:
 - (a) forged to ASTM A105,
 - (b) dimensions and pressure ratings to ASME B16.11, Class 3000.
 - .5 half couplings:
 - (a) forged carbon steel to ASTM A105,
 - (b) dimensions and pressure rating to ASME B16.11, Class 3000 socket weld or threaded ends,
 - (c) NPT ends to ASME B1.20.1.

.3 Flanges:

- .1 flat-faced cast iron to ANSI B16.1, Class 125.
- .2 raised-face forged carbon steel to ASME B16.5, Class 150 and Class 300, weld neck with wall thickness to match pipe, or slip on type.
- .3 studs, bolts and nuts to ANSI B18.2.1, ANSI 18.2.2 and ASTM A194, "high strength" type.
- .4 gaskets:
 - (a) styrene butadiene rubber sheet to ANSI B16.21.
 - (b) 1.6 mm (1/16 in) thick.

Standard of Acceptance

- Chesterton - fig. 100
- Beldam

.4 Grooved fittings and couplings:

- .1 couplings listed to CSA B242,
- .2 listed for combination of fittings, couplings and gaskets to ULC/ORD-C213,
- .3 rolled or cut grooved (depending on pipe wall thickness), standard or rigid style,
- .4 fittings and couplings NPS 2 to 12: malleable iron to ASTM A47 or ductile iron to ASTM A536,
- .5 gaskets: dry lubricated EPDM,
- .6 design temperature rating: -34°C (-30°F) to 110°C (230°F),
 - (a) design pressure rating: 2400 kPa (350 psig),

Standard of Acceptance

- Victaulic
- Gruvlok

2.3 Pipe Supports

- .1 Pipe supports and hangers to conform to specification section 20 05 29 except/and as specified herein.
- .2 Pipe hangers and supports to be listed ULC/ORD-C203 or UL 203 for fire suppression service, except where such listing requirement is excluded under applicable NFPA standards.

2.4 Dielectric Fittings

- .1 Dielectric unions – NPS 2 and under:
 - .1 body and union nut material selected to suit connecting piping materials, including carbon steel/copper, carbon steel/stainless steel, and copper/stainless steel,
 - .2 flat-face union design,
 - .3 tail-piece with FNPT ends with thermobaked epoxy coating, and Teflon shoulder gasket,
 - .4 head-piece with integral O-ring, with threaded or soldered pipe ends.
 - .5 union nut,
 - .6 pressure rating: Class 3000.
 - .7 dielectric coating resistance rating: minimum 500 V/mil thickness.

Standard of Acceptance

° Hart Industrial Unions - fig. D-3136

3 EXECUTION

3.1 Piping Installation General Requirements

- .1 General layout of mains, risers, run-outs and connection details of piping systems are shown.
- .2 Install concealed pipes close to building structure to keep furring spaces to minimum and minimize obstruction to other services in ceiling spaces.
- .3 Run exposed piping parallel to walls and conserve headroom and space, except where specific installation details are shown.
- .4 Support piping in accordance with the requirements of the NFPA standard applicable to the system type, subject to and in accordance with the requirements of specification section 20 05 29.
- .5 Ream pipe after cutting to length and clean off scale and dirt inside and outside of pipe before threading, grooving or welding.
- .6 Provide bends, expansion loops, hoses or joints to compensate for pipe seismic movement.
- .7 Anchor, guide and laterally support vertical and horizontal piping to support filled weight and absorb thrust under operating conditions.
- .8 Erect piping so that gravity forces and thrust from changes in direction do not stress connections to apparatus.
- .9 Provide dielectric couplings or flanges where steel pipe connects to copper tube.
- .10 Install drain valves at low points in water piping systems and in valved run-outs from risers so that system or isolated parts of system can be drained.
- .11 Do not use galvanized materials in contact with glycols.
- .12 Personnel involved in installation of grooved joint piping and fittings to be trained by product manufacturer and be conversant with;
 - .1 pipe end preparation and special tools,
 - (a) pipe ends to be clean and free from indentations, projections and roll marks in area from pipe end to groove.
 - (b) dimensions to be according to standard cut groove or roll groove in accordance with CSA
 - .2 coupling and fitting selection.
 - .3 joint assembly to accommodate expansion, contraction, and flexibility,
 - .4 specifications and/or recommendations with respect to support, anchorage and guiding of pipe systems.

3.2 Pipe Joints

- .1 Refer to applicable fire suppression system specification sections for permissible type of pipe joints to be used and any restrictions therein.
- .2 Use flat-faced steel flanges when attaching to cast iron flanges.

3.3 Dielectric Fittings

- .1 Provide dielectric fittings where copper tubing is connected to carbon steel or galvanized steel pipe.
- .2 Dielectric fittings are not required to separate carbon steel or galvanized steel pipe from:
 - .1 brass or bronze valves provided that carbon steel pipe or galvanized steel pipe is connected to both sides of the valve, or

.2 hose valves.

- .3 Bronze or brass valves are not to be used as dielectric fittings. Where a brass or bronze valve is installed at the connection point between carbon steel/galvanized steel pipe and copper tube systems, provide a dielectric fitting on either side of the valve.

3.4 Welding Procedures

- .1 Welding of fire suppression piping to be in accordance with specification section 20 05 24 except as otherwise required by the NFPA standard applicable to the type of fire suppression system.
- .2 Welding acceptance criteria to be in accordance with the NFPA standard applicable to the type of fire suppression system.

3.5 Pressure and Leak Testing

- .1 In accordance with the applicable specification sections of Division 21.

END OF SECTION

WET PIPE SPRINKLER SYSTEM

21 13 13

1 GENERAL

1.1 Scope

- .1 Provide wet pipe automatic sprinkler systems.
- .2 Provide installation drawings and hydraulic calculations, designed and sealed by a professional engineer licensed in the province or territory of the Work.

1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
 - .1 21 05 01 Common Work Results for Fire Suppression
 - .2 21 05 23 General-Duty Valves for Fire Protection

1.3 Definitions

- .1 The following definitions apply to this section.
 - .1 **Pressure reducing valve** – a valve that reduces the inlet water pressure to a regulated constant outlet pressure under static (no flow) and dynamic (water flowing) conditions (“pressure reducing” and “pressure controlling” valves have the same meaning).

1.4 Applicable Codes and Standards

- .1 Legislation:
 - .1 Ontario Building Code
- .2 Installation codes and standards:
 - .1 ASTM C636 Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustic Tile and Lay-In Panels
 - .2 NFPA 13 Standard for the Installation of Sprinkler Systems
- .3 Insurance company standards:
 - .1 FM Global Engineering Data Sheets.
- .4 Product standards:
 - .1 ASTM C635 Standard Specification for Manufacture, Performance and Testing of Metal Suspension systems for Acoustic Tile and Lay-in Panel Ceilings
 - .2 UL 199 Standard for Automatic Sprinklers for Fire Protection Services

1.5 Qualified Subcontractors

- .1 Sprinkler work to be undertaken by specialist fire protection installation firm with an established reputation in this field, and licences or otherwise qualified to perform such work where required by regulation.

1.6 Design Criteria

- .1 Piping design temperature: 38°C (100°F)

- .2 Piping design pressure: 1200 kPa (175 psig)
- .3 Sprinkler system type: stand-alone
- .4 Consultant's indicative system layout is designed to NFPA 13 and FM requirements using [hydraulic method for hazard classification shown with design densities and design areas for each zone as detailed.

1.7 Design Services

- .1 Provide engineering design services for the automatic sprinkler systems, including piping system detailed fabrication and installation drawings, supported by contractor's own hydraulic calculations and water supply test flow data.
- .2 Design of wet-pipe sprinkler systems is to conform with the requirements of NFPA 13 of the edition adopted by the AHJ, except/and as otherwise specified herein.
- .3 Coordinate sprinkler system layout with the work of other Trades. Prepare fabrication/installation drawings taking into account this coordination.
- .4 Conduct a site water flow test and prepare hydraulic calculations based on those test results.

1.8 Submittals

- .1 Submit manufacturer data sheets for products specified herein.
- .2 Prepare and submit shop drawings for sprinkler system fabrication and installation drawings including hydraulic calculations;
 - .1 forward three copies to Owners Insurers for review and acceptance,
 - .2 after shop drawings are accepted by reviewing authority, submit copies of these stamped shop drawings and product data sheets to Consultant for review.

2 PRODUCTS

2.1 Pipe, Fittings and Valves

- .1 Pipe and fittings: in conformance with specification section 21 05 01 except/and as specified herein.
- .2 Valves: in conformance with specification section 21 05 23.
- .3 Pipe minimum wall thickness: in accordance with Table 1 except as follows:
 - .1 use schedule 40 of either ASTM A53 or A135 in the following locations:
 - (a) exposed vertical piping in parking garages, truck docks and other areas subject to vehicular traffic, between floor level and to a height of 3.0 m (10 ft) above floor level,
 - (b) exposed vertical piping in factories and manufacturing plants, between floor level and to a height of 5.0 m (15 ft) above floor level or the bottom of the roof structural steel, whichever is lower,
 - (c) do not use ASTM 795 in the above listed locations.

Table 1: Pipe Selection and Minimum Pipe Wall Thickness			
Pipe Size	Jointing Method	ASTM A53, ASTM A135	ASTM A795
≤ 2-1/2	Threaded, Cut Groove	Schedule 40	Standard Weight

Table 1: Pipe Selection and Minimum Pipe Wall Thickness			
Pipe Size	Jointing Method	ASTM A53, ASTM A135	ASTM A795
2-1/2 to 6	Welded, Roll Groove	Schedule 10	Light-Weight
	Cut Groove	Schedule 40	Standard- Weight
8 to 10	Welded Roll Groove	Schedule 20	Light-Weight
	Cut Groove	Schedule 40	Standard-Weight
≥ 12	Welded, Roll Groove	9.5 mm (0.375 in)	Not applicable

.4 Mechanical Tees for grooved pipe fittings:

- .1 restricted use; refer to Part 3,
- .2 gasket-sealed mechanical Tee's, for installation of branch piping to mains pipe,
- .3 ductile iron body to ASTM A-395, with EPDM gasket,
- .4 gull-wrap coupling around pipe mains; half-coupling with U-bolt arrangement not permitted.

Standard of Acceptance

- Victaulic - fig. 920/920N
- Gruvlock

2.2 Pipe Supports, Hangers and gaskets

- .1 To section 21 05 01.

2.3 Sprinkler Heads

- .1 Ratings:
 - .1 listed to UL 199 for Canada and FM approved for fire service,
 - .2 standard temperature rating 57°C to 74°C (135°F to 165°F) with intermediate or high temperature rating to suit local conditions.
 - .3 thermal sensitivity:
 - (a) Quick Response type for Light and Ordinary hazard applications
 - (b) Standard response type for Extra hazard applications.

Standard of Acceptance

- Viking
- Tyco
- Reliable
- Victaulic

- .2 General purpose sprinkler head types in accordance with Table 1.

Table 1: Sprinkler Head Types						
Type	Orientation	Feature	Body Finish	Escutcheon Finish	Release	Remarks
U-1	Upright	---	Bronze body	---	Glass Bulb	12 mm (½ in) diameter orifice or 13 mm (17/32 in) diameter orifice as shown
P-2	Pendent	Concealed	Bronze	White	Glass Bulb	Fusible cover plate
S-1	Side Wall	---	Bronze	Chrome	Link & Lever	---
S-2	Side Wall	---	Chrome	Chrome	Link & Lever	---

3 EXECUTION

3.1 Piping Installation General Requirements

- .1 Install sprinkler piping and supports in accordance with specification section 21 05 01 except/and as specified herein.
- .2 Provide headers, alarm check valve assemblies, valves, test valves, and fire department connections.
- .3 Install excess pressure pump across alarm check valve.
- .4 Extend piping and connect to sprinklers.
- .5 Provide NPS ¾ drain valves with hose end and caps in the following locations:
 - .1 at the bottom of sprinkler risers,
 - .2 at trapped low points in piping system.
- .6 Provide NPS ¾ manual air vent valve with cap and chain at the top of each sprinkler riser and where shown;
 - .1 run NPS ¾ air vent piping from top of riser and down to a location where the manual vent valve is accessible,
 - .2 manual vent valve to be located at a height of not more than 2.1 m (7 ft) above local floor level, and positioned so outlet is pointed down.
- .7 Provide additional sprinkler heads with associated piping for sprinkler protection under ducts, under obstructions, and in blind spaces. Identify additional sprinkler heads on shop drawings with capital letter "A" and resubmit drawings to permit inclusion of these sprinkler heads in hydraulic calculations.

3.2 Mechanical Tees for Branch Piping

- .1 The use of mechanical Tees for grooved joint installation is restricted by the following conditions:
 - .1 may be used in existing buildings for connection of single- sided branch piping connections to existing installations,
 - .2 may be used in new buildings, for single-sided branch piping connections in areas without ceilings, and
 - .3 where specifically authorized by Consultant on a case-by-case basis.

3.3 Flexible Sprinkler Hose Connectors

- .1 Not permitted.

3.4 Sprinkler Head Selection and Layout

- .1 Use concealed pendant sprinklers where suspended ceilings occur. Locate sprinklers in symmetrical pattern to suit reflected ceiling plans and to avoid speakers, fire alarm components, lighting fixtures, ductwork and diffusers. In general, centre heads in ceiling tiles. Examine architectural reflected ceiling plan to coordinate sprinkler head layout and locations.

3.5 Pressure Testing

- .1 Conduct pressure testing of sprinkler piping systems in accordance with requirements of NFPA 13 and building insurer requirements, if any, and as follows.
- .2 In existing buildings, conduct an initial pneumatic pressure test of the new and modified work before connection to the existing system, to test for significant leaks before filling the modified installation or new work with water.
 - .1 isolate the new piping from the existing system,
 - .2 pressure test the new piping at 280 kPa (40 psig) using oil-free compressed air or nitrogen,
 - .3 maintain pressure test for one hour without loss of pressure,
 - .4 if any leaks are discovered, repair leaks and retest.
- .3 Conduct hydrostatic pressure tests at the test pressures and for the test durations as follows:
 - .1 for new piping systems with a working pressure of 1030 kPa (150 psi) or less:
 - (a) a minimum of 1380 kPa (200 psi) for a test period of not less than two hours,
 - .2 for new piping systems or portion thereof with a working pressure of greater than 1030 kPa (150 psi):
 - (a) a minimum of the working pressure plus 345 kPa (50 psi) for a test period of not less than two hours,
 - .3 for modifications or additions to an existing systems involves more than 20 sprinkler heads:
 - (a) the test pressure and duration as specified for a new installation, except only the new piping is to be tested with the new piping isolated from the existing systems,
 - (b) the new piping section may be isolated by a service valve at the tie-in point to the existing system, or it may be isolated by installation of a temporary plug,
 - (c) for installation of a temporary test plug, a section of the new pipe at the connection to the existing system is removed; this spool piece is not to exceed a length of 300 mm (12 in.) nor contain more than two pipe joints.
 - (d) after pressure testing is completed and the spool piece is reinstalled, conduct an in-service pressure test of the spool piece and its joints.
 - .4 where the work only involves the modification to an existing system that impacts not more than 20 sprinkler heads, only an in-service pressure test is required,
 - .5 where modifications to an existing system only involves relocating sprinkler heads and associated pipe drops (but without any changes to any other system piping), only an in-service pressure test is required.
- .4 In-service pressure test:
 - .1 where an in-service pressure test is required, return the sprinkler system to its normal operating condition and bleed-off trapped air as much as possible,
 - .2 visually inspect the subject joints, using joint leak detection solution.

- .5 Pressure testing of multi-storey buildings:
 - .1 pressure test the sprinkler risers separate and isolated from on-floor piping, except that the feed main connecting the risers may be included in the riser pressure test,
 - .2 pressure test each on-floor sprinkler zones separately and independently of the system sprinkler risers; isolate each floor from the system riser during the test.
- .6 Pressure test acceptance criteria:
 - .1 pressure loss not exceeding 10 kPa (1.5 psi) as measured by installed pressure gauge, or where visual examination of all pipe joints determines there are no visible leaks.

3.6 Operational Testing

- .1 Conduct an operational test of all flow control and alarm devices. Test sprinkler systems in accordance with requirements of NFPA 13, and building insurer requirements (if any).
- .2 Schedule testing to give at least two weeks' notice to AHJs having jurisdiction for:
 - .1 building/plumbing Inspector,
 - .2 fire department representative,
 - .3 insurer's representative,
 - .4 Owner, and
 - .5 Consultant.
- .3 Prior to testing, ensure that valves, flow switches, pressure switches, supervisory switches and other devices are functioning and in-service.

3.7 Testing Reports and Certificates

- .1 Provide completed and signed Contractor's Material and Test Certificate for above ground piping and Contractor's Material and Test Certificate for underground piping.
- .2 Submit copies of completed Certificates to the Consultant, and include copies in the Operating and Maintenance manuals.

END OF SECTION

COMMON WORK RESULTS FOR PLUMBING PIPING

22 05 01

1 GENERAL

1.1 Scope

- .1 Provide piping systems for plumbing, drain and vent systems for:
 - .1 potable (domestic) water systems,
 - .2 drainage system including:
 - (a) sanitary drainage and vent systems,
 - (b) storm water drainage systems,
 - .3 other plumbing systems including:
 - (a) specific duty piping systems otherwise specified in Division 22.

1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
 - .1 20 05 73.13 Mechanical Services for General Facility Equipment

1.3 Applicable Codes and Standards

- .1 Legislation:
 - .1 Ontario Building Code
 - .2 Municipal bylaws regarding potable water, water services, and sewage systems.
- .2 Installation standards and codes:
 - .1 AWWA C651 Disinfecting Water Mains.

1.4 Qualified Tradesmen

- .1 Work to be performed by qualified and recognized firm with an established reputation in this field, using tradesmen holding certificates of competency.

1.5 Design Criteria – Pressure Piping Systems

- .1 The following design conditions apply unless otherwise shown on drawings.
- .2 System design criteria:
 - .1 Domestic Cold Water Service (to building):
 - (a) Design pressure: 900 kPa (130 psig)
 - (b) Design temperature: 25°C (77°F)
 - .2 Potable water:
 - (a) Design pressure: 900 kPa (130 psig)
 - (b) Design temperature: 107°C (225°F)

2 INSTALLATION

2.1 Piping

- .1 Piping system routing is shown diagrammatically. Locate mains, risers and runouts concealed behind furrings or above ceilings except in mechanical equipment rooms and access spaces where piping is to be exposed.
- .2 Determine areas without ceilings from Architectural Drawings and Room Finish Schedules, and in these areas keep piping as high as possible.
- .3 Anchor, guide and support vertical and horizontal runs of piping to resist dead load and absorb thrust.

2.2 Domestic Cold Water System Distribution

- .1 Extend existing domestic cold water system with
 - .1 distribution pipe and fittings,
 - .2 valves,
 - .3 zone or equipment backflow protection.
- .2 Minimum water pressure at street level: approximately 500 kPa (70 psi).
- .3 Provide valved connections from supply system, to fixtures and other equipment requiring cold water.

2.3 Domestic Hot Water System Distribution

- .1 Extend existing domestic hot water system with
 - .1 distribution pipe and fittings
 - .2 valves
 - .3 zone or equipment backflow protection.
- .2 Provide valved connections from hot water supply system to fixtures and other equipment requiring hot water.

2.4 Domestic Hot Water Recirculation System

- .1 Extend existing domestic hot water recirculation system with
 - .1 distribution pipe and fittings
 - .2 valves
- .2 Connect ends of hot water risers to recirculation mains and extend to recirculation pump.
- .3 Provide minimum flow balancing valves at each connection between the domestic hot water loop and the hot water recirculation loop.

2.5 Drainage

- .1 Provide roof drains and storm drainage piping system.
- .2 Provide waste and vent connections to plumbing fixtures and equipment.
- .3 Drainage fittings;
 - .1 do not use double hubs, straight crosses, double T's, or double TY's in soil or waste pipe below any fixture,
 - .2 do not use branch fittings other than full "Y" or "Y" and an eighth bend, on soil or waste pipe running in horizontal direction,

- .3 do not use quarter bend placed on its side,
- .4 do not use inverted joints below fixtures,
- .5 do not install cleanouts above food preparation or patient treatment areas. In these areas carry rodding connection up to floor cleanout fitted with adjustable gasketed access cover and plug, with cleanout body cast in floor slab above,
- .6 drainage fittings to match connected piping for quality and wall thickness.

2.6 Water and Waste Connections

- .1 Provide hot and cold water, waste and vent connections to building service equipment. Provide connections to Owners equipment and equipment supplied by Divisions of the Work other than Division 20 to 25, as specified herein and in accordance with specification section 20 05 73.13.
- .2 Provide vacuum breakers and backflow preventers on equipment connections, and hose bibs, and on fixture connections without adequate air gaps.
- .3 Where hot and cold water supply pipes connect to combination supply fitting with shut-off valve on discharge, or where combination supply fitting is equipped with manual or thermostatic mixing valve, equip each hot and cold water supply pipe with composition disc swing check fitting.
- .4 Provide shut-off valve on each service line close to the apparatus and brass traps complete with cleanout on waste connection unless waste discharges directly into floor drain or funnel drain.
- .5 Where specific sizes are not shown, valves, and final connections to equipment to be one pipe size larger than equipment tapping size, and trap and drain size to be one pipe size larger than waste connection on apparatus.

2.7 Pressure Testing – Water Pressure Piping Systems

- .1 Pressure test piping before insulation is applied.
- .2 Initial pneumatic leak test:
 - .1 Conduct an initial pneumatic pressure test at a maximum pressure of 70 kPa (10 psig) prior to hydrostatic pressure test, to check for large leaks or incomplete joints.
 - .2 Remove compressed air source and maintain this pressure for the time necessary to inspect for leaks, but not less than 2 hours.
 - .3 Maintain pressure and examine each joint with commercial leak detector solution.

Standard of Acceptance

- Snoop
 - Leak-tec
- .4 Repair leaks where found prior to performing hydrostatic pressure tests.
- .5 During pneumatic pressure tests, comply with the site safety requirements for notification and guarding during testing with compressed gasses.
- .3 Final hydrostatic pressure test:
 - .1 Use the system design pressure for the entire installation, unless different design pressures are indicated for each floor.
 - .2 Fill the system with water and gradually increase the system pressure to 150% of the design pressure and hold for 10 minutes, then reduce pressure to the design pressure.
 - .3 Inspect each pipe joint for leaks.
 - .4 As an alternative to inspection of each joint for leaks, conduct a 24 hour standing pressure test:

- (a) raise the water pressure to 150% of the design pressure for 10 minutes, then reduce pressure to design pressure,
 - (b) record the test pressure one (1) hour after establishing the system hydrostatic test pressure at the design pressure. Record ambient air temperature at the same time.
 - (c) at the end of the 24 hour standing test period, record the test pressure and ambient air temperature. Make adjustments to the measured end-of-test pressure to account for change in fluid density due to change in ambient air temperature,
 - (d) acceptance criteria: maximum pressure loss over 24 hours not to exceed 1% of test pressure, corrected for ambient temperature,
 - (e) where acceptance criteria is not met, inspect pipe joints for leaks.
- .5 Where leaks are found, repair leaks and retest piping as specified above.
- (a) for soldered or brazed joints, one attempt at repairing the joint is permitted. If joint continues to fail, cut-out and replace the fitting.

2.8 Pressure Test Report

- .1 Maintain a log of all pressure tests, including locating of where leaks have been repaired. Submit the log to the Consultant for review when requesting prior to substantial completion of the Work. Where a piping system is subject to AHJ inspection, provide evidence of such inspection by means of an AHJ inspection report or name of the AHJ inspector and the date they witnessed the pressure test.

2.9 Flushing and Cleaning - Building Water Distribution Piping

- .1 Conduct first fill and pressure testing of building distribution piping only after completion of flushing and disinfection of water service pipe.
- .2 Complete piping pressure tests prior to flushing and cleaning operations.
- .3 Flush water distribution piping through available outlets with sufficient flow to produce velocity of 1.5 m/s, within pipe for 10 minutes, or until foreign materials have been removed and flushed water is clear.
- .4 Minimum flushing flowrates:

Pipe size	Minimum Flow	
	L/s	USGPM
NPS		
2	3.3	52
2 1/2	4.7	75
3	7.3	115
4	12.6	200

- .5 Open and close valves, hydrants and service connections to ensure thorough flushing.

2.10 Testing and Balancing – Water Pressure Piping Systems

- .1 Balance domestic water piping systems where double regulating valves are installed, including hot water recirculation piping and as otherwise shown.

END OF SECTION

GENERAL-DUTY VALVES FOR PLUMBING PIPING

22 05 23.13

1 GENERAL

1.1 Scope

- .1 Provide valves for general duty service in plumbing piping systems, including shut-off valves, check valves, manual balancing valves, and automatic flow balancing valves.
- .2 Valves under this specification section are provided for:
 - .1 Domestic (potable) water systems using copper tubing, stainless steel pipe or tube, ductile iron water piping, and galvanized steel piping.

1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section integrates with or refers to the following specification sections:
 - .1 20 05 23 General Requirements for Valves
 - .2 22 05 01 Plumbing - General

1.3 Definitions

- .1 The following definitions apply to this section.
 - .1 **Contaminant-free:** means the material is free of contaminants and impurities to the prescribed limits of NSF/ANSI 61 – section 8 (NSF/ANSI 61/8), but excludes evaluation for lead.
 - .2 **Lead-free:** means the weighted average lead content does not exceed 0.25% when evaluated in accordance with the test methods in NSF/ANSI 61-Annex G or NSF/ANSI 372.

1.4 Submittals

- .1 Conform to the requirements of Specification section 20 05 23 except/and as follows.
- .2 For double regulating valves, in addition to manufacturer data sheets, submit a schedule listing all double regulating valves and include the following information:
 - .1 a valve reference number,
 - .2 valve service (e.g. associated equipment, or distribution piping service by drawing, room, etc.)
 - .3 associated pipeline size, NPS
 - .4 valve body size, NPS
 - .5 specified design flow rate,
 - .6 valve minimum and maximum flow rate limits,
 - .7 valve pressure drop at specified design flow rate,
 - .8 expected valve open position (number of valve turns open, percent valve stroke, etc.).
- .3 For automatic flow balancing valves, in addition to manufacturer data sheets, submit a schedule listing all automatic flow balancing valves and include the following information:
 - .1 a valve reference number,
 - .2 valve service (e.g., where the valve is located, floor, room, etc.),
 - .3 associated pipeline size, NPS
 - .4 valve body size, NPS

- .5 specified design flow rate,
- .6 valve fixed flow rate,
- .7 valve operating differential pressure range.

1.5 Applicable Codes and Standards

- .1 Refer to section 20 05 23 and as specified herein.
- .2 Product standards:
 - .1 CSA B125.3 Plumbing Fittings
 - .2 NSF/ANSI 61 Drinking Water System Components – Health Effects
 - .3 NSF/ANSI 372 Drinking Water System Components – Lead Content (formerly NSF/ANSI 61, Annex G).

2 PRODUCTS

2.1 General

- .1 Where products are specified as being lead-free, they shall be listed to either:
 - .1 CSA B125.3;
 - .2 NSF/ANSI 61-G; or
 - .3 NSF/ANSI 372.
- .2 Where products are specified as being contaminant-free, they shall be listed to either:
 - .1 CSA B125.3;
 - .2 NSF/ANSI 61-G; or
 - .3 NSF/ANSI 61/8

2.2 Ball Valves: Brass Body (type BV-1)

- .1 NPS 4 and under, copper alloy body:
 - .1 To MSS SP-110, 600 CWP, two-piece bronze or DZR brass body, full port, stainless steel or chrome plated bronze ball, PTFE seat rings, solder or NPT threaded ends.
 - .2 Handle extensions suitable to clear 50 mm (2 in) pipe insulation thickness.
 - .3 Required MCPR: 2500 kPa (363 psig) at 93°C (200°F).
 - .4 Certified for lead-free and contaminant-free service.
 - .5 Soldered ends: NPS 2 and under.

Standard of Acceptance

- Kitz - fig. 859
- Apollo - fig. 77FLF-20x
- Nibco - fig. S-685-66-LF
- Watts - fig. LFB6081

- .6 Threaded ends: NPS 4 and under.

Standard of Acceptance

- Kitz - fig. 858

- Apollo - fig. 77FLF-10x
- Nibco - fig. T-685-66-LF
- Watts - fig. LFB6080

2.3 Ball Valves: Stainless Steel Body (type BV-2)

.1 NPS 4 and under, threaded ends:

- .1 To MSS SP-110, 600CWP, two piece T316 stainless steel body, full port, stainless steel or chrome plated bronze ball, PTFE seat rings, NPT threaded ends.
- .2 Handle extensions suitable to clear 50 mm (2 in) pipe insulation thickness.
- .3 Required MCPR: 2500 kPa (363 psig) at 93°C (200°F).
- .4 Certified for lead-free and contaminant-free service.

Standard of Acceptance

- Apollo - fig. 76F-10x series (NPS 2 and under)
- Watts - fig. S-FBV-1 series

.2 NPS 1- ½ to NPS 12, flanged ends:

- .1 To MSS SP-72, two piece CF8M stainless steel body, full port, stainless steel ball, PTFE seat rings, flanged ends.
- .2 Locking handles up to NPS 4, and gear operators for NPS 6 and over.
- .3 Certified for lead-free and contaminant-free service.
- .4 ASME Class 150:
 - (a) Required MCPR: 1600 kPa (232 psig) at 93°C (200°F).

Standard of Acceptance

- Apollo - fig. 87A-200 series

.5 ASME Class 300:

- (a) Required MCPR: 4000 kPa (580 psig) at 93°C (200°F).

Standard of Acceptance

- Apollo - fig. 87A-900 series

2.4 Globe Valves (type GLV-1)

.1 NPS 2 and under:

- .1 To MSS SP-80, Class 125 bronze body valves, brass or bronze disc, threaded bonnet, threaded or soldered ends.
- .2 Required MCPR: 1200 kPa (174 psi) at 93°C (200°F).
- .3 Certified for lead-free and contaminant-free service.
- .4 Soldered ends:

Standard of Acceptance

- Kitz - fig. 812
- Apollo - fig. 121S-LF

.5 Threaded ends:

Standard of Acceptance

- Kitz - fig. 811
- Apollo - fig. 121T-LF

2.5 Gate Valves: Bronze Body (type GTV-1)

.1 NPS 2 and under:

- .1 To: MSS SP-80, Class 125; or MSS SP-139, 300 CWP, bronze body, solid wedge brass or bronze disc, non-rising stem, screw in or union bonnet.
- .2 Required MCPR: 1200 kPa (174 psi) at 93°C (200°F).
- .3 Certified for lead-free and contaminant-free service.
- .4 Soldered ends:

Standard of Acceptance

- Kitz - fig. 828
- Apollo - fig. 102SLF
- Crane (GGC) - fig. LF1320
- Nibco - fig. S-111-LF

.5 Threaded ends:

Standard of Acceptance

- Kitz - fig. 827
- Apollo - fig. 102TLF
- Crane (GGC) - fig. LF438
- Nibco - fig. T-113-LF

2.6 Gate Valves: Cast Iron Body (type GTV-2)

.1 NPS 2 to 12:

- .1 To: MSS SP-70, Class 125, cast iron body, solid wedge bronze disc and bronze seat rings, adjustable graphite stem packing, bolted bonnet.
- .2 Finish: FDA food grade epoxy power coat,
- .3 Required MCPR: 1380 kPa (200 psi) at 38°C (100°F).
- .4 CRN to CSA B51,
- .5 Certified for lead-free and contaminant-free service.
- .6 End connections: flat-faced flanged, suitable for ASME Class 125 and Class 150 pipe flanges,
- .7 Non-rising stem:

Standard of Acceptance

- Apollo - fig. 610F-LF

.8 Outside screw and yoke:

Standard of Acceptance

- Apollo - fig. 611F-LF

2.7 Butterfly Valves - Flanged

.1 NPS 2 to NPS 12, ductile iron (type BFV-1):

- .1 To MSS-SP-67, ductile iron lug body style, with flange bolt holes drilled and tapped for ANSI 150 flange pattern.
- .2 Required MCPR: 1200 kPa (174 psi) at 93°C (200°F).
- .3 Stainless steel shaft, aluminum bronze or 316 stainless steel or ductile iron/nickel plated disc, and replaceable EPDM resilient seat to provide bubble tight shut-off under system pressure from either side with flange removed from un-pressurized side.
- .4 ISO 5211 mounting pad.
- .5 Locking handles up to NPS 4, and gear operators for NPS 6 and over.
- .6 Certified for lead-free and contaminant-free service.

Standard of Acceptance

- Nibco - fig. LD-2000
- Apollo - fig. LD 141, LD 145
- Kitz - fig. 6122EL
- MA Stewart - fig. L-D-4-A-E-LH
- Watts - fig. DBF-03
- Milwaukee - fig. ML233E, ML333E
- Crane Center Line fig. 200

.2 NPS 2 to NPS 12, stainless steel (Type BFV-2):

- .1 To MSS-SP-68, Class 300, CF8M stainless steel lug body style, with flange bolt holes drilled and tapped for ANSI 300 flange pattern.
- .2 Required MCPR: 4000 kPa (580 psi) at 93°C (200°F).
- .3 T316 or 17-4 stainless steel disc and shaft, TFM-PTFE seat complete with titanium or 316 stainless steel spiral wound back-up ring to provide bubble tight shut-off under system pressure from either side, when installed with single flange.
- .4 ISO 5211 mounting pad.
- .5 Locking handles up to NPS 4, and gear operators for NPS 6 and over.
- .6 Certified for lead-free and contaminant-free service.

Standard of Acceptance

- Apollo - fig. 230
- Keystone - fig. K-Lok 37

2.8 Butterfly Valves – Groove Ends

.1 NPS 2 to NPS 12, stainless steel (type BFV-4).

- .1 To MSS SP-67, CF8M stainless steel body, and grooved ends to CSA B242.
- .2 Required MCPR: 2000 kPa (290 psi) at 93°C (200°F).
- .3 Stainless steel shaft, CF8M stainless steel disc, and fluoroelastomer seat to provide bubble tight shut-off under system pressure from either side with flange removed from un-pressurized side.
- .4 ISO 5211 mounting pad.
- .5 Locking handles up to NPS 3, and gear operators for NPS 4 and over.

- .6 Certified for lead-free and contaminant-free service.

Standard of Acceptance

- Victaulic - fig. Vic 300 MasterSeal series 461

- .2 NPS 2-1/2 to NPS 6, grooved ends for copper tubing (type BFV-5).

- .1 To MSS SP-67, brass or bronze body, grooved ends for copper tubing.
- .2 Required MCPR: 2000 kPa (290 psi) at 93°C (200°F).
- .3 Stainless steel shaft, aluminum bronze disc with fluoroelastomer seat or ductile iron with EPDM encased disc/seal combination.
- .4 ISO 5211 mounting pad.
- .5 Locking handles up to NPS 6.
- .6 Certified for lead-free and contaminant-free service.

Standard of Acceptance

- Victaulic - fig. Vic 608N
- Gruvlok - fig. AN6721

2.9 Inline Silent Check Valves

- .1 NPS 2 and under:

- .1 To MSS SP-80, Class 125, bronze or stainless steel body, inline spring-actuated disc or ball type, and PTFE or EPDM seat.
- .2 Required MCPR: 1200 kPa (174 psi) at 93°C (200°F).
- .3 Certified for lead-free and contaminant-free service.
- .4 Soldered ends:

Standard of Acceptance

- Nibco – fig. S-480-Y-LF
- Apollo – fig. CVB-LF (61LF-600)
- Kitz – fig. 826

- .5 Threaded ends:

Standard of Acceptance

- Nibco - fig. T-480-Y-LF
- Apollo - fig. CVB-LF (61LF-500)
- Kitz - fig. 836

- .2 NPS 2 to NPS 12:

- .1 To MSS SP-125, cast iron body with flat faced flange or wafer body, inline spring-actuated silent type, replaceable PTFE or BUNA-N seats, bronze faced iron or bronze disc.
- .2 Required MCPR: 13200 kPa (188 psi) at 65°C (150°F).
- .3 Certified for lead-free and contaminant-free service.
- .4 Class 125:
 - (a) Required MCPR: 1380 kPa (200 psi) at 65°C (150°F).

Standard of Acceptance

- Nibco - fig. F-910-W-LF, W-910-LF
- Valmatic - fig. VM-8802-S

.5 Class 250:

- (a) Required MCPR: 2700 kPa (392 psi) at 65°C (150°F).

Standard of Acceptance

- Nibco - fig. F-960-W-LF, W-910-LF
- Valmatic - fig. VM-8802-S

.3 NPS 2 and over, grooved ends:

- .1 CF8M stainless steel body with spring-assisted twin stainless steel discs, and fluoroelastomeric seat.
- .2 Required MCPR: 2000 kPa (290 psi) at 93°C (200°F).
- .3 Certified for lead-free and contaminant-free service.

Standard of Acceptance

- Victaulic - fig. 816

2.10 Double Regulating Valves (DRVLF)

.1 NPS 3 and under, threaded or soldered:

- .1 Brass body, plug type stem with flow measurement ports and tamper-proof setting.
- .2 NPT threaded or soldered ends.
- .3 Required MCPR:
 - (a) Soldered: 2000 kPa (300 psig) at 93°C (200°F).
 - (b) Threaded: 2750 kPa (400 psi) at 93°C (200°F).
- .4 Certified for lead-free and contaminant-free service.

Standard of Acceptance

- Bell and Gossett - fig. CB-*-LF, RF-*-LF
- Nexus - fig. Ultra MBNL
- Victaulic/Tour and Anderson - fig. 78BL

.2 Flow meter for DRVs:

- .1 Differential pressure gauge with calibration charts or digital flow meter type.
- .2 Hoses and fittings to suit manual double regulating valves.

Standard of Acceptance

- Bell and Gossett - Readout Kit
- Nexus - Meter Kit, MKM series

2.11 Automatic Flow Balancing Valve (AFBV)

.1 NPS ½ to NPS ¾, threaded:

- .1 Automatic flow balancing valve providing constant flow rate over a wide differential pressure control range.

- .2 Stainless steel or brass body, with stainless steel cartridge and EPDM seals.
- .3 Performance:
 - (a) +/- 5% flow rate over 95% of control range.
 - (b) Differential pressure control range: minimum of 14 to 220 kPa (2 to 32 psi) operating range.
- .4 NPT threaded ends.
- .5 Minimum MCPR: 2750 kPa (400 psi) at 93°C (200°F).
- .6 Certified for lead-free and contaminant-free service.

Standard of Acceptance

- Victaulic/Tour and Andersson - fig. 76X
- Griswald Controls - fig. K Valve

2.12 Solenoid Valves for Potable Water

- .1 Construction:
 - .1 2-way bronze, brass or composite engineered plastic body valve with EPDM seals and disc,
 - .2 control function: On/Off,
 - .3 for normally closed or normally open operation as shown,
 - .4 pilot operated electric solenoid with general purpose enclosure and conduit hub,
 - .5 minimum allowable working pressure: 1035 kPa (150 psig),
 - .6 minimum operating differential pressure: 820 kPa (120 psi)
 - .7 minimum design temperature: 82°C (180°F)
 - .8 manual override operator for normally-closed valves,
 - .9 pipe ends: ASME B1.20.1 NPT threaded ends, or push/twist lock connector for copper tube,
 - .10 certified for lead-free and contaminant-free service.
 - .11 listed to CSA C22.2 No. 139,
 - .12 power supply: 24 VAC, 24 VDC or 120 VAC.
 - .13 valve size limits based on service temperature:

Valve Size	Maximum Water Temperature
NPS 1	50°C (122°F)
NPS ¾ and smaller	82°C (180°F)

Standard of Acceptance

- ASCO - fig 212

3 EXECUTION**3.1 Installation**

- .1 Refer to section 20 05 23 and as required herein.
- .2 Use certified lead-free and contaminant-free valves on potable cold, hot and recirculating water systems. Valves not certified as lead-free may only be used on non-potable water systems, pumped drainage systems and other similar systems.

3.2 Valve Selection Based on Pressure Rating

- .1 Unless otherwise specified herein or shown, select valves that have a Minimum Component Pressure Rating (MCPR) which exceed the applicable piping system Design Pressure and Design Temperature specified in section 22 05 01.
- .2 Where drawings indicate either: (a) a pressure rating; or (b) a pressure rating and Class rating, by floor level then select valves as follows:
 - .1 for all valves, select a valve with a MCPR rating equal to or greater than the pressure rating indicated on the drawings for each floor level,
 - .2 for clarity, even if a valve has an ASME Class rating, do not select a valve based on its Class to match any Class rating shown on the drawings.

3.3 Manual Valve Selection Based on Service and Pipe Material

- .1 Select manual valve types based on the requirements of Table 1.

Table 1: Manual Valve Selection		
Piping System	Pipe and Tube Material	Manual Valve Type
Domestic Cold Water Domestic Hot Water Domestic Recirculating Water Domestic Tempered Water	Copper	BV-1 GLV-1 GTV-1, GTV-2 BFV-1, BFV-2, BFV-5
	Stainless Steel	BV-2 BFV-2, BFV-4
	Ductile Iron	BFV-1, BFV-2, GTV-2
Domestic Cold Water (Industrial Occupancies only)	Galvanized steel	BV-1 GTV-2 BFV-1, BFV-3
Non-potable water	Copper	BV-1 GLV-1 GTV-1 BFV-1, BFV-2, BFV-5
	Stainless Steel	BV-2 BFV-2, BFV-4
	Galvanized Steel	BV-1, BV-2 GLV-1 GTV-1, GTV-2, GTVNP BFV-1, BFV-2, BFV-3, BFV-4
Pumped Sanitary Drainage Pumped Storm Drainage	Copper	BV-1, BV-2
	Galvanized Steel	BV-1, BV-2

3.4 Check Valves

- .1 Select check valves based on the requirements of Table 2.

Table 2: Check Valve Type Selection	
General use	Inline silent check
Domestic water heaters	Inline silent check
Temperature mixing valves	Inline silent check
Elevator sump pump discharge Clear waste sump pump discharge	Inline silent check or non-slam swing check
Sanitary sump pump discharge Storm sump pump discharge	Non-slam swing check valve

3.5 Double Regulating Valves Installation

- .1 Consult with double regulating valve manufacturer to ensure correct valve selection. Balancing valves to be sized according to design flow rate.
- .2 Size and select valves for flows as shown, based on at 6 kPa (2 ft) pressure drop across the valve in the fully open position, and in accordance with manufactures recommendation. Table 3 identifies the nominal valve size selection:

Table 3: Double Regulating Valve Nominal Sizing				
Valve Size NPS	Nominal Flow			
	Min.	Max.	Min.	Max.
	L/s	L/s	gpm	gpm
½	0.038	0.177	0.6	2.8
¾	0.126	0.379	2.0	6.0
1	0.246	0.631	3.9	10.0
1-¼	0.316	0.947	5.0	15.0
1-½	0.416	1.262	6.6	20.0
2	0.795	2.272	12.6	36.0
2-½	2.398	6.310	38.0	100.0
3	1.956	8.203	31.0	130.0
4	4.291	12.620	68.0	200.0
5	5.679	20.192	90.0	320.0
6	11.48	28.395	182.0	450.0
8	23.16	51.742	367.0	820.0
10	34.07	82.030	540.0	1300.0
12	60.58	94.650	960.0	1500.0

- .3 Install double regulating valves with five pipe diameters of straight pipe on inlet side, two pipe diameters on outlet side and 10 pipe diameters from any pump.
- .4 Install double regulating valves with ports facing horizontal or facing up. Do not install with ports facing down to prevent debris from falling and accumulating inside the ports.

3.6 Automatic Flow Balancing Valves Installation

- .1 Select automatic flow balancing valves to suit the flow rates as shown at a pressure differential of 35 kPa (5 psig). Where the indicated flow rate falls between two catalogued values, select the lower flow rated valve.

End of Section

TESTING ADJUSTING AND BALANCING FOR PLUMBING 22 05 93

1 GENERAL

1.1 Scope

- .1 Test, adjust, and balance ("TAB") plumbing systems installed, modified or extended as part of this work, including:
 - .1 domestic hot water systems,
 - .2 domestic hot water recirculation systems

1.2 Qualified Tradesperson

- .1 Work to be performed by qualified, licensed and recognized firm with an established reputation in this field, using tradesperson holding applicable certificates of competency.

1.3 Accuracy

- .1 Adjust systems until operating values are within the acceptance criteria stated for each system type. Where an acceptance criterion is not stated, balance the system so that measured values are within $\pm 5\%$ of design value.
- .2 Measurement device accuracy:

Measurement	Application	Device	Accuracy
Liquid Flow	Piping	Installed meter	As per meter rating
Liquid Flow	Equipment	Differential Pressure and equipment data	See below
Temperature	Liquids	Digital Electronic Thermometer	$\pm 0.2^{\circ}\text{C}$ over 0 to $+40^{\circ}\text{C}$
Temperature	Liquid	Digital Electronic Thermometer	$\pm 0.4^{\circ}\text{C}$ < 0°C and $> +40^{\circ}\text{C}$
Pressure	Liquid, Gas, Steam	Bourbon type	$\pm 1.0\%$ of reading
RPM	Motor, fans	Chronometer tachometer	$\pm 1.0\%$ of reading
Voltage	All	Portable	$\pm 2.5\%$ of reading
Current	All	Portable clamp-on ammeter	$\pm 2.5\%$ of reading

1.4 Audit Verification

- .1 After review of the draft TAB report by Consultant, the Consultant may at their sole discretion require re-measurement of TAB results on an audit sample rate of 5% of all measured equipment, at no cost extra to the Contract Price or change to project schedule.
- .2 If audited results indicate a variance of more than 10% between the original reported value and the audit measured value for a piece of equipment, re-balance the audited device. If this excessive variance condition occurs at more than 25% of the number of audited equipment sample, re-balance the entire affected system at no cost extra to the Contract Price or change to project schedule.

1.5 Preparatory Work

- .1 Review design drawings and specifications, shop drawings, interference drawings and other related documentation to become familiar with their intended performance.
- .2 Carry out site visits during later stages of construction to ensure that arrangements for TAB are incorporated. Confirm proper placement of thermometer wells, test ports, pressure gauge cocks, and balancing valves.
- .3 Commence TAB measurements when building is “closed in” and work is sufficiently advanced including;
 - .1 permanent heating is in operation,
 - .2 potable water systems have been flushed and cleaned.

1.6 Measurement Parameters

- .1 Reporting units of measure:

Parameter	Unit	Abbreviation
Mass	kilogram	kg
Length	metre	m
Volume	litre	L
Volume flow rate	Litres per second	L/s
Time	seconds	s
Temperature	Celsius	°C
Pressure	kilopascal	kPa
Pump Head	metre	m
Pump Pressure	kilopascals	kPa
Mass flow rate	kg per second	kg/s
Heat flow rate	kilowatts	kW
Electrical Power	kilowatts	kW
Voltage	Volts	V
Electrical Current	amps	A
Rotation speed	Rotations per minute	RPM

2 PRODUCTS

- 2.1 Not used.

3 EXECUTION – DOMESTIC WATER DISTRIBUTION

3.1 Measurement Parameters

- .1 The following measurement parameters identify the minimum requirements for inclusion in the TAB process:
 - .1 volume flow rate,

- .2 temperature,
- .3 pressure (gauge),
- .4 equipment related;
 - (a) rotational speed (rpm),
 - (b) electrical power, kW
 - (c) voltage, V
 - (d) current, A,
- .2 Measurement are required at and around equipment to establish fluid side performance of;
 - .1 domestic water heaters and heat exchangers.
 - .2 domestic water booster pumps,
 - .3 hot water recirculation pumps.
- .3 Measurement are required to characterize system performance;
 - .1 water flowrates at plumbing fixtures,
 - .2 hot water recirculation flow rates.

3.2 General Requirements

- .1 Use permanent water flow meters, temporary non-invasive flow meters, or metered fittings and pressure gauges to determine flow rates for system balance.
- .2 Base flow balance flow rates on (in order of preference):
 - .1 permanent flow meters,
 - .2 temporary non-invasive flow meters,
 - .3 double regulating valves,
 - .4 differential pressure measurement across heat transfer elements, with flowrate determined from manufacturer's literature

3.3 Hot Water Recirculation Balancing Procedure

- .1 Where circuit-balancing valves are used on hot water recirculation systems, adjust each valve to obtain the required design flow rate.
- .2 Where pressure-independent flow regulating valves are used in a hot water recirculation system, for each valve;
 - .1 measure system static pressure at the closest service sink to the pressure-independent flow control valve where a pressure gauge may be added to the faucet outlet ("adjacent system inlet static pressure"), and record system static pressure at the at-test system operating condition,
 - .2 measure system static pressure at the inlet to the recirculating pump,
 - .3 verify model type and size of each pressure-independent flow regulating valve and record results in the TAB report. Include the following data for each valve:
 - (a) location of flow control valve (i.e. floor level, room reference),
 - (b) adjacent system inlet static pressure,
 - (c) recirculation pump inlet static pressure,
 - (d) calculated differential pressure estimate (excluding pipe friction losses),
 - (e) valve model and size, with flow rate at the calculated differential pressure.

3.4 Plumbing Fixtures Hot Water Test Procedure

- .1 At each floor level, measure the cold and hot water static pressure at the outlet of any fixture that can have a pressure gauge attached to it.
- .2 For plumbing fixtures with automatic hot water temperature or pressure control, test and set each fixture as follows:
 - .1 flow hot water from the fixture for a sufficient time to stabilize hot water temperature,
 - .2 if hot water temperature is greater or less than specified water supply temperature, adjust fixture to obtain required hot water outlet temperature,
 - .3 record adjusted temperature results for all fixtures.
- .3 For sinks and lavatories, perform the following hot water time-to-delivery test;
 - .1 randomly select 10% of all fixtures, evenly distributed by type and over each floor, with selections approved by Consultant,
 - .2 do not select a fixture where it shares a portion of a hot water dead-leg pipe with another selected test fixture,
 - .3 allow each floor to be at rest (no water flow from plumbing fixtures) for a period of 24 hours prior to conducting the time-to-delivery test,
 - .4 at each fixture, run hot water (or tempered water for fixtures with blending valves) into a receptacle that has a bottom outlet, with the outlet sized to allow water to collect in and simultaneously drain from the receptacle. Record the time required for the hot water in the receptacle to stabilize at the expected water outlet temperature,
 - .5 after completion of the preceding test, measure the flow rate from the fixture using another receptacle and a stop-watch,
 - .6 record the time-to-delivery of design hot water temperature and measured flow rate for each selected fixture. Include the fixture type and room location of the fixture.

4 EXECUTION - MISCELLANEOUS

4.1 Balance Position Marking

- .1 Mark the balance position of valves at the completion of the final testing:
 - .1 valves: self-adhesive label, placed on piping (insulated or not) adjacent to valve, neatly filled in with either % valve open, or number of valve turns to open.
- .2 Additional requirements for circuit-balancing valves with test ports:
 - .1 remove valve handle or other protective device, and set memory stop to limit valve open travel. Replace valve handle or protective cover.

5 EXECUTION - REPORT PRESENTATION AND VERIFICATION

5.1 Required Reports

- .1 Provide the following reports:
 - .1 Water balancing and equipment test report.

5.2 Record Keeping

- .1 Keep records of trial and final balance and submit preliminary report as each system is completed.

- .2 Do not submit the final TAB report until all audit verification re-measurements, and any required re-balancing, is completed to the satisfaction of Consultant.

5.3 Report Format

- .1 Reports to incorporate approved standard forms, with values expressed in the same units as shown on Contract Documents.
- .2 Include "as-built" system schematics, marked-up to show as-measured flow quantities and measurement points. Use as-built drawings and ventilating line diagrams for reference.
- .3 Submit an electronic PDF copy of the draft TAB report for review by Consultant. Where a report page length is more than 20 pages, include bookmarks in the PDF document organizes by system number and/or name.
- .4 After any revisions requested by Consultant have been made and final review accepted by Consultant, submit the final TAB report in the following formats:
 - .1 two (2) hard copies of the completed report, each with index tabs and bound in "D" ring binders,
 - .2 electronic file PDF copies by email or drop-box as coordinated with Owner and Consultant.

5.4 Completion

- .1 Continue TAB until reports are approved.
- .2 The Substantial Performance of the Mechanical Work will be considered reached when the initial Start-Up and Performance Testing report is accepted by the Consultant and in the opinion of the Consultant all systems have been satisfactorily installed, operated tested, balanced, and adjusted to meet the specified and intended performance.
- .3 The substantial performance of the Work is not dependent upon alternate season testing.
- .4 The total performance of the Work will not be considered reached until the alternate season testing and balancing is completed and the final report submitted has been reviewed by Consultant and accepted by the Owner.

END OF SECTION

DOMESTIC WATER PIPING - COPPER 22 11 16.13

1 GENERAL

1.1 Scope

- .1 Provide copper tube and fittings for potable domestic water piping systems for aboveground installations.

1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
 - .1 20 05 24 Welding and Brazing
 - .2 22 05 01 Plumbing Piping Systems – General Requirements
 - .3 22 05 23.13 General-duty Valves for Plumbing Piping
 - .4 20 05 29 Common Hanger and Support Requirements for Piping

1.3 Definitions

- .1 The following definitions apply to this specification section:
 - .1 **Exposed areas:** include inside service rooms and above lay-in tile ceilings, but excludes: vertical and horizontal service shafts; above any other ceiling construction; and inside walls and partitions.

1.4 Applicable Codes and Standards

- .1 Installation standards:
 - .1 Copper Development Association (CDA) Copper Tube Handbook
- .2 Product standards:
 - .1 ASME B16.15 Cast Bronze Threaded Fittings, Classes 125 and 250
 - .2 ASME B16.18 Cast Copper Alloy Solder Joint Pressure Fittings
 - .3 ASME B16.22 Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
 - .4 ASME B16.24 Cast Copper Alloy Pipe Flanges and Flanged Fittings; Class 150, 300, 400, 600, 900, 1500, & 2500.
 - .5 ASME B16.50 Wrought Copper and Copper Alloy Braze-Joint Pressure Fittings
 - .6 ASTM A193 Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High Temperature
 - .7 ASTM A194 Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both
 - .8 ASTM B32 Standard Specification for Solder Metal
 - .9 ASTM B88 Standard Specification for Seamless Copper Water Tube
 - .10 ASTM B813 Standards Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube
 - .11 ASTM B828 Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings.
 - .12 AWS A5.8 Brazing Filler Metal.

- | | |
|----------------|--|
| .13 AWS A5.31 | Specification for Fluxes for Brazing and Braze Welding |
| .14 AWS C3.4 | Specification for Torch Brazing |
| .15 CSA B242 | Groove and Shouldered Type Mechanical Couplings |
| .16 MSS SP-106 | Cast Copper Alloy Flanges and Flanged Fittings, Class 125, 150 and 300 |

2 PRODUCTS

2.1 Copper Tube

- .1 Hard drawn, type L.
- .2 Listed to ASTM B88 and to have certification markings made by testing agency accredited by Standards Council of Canada.

2.2 Fittings

- .1 Brass or bronze flanges and flanged fittings: to ASME B16.24.
- .2 Brass or bronze threaded fittings: to ASME B16.15.
- .3 Solder/brazed fittings: cast bronze to ASME B16.18, or wrought copper and bronze to ASME B16.22.
- .4 Threaded fittings including unions to ASME B16.15, Class 250.

2.3 Joints

- .1 Solder: 95:5 tin-antimony solder to ASTM B-32.
- .2 Silver brazing alloy to AWS A5.8 classification BCUP-5.

Standard of Acceptance

- Handy Harman "SIL-FOS"
- All-State Welding Alloys "SILFLO 15"

.3 Flanges:

- .1 Threaded end connection: flat face, cast copper alloy to ASME B16.24, class 150 and 300, NPT threaded,
- .2 Brazed end connection: flat face, cast copper alloy to MSS SP-106, class 150 or 300.
- .3 Dielectric flanges: to specification section 22 05 01.
- .4 Studs and bolts: stainless steel to ASTM A193.
- .5 Nuts: stainless steel type 316, to ASTM A194.

.4 Flange gaskets:

- .1 Full flat-faced style to ANSI B16.21.
- .2 Suitable for use in potable water service and listed to NSF/ANSI 61.
- .3 Ethylene propylene diene monomer (EPDM);
 - (a) required working pressure: 1700 kPa (250 psi) at up to 95°C (203°F)
- .4 Compressed mineral fibers bonded with nitrile (NBR);
 - (a) required working pressure: 2750 kPa (400 psi) at up to 95°C (203°F)

Standard of Acceptance

- American-Biltrite (EPDM) – fig. AB-576
- Durlon (NBR) – fig. 7910

.5 Roll grooved piping:

- .1 Roll groove positive clamp gasketed couplings or roll groove flange adapters for copper piping to CSA B242.

Standard of Acceptance

- Victaulic - fig. 607
- Gruvlock
- Couplox
- Shurjoint

3 EXECUTION

3.1 Installation

- .1 Refer to section 22 05 01 for piping design criteria and general requirements for piping installation.
- .2 Install tubing close to building structure to minimize furring and conserve headroom. Group tubing and run parallel to walls and ceilings.
- .3 Cut tube square, ream tube ends and clean tubing and tube ends before joint assembly.
- .4 Before making solder or brazed joints, remove working parts of valves, clean inside of solder fittings and outside of mating pipe with emery paper and coat with applicable flux.

3.2 Pipe Supports

- .1 Support piping and tubing in accordance with specification section 20 05 29 except as specified herein.
- .2 Support horizontal copper tubing at intervals in accordance with Table 1:

Table 1: Horizontal Pipe Support Spacing for Copper Tube		
Pipe Size NPS	Rod Diameter	Maximum Spacing
½	M10 (3/8 in)	1.5 m (5 ft)
¾ to 1¼	M10 (3/8 in)	1.8 m (6 ft)
1½	M10 (3/8 in)	2.4 m (8 ft)
2	M10 (3/8 in)	2.4 m (8 ft)
2½	M12 (½ in)	3.0 m (10 ft)
3	M12 (½ in)	3.0 m (10 ft)
4	M16 (5/8 in)	3.0 m (10 ft)

- .1 Support vertical pipe and tube risers;
- .1 at the base (bottom) of the riser by a support that is independent of any adjacent horizontal pipe supports,

- .2 at every other floor level with pipe riser clamps, but not to exceed a vertical spacing of more than 7.5 m (24.5 ft).

3.3 Class Rated Fittings

- .1 Select ASME Class rated fittings and flanges in accordance with the following Table 2 for design pressure limits at coincident design temperature limits unless otherwise shown on drawings.

Table 2: Pressure and Temperature Limits for Class Rated Fittings		
Class	Maximum Design Pressure	Maximum Coincident Design Temperature
150	1720 (250 psi)	≤ 38°C (100°F)
150	1400 kPa (200 psi)	≤ 121°C (250°F)
300	3700 kPa (535 psi)	≤ 38°C (100°F)
300	3100 kPa (450 psi)	≤ 121°C (250°F)

3.4 Joints and Fittings

- .1 Joints in tubing:
- .1 NPS ½ to NPS 2:
 - (a) soldered.
 - .2 NPS 2-1/2 and larger:
 - (a) brazed, flanged joints.
- .2 Make solder joints in accordance with the recommendations of the CDA handbook.
- .3 Make braze joints in accordance with specification section 20 05 24.
- .4 Use manufactured fittings. Use of fabricated pulled-tee's is subject to approval by the local municipal authority for plumbing, and only brazed butt weld joints shall be used.
- .5 For flange joints, select gasket materials in accordance with the following Table 3 so that gasket pressure and temperature both exceed the piping system design pressure and design temperature.

Table 3: Flange Gasket Selection				
Gasket Temperature Limit	Gasket Pressure Limit	Gasket Material	Gasket Thickness	Figure
95°C (203°F)	1720 kPa (250 psig)	EPDM	1.5 m (1/6 in)	A-B AB-576
	2750 kPa (400 psig)	NBR	1.5 m (1/6 in)	Durlon 7910

3.5 Equipment Connections

- .1 Make pipe connections to equipment as follows.
 - .1 NPS 2 and smaller: threaded fittings.
 - .2 NPS 2 ½ and larger:
 - (a) flanged connections, or
 - (b) grooved end where equipment has compatible factory-prepared grooved ends.
- .2 Where connection is made to equipment with a threaded fitting, provide a union between the isolation valve and the equipment connection.
- .3 For threaded flanges, provide a sweat x NPT adaptor; do not thread tubing directly.
- .4 Provide a dielectric union or dielectric flange in accordance with specification section 22 05 01 when connecting potable water piping to equipment with carbon steel connections. Dielectric fittings are not required when connecting to equipment with stainless steel connections.

3.6 Valves

- .1 Provide valves in accordance with specification section 22 05 23.13.
 - .1 Isolate equipment, fixtures and branches with gate, ball or butterfly valves.
 - .2 Use globe, DRVs, ball or butterfly valves for throttling service.

3.7 Pressure Testing, Flushing and Balancing

- .1 Pressure test, flush and balance water systems to specification section 22 05 01.

END OF SECTION

DOMESTIC WATER PIPING SPECIALTIES

22 11 19

1 GENERAL

1.1 Scope

- .1 Provide domestic water piping specialties and accessories.

1.2 Applicable Codes and Standards

- .1 Product standards:
 - .1 ANSI/ASSE 1010 Water Hammer Arrestors
 - .2 CSA-B125 Plumbing Fittings.
 - .3 CSA B.64.1.1 Atmospheric Vacuum Breakers (AVB)
 - .4 CSA B.64.1.2 Pressure Vacuum Breakers (PVB)
 - .5 CSA B64.2.1 Hose Connection Vacuum Breaker (HCVB) with Manual Drain Feature
 - .6 CSA B64.4 Backflow Preventers, Reduced Pressure Principle (RP)
 - .7 CSA B64.5 Backflow Preventers, Double Check Valve Type (DCVA)
 - .8 CSA B64.10 Manual for the Selection and Installation of Backflow Prevention Devices/Manual for the Maintenance and Field Testing of Backflow Prevention Devices
 - .9 CSA B137.6 Chlorinated Polyvinylchloride (CPVC) Pipe, Tubing, and Fittings for Hot- and Cold-Water Distribution Systems
 - .10 CSA C22.2 No. 14 Industrial Control Equipment
 - .11 CSA C22.2 No. 94.1 Enclosures for Electrical Equipment, Non-Environmental Considerations
 - .12 NSF/ANSI/CAN 61 Drinking Water System Components – Health Effects
 - .13 NSF/ANSI/CAN 372 Drinking Water System Components – Lead Content
 - .14 PDI-WH201 Plumbing and Drainage Institute - Standard Water Hammer Arresters

1.3 Submittals

- .1 Submit product data sheets for materials specified herein.

2 PRODUCTS

2.1 Dielectric Fittings

- .1 Dielectric unions – NPS 2 and under:
 - .1 body and union nut material selected to suit connecting various dissimilar piping materials, including all pair combinations of copper, stainless steel, carbon steel and galvanized steel.
 - .2 flat-face union design,
 - .3 tail-piece with FNPT ends with thermobaked epoxy coating, and Teflon shoulder gasket,
 - .4 head-piece with integral O-ring, with threaded or soldered pipe ends.
 - .5 union nut,
 - .6 pressure rating: Class 3000.

- .7 dielectric coating resistance rating: minimum 500 V/mil thickness.

Standard of Acceptance

- Hart Industrial Unions - fig. D-3136 series

- .2 Dielectric insulating flanges – NPS 2-1/2 to NPS 4;

- .1 for connecting copper to galvanized steel piping.
- .2 Ductile iron flanges, Class 125 to ANSI B16.42.
- .3 copper tailpiece for soldered joint,
- .4 FNPT thread to AMSE B1.20.1 x copper solder joint,
- .5 BUNA-N gasket,
- .6 lead free materials to NSF 61+G.
- .7 maximum design pressure: 1200 kPa (175 psi)
- .8 maximum operating temperature: 82°C (180°F)

Standard of Acceptance

- Watts No. LF3100

- .3 Dielectric insulated flange – single face with copper tube tailpiece – NPS 2 to NPS 6;

- .1 for connecting copper to galvanized steel piping,
- .2 Van Stone style carbon steel flange with copper tailpiece with flared end,
- .3 carbon steel flange, Class 150 to ANSI B16.5, with powder coated finish.
- .4 copper tailpiece with rolled flange face-end, and EPDM insulating gasket isolating the copper tube from the steel flange,
- .5 copper tailpiece end connection: rolled groove or sweat.

Standard of Acceptance

- CTS Flange Canada - fig. CTS Copper Flange Adaptor

- .4 Dielectric flange isolating gasket kits for flanges NPS 6 and over:

- .1 for use with ASME Class 150 and 300 dimensional flanges.
- .2 suitable for connecting various dissimilar piping materials, including all pair combinations of copper, stainless steel, carbon steel and galvanized steel.
- .3 compatible with pressure and temperature service,
- .4 gasket: BUNA-N or EPDM gasket seals compatible with potable water,
- .5 flange bolt insulating sleeves: non-conductive isolating bolt sleeve and washer assemblies to prevent metal-to-metal contact between flange bolt and flange.

Standard of Acceptance

- Advance Products and Systems

2.2 Wall Hydrants

- .1 Concealed key operated non-freeze type;

- .1 integral vacuum breaker,
- .2 stainless steel or bronze box,
- .3 hinged locking door,
- .4 galvanized casing,
- .5 adjustable wall flange.

Standard of Acceptance

- Jay R. Smith - fig. 5509QT
- Mifab - fig. MHY-26
- Zurn - fig. Z-1320

- .2 Key operated non-freeze type;
 - .1 integral vacuum breaker,
 - .2 stainless steel, nickel bronze or chrome plated body and backer plate,
 - .3 removable key operator.

Standard of Acceptance.

- Jay R. Smith - fig. 5609QT
- Mifab - fig. MHY-16
- Zurn - fig. ZN-1321

2.3 Water Hammer Arresters

- .1 Stainless steel construction with precharged air chamber of nesting bellows.
- .2 Selected in accordance with Plumbing and Drainage Institute Standard PD1-WH201.
- .3 Listed to ANSI/ASSE 1010

Standard of Acceptance

- Jay R. Smith - fig. Hydrotrol 5000 series
- Mifab - fig. WHB series
- Zurn - fig. Shocktrol Z-1700 series]

2.4 Trap Seal Primers

- .1 Electrically operated manifold units – Type A:
 - .1 factory assembled in 1.5 mm (16 ga) recessed metal cabinet with hinged stainless steel lockable access door,
 - .2 atmospheric vacuum breaker,
 - .3 24 hr controller with manual over ride switch,
 - .4 120 Volt solenoid valve,
 - .5 NPS ¾ or NPS ½ valved inlet water connection,
 - .6 calibrated water distribution manifold,
 - .7 NPS ½ outlet compression fittings,
 - .8 power supply: 120 VAC.

Standard of Acceptance

- Precision Plumbing Products - fig PT-3 thru PT-30
- Mifab - fig.MI-100

.2 Electrically operated manifold units – Type B:

- .1 Same as Type A electronic trap seal primer, except distribution manifold is shipped loose for field installation external to the trap primer cabinet.

2.5 Vacuum Breakers

.1 Atmospheric type (“AVB”):

- .1 listed to CSA B.64.1.1.

.2 NPS ¼ to 3:

- (a) atmospheric type (AVB), with single float and disc, and
(b) large atmospheric port.

Standard of Acceptance

- Watts - fig. 288A
- Cash Acme - fig. V-101

.2 Pressure type (“PVB”):

- .1 listed to CSA B.64.1.2.

.2 NPS ½ to 2:

- (a) pressure type (PVB) with spring loaded single float and disc,
(b) independent first check, shut off valves, and ball type test cocks.

Standard of Acceptance

- Watts - fig. 800

.3 Hose connection type (“HCVB”):

- .1 listed to CSA B.64.2

.2 NPS ¾:

- (a) atmospheric vent vacuum breaker with non-removable single check,
(b) hose connection,
(c) drainage feature to prevent freezing,

Standard of Acceptance

- Watts - fig. 8
- Cash Acme – fig. V-3

2.6 Strainers

.1 NPS ½ to NPS 3:

- .1 wye pattern, bronze body, solid retainer cap with gasket, and NPT threaded or soldered end,
.2 type 304 stainless steel baskets: 1.2 mm (3/64 in) diameter perforations,
.3 required MCPR: 2750 kPa (400 psi) at 93°C (200°F)
.4 listed to NSF/ANSI/CAN 61 including /G or NSF/ANSI/CAN 372.

Standard of Acceptance

- Watts - fig. LF777, LFS777
- Zurn - fig. YBXL
- Cash Acme

.2 NPS 4 to NPS 10:

- .1 simplex basket strainer, cast iron body, bolted screen retainer cover, plugged drain/blowdown NPT connection, ASME Class 125 flat faced flange ends,
- .2 type 304 stainless steel baskets: 3.2 mm ($\frac{1}{8}$ in) diameter perforations,
- .3 required MCPR: 1370 kPa (200 psi) at 66°C (150°F),
- .4 listed to NSF/ANSI/CAN 61 including /G or NSF/ANSI/CAN 372.

Standard of Acceptance

- Watts - fig. LF98FB-CIB

3 EXECUTION

3.1 Dielectric Fittings

- .1 Provide dielectric fittings at the connection point between the following combinations of dissimilar metals:
 - .1 copper and stainless steel,
 - .2 copper and carbon steel or galvanized steel,
 - .3 stainless steel and carbon steel or galvanized steel.
- .2 Brass or bronze valves are not to be used for the purpose of a dielectric fitting on potable water systems and non-potable water systems. Where a brass or bronze valve is installed at the connection point between carbon steel/galvanized steel pipe and copper tube systems, provide a dielectric fitting on either side of the valve.
- .3 Where potable water connects to a backflow protection device for make-up water to an HVAC piping system or process piping system, install the dielectric fitting at either side of the backflow preventer.

3.2 Wall Hydrants

- .1 Install between 600 mm and 750 mm (24 and 30 in.) above finished grade level.

3.3 Water Hammer Arresters

- .1 Select, supply and install water hammer arrestors in accordance with PDI-WH 201 on branch supplies to each fixture or group of fixtures.
- .2 In addition, provide water hammer arrestors on branch supplies to each piece of owner's process equipment, of the size as shown.

3.4 Trap Seal Primers

- .1 Electronic manifolds:
 - .1 Install trap seal primer panels in the locations as shown on drawings to serve individual or groups of floor drains and/or hub drains.
 - .2 120V/1ph/60 Hz power supply will be brought to electric manifolded units under Division 26 and connected under Division 22.

- .3 For Type B trap primer unit, pipe the outlet of the primer unit in type L hard-drawn copper down through the floor slab and connect to the trap primer distribution manifold located in ceiling space below.
- .2 Trap primer tubing:
 - .1 Use soft annealed copper tube to connect trap primer distribution manifold to floor drains and/or funnel drains.

3.5 Back-Flow Preventers and Vacuum Breakers

- .1 Provide back-flow preventers and vacuum breakers in accordance with CSA B64.10.
- .2 Install backflow preventers horizontally, in accordance with manufacturer's recommendations, but not less than 750 mm (30 in.) and not greater than 1500 mm (59 in.) above the floor level, or a fixed work platform, in front of the valve.
- .3 Install pressure vacuum breakers not more than 1500 mm (56 in.) above the floor level, or a fixed work platform, in front of the valve.
 - .1 exception: where the pipe connection to the protected fixture or equipment is higher than 1500 mm (56 in.) above the floor, locate the pressure vacuum breaker at an elevation just high enough so that the outlet pipe to the fixture/equipment does not rise above the vacuum breaker.
- .4 Pipe relief ports and air vents from backflow preventer, with an air gap, to nearest floor/hub drain or service sink using hard-drawing DWV copper tube.
- .5 Position backflow preventers and pressure vacuum breakers so that test ports are accessible.
- .6 Provide cabinets for backflow preventers as shown.

3.6 Strainers

- .1 Install with sufficient space to remove baskets.
- .2 Provide a valved blow-down drain line on NPS 4 to NPS 10 basket strainers, and pipe blow-down line in hard type L copper tube and terminate over floor drain, hub drain or trench drain.

END OF SECTION

SANITARY WASTE AND VENT PIPING – CAST IRON AND COPPER

22 13 16.13

1 GENERAL

1.1 Scope

- .1 Provide cast iron pipe and fittings and/or copper tube and fittings for sanitary soil and waste drain and vent piping, for aboveground and buried services.
- .2 Provide PVC-DWV piping for urinal fixture drains and a portion of the fixture vent piping.
 - .1 For clarity, the use of PVC DWV piping under this specification section is restricted to this purpose.

1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
 - .1 20 05 25 Excavation and Backfilling
 - .2 20 05 29 Common Hanger and Support Requirements for Piping

1.3 Applicable Codes and Standards

- .1 Installation standards and codes:
 - .1 Cast Iron Soil Pipe Institute (CISPI) Technical Manual
- .2 Product standards:
 - .1 ASME B16.23 Cast Copper Alloy Solder Joint Drainage Fittings: DWV
 - .2 ASME B16.29 Wrought Copper and Wrought Copper Alloy Solder-Joint Drainage Fittings-DWV
 - .3 ASTM B32 Standard Specification for Solder Metal
 - .4 ASTM B306 Standard Specification for Copper Drainage Tube (DWV)
 - .5 ASTM C564 Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
 - .6 ASTM C1540 Standard Specification for Heavy Duty Shielded Couplings Joining Hubless Cast Iron Soil Pipe and Fittings.
 - .7 ASTM B828 Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings.
 - .8 CSA B70 Cast Iron Soil Pipe, Fittings, and Means of Joining
 - .9 CSA-B125 Plumbing Fittings.
 - .10 CSA B158.1 Cast Brass Solder Joint Drainage, Waste, and Vent Fittings
 - .11 CSA B602 Mechanical Couplings for Drain, Waste, and Vent Pipe and Sewer Pipe.

2 PRODUCTS

2.1 Copper DWV Pipe and Fittings

- .1 Application: inside of buildings only. Do not use for buried drain or vent.
- .2 Pipe:
 - .1 copper DWV tube to ASTM B306
 - .2 certification markings made by testing agency accredited by Standards Council of Canada.

.3 Fittings:

- .1 copper or copper alloy to ASME B16.23, or ASME B16.29.

.4 Solder

- .1 tin-antimony 95/5 to ASTM B32 alloy Sb5.

2.2 Cast Iron DWV Pipe and Fittings

- .1 Application: inside of buildings and buried drain and vent.

.2 Pipe and fittings:

- .1 cast to CSA B70,
.2 with heavy bituminous coating for buried service.
.3 riser fittings with integral riser support ring for hub-less piping installed in vertical risers.

.3 Joints below grade:

- .1 Plain end made up using mechanical sleeve joints to CSA B602 and ASTM C1540 with neoprene or butyl rubber compression gaskets to ASTM C564, with stainless steel sleeve and not less than four stainless steel drive clamps with stainless steel worm gears.

.4 Joints above ground:

- .1 Plain end made up using mechanical sleeve joints to CSA B602 and ASTM C1540 with neoprene or butyl rubber compression gaskets to ASTM C564, with stainless steel sleeve and not less than four stainless steel drive clamps with stainless steel worms.
.2 Hub and spigot made up neoprene gasket to ASTM C564 and lubricating compound.

3 EXECUTION

3.1 Installation General

- .1 Install soil, waste and vent piping in accordance with the requirements of the plumbing code applicable at the project location. Except as otherwise shown, venting of fixtures may use any method permitted in the plumbing code.
.2 Install suspended piping to grade, parallel and close to walls and ceilings to conserve headroom and space.
.3 Install piping close to building structure to minimize furring. Group piping and run parallel to walls and ceilings.

3.2 Cast Iron Piping

- .1 Install cast iron drainage piping in accordance with Cast Iron Soil Pipe and Fittings (CISPF) Technical Manual.
.2 Lay buried piping in bedding prepared in accordance with specification section 20 05 25. Support piping on 150 mm (6 in.) thick bedding material, shaped to accommodate hubs and fittings, to line and grade as shown. Backfill with cover material to 300 mm above top of pipe or to underside of floor slab whichever is less.
.3 Assemble and tighten mechanical sleeve joints to coupling manufacturers recommended torque value with torque wrench.
.4 Install cast iron hub-and-spigot joints with neoprene compression gasket and lubrication in accordance with manufacturer requirements.

- .5 Provide thrust restraints consisting of pipe clamps and restraint rods installed across tees, elbows, and blind plugs (cleanouts), for cast iron drainage piping NPS 5 and larger.
- .6 Provide sway braces on all horizontal piping where the hanger length is greater than 450 mm (18 in) measured from the top of the pipe to the structure connection point, as follows:
 - .1 transverse brace at 12 m (40 ft) intervals,
 - .2 longitudinal brace at 24 m (80 ft) intervals,
 - .3 a transverse brace of one pipe section may act as a longitudinal brace for a second pipe section connected perpendicular to the first section, provided the brace is located within 600 mm (24 in) of the connection.
 - .4 for clarity, these braces are required even where seismic restraint is not required.

3.3 Copper Tubing

- .1 Cut copper tube square, ream tube ends and clean tubing and tube ends before joint assembly.
- .2 Before assembling solder joints, clean inside of solder fittings and outside of mating pipe with emery paper and coat with flux.
- .3 Solder joints in copper pipe with blow torch or oxy-acetylene flame.

3.4 Pipe Supports

- .1 Support piping in accordance with specification section 20 05 29 except as specified herein.
- .2 Support horizontal copper DWV tubing in accordance with Table 1A:

Table 1A: Horizontal Pipe Support Spacing for Copper Tube		
Pipe Size NPS	Rod Diameter	Maximum Spacing
½	M10 (3/8 in)	1.5 m (5 ft)
¾ to 1¼	M10 (3/8 in)	1.8 m (6 ft)
1½	M10 (3/8 in)	2.4 m (8 ft)
2	M10 (3/8 in)	2.4 m (8 ft)
2½	M12 (½ in)	3.0 m (10 ft)
3	M12 (½ in)	3.0 m (10 ft)
4	M16 (5/8 in)	3.0 m (10 ft)

- .3 Support horizontal cast iron DWV piping in accordance with Table 1B and as follows;
 - .1 one pipe support for each end of the pipe, located at or within 150 mm (6 in) of each hub or mechanical joint,
 - .2 for mechanical joints, if the pipe length between adjacent fittings is 300 mm (12 in) or less, reduce the support spacing to a maximum of 1000 mm (39 in),
 - .3 where multiple joints occur within a 1000 mm (39 in) developed pipe length;
 - (a) support may be reduced to every other hub or mechanical joint, or

- (b) where the pipe run is made of multiple fittings connected end-to-end, provide a 1.6 mm (16 ga) galvanized steel half sleeve underneath the pipe and fittings, and support the sleeve with a support at each end of the sleeve.

Table 1B: Horizontal Pipe Support Spacing for Cast Iron DWV Piping			
Pipe Size NPS	Maximum Spacing	Clevis Hanger: Minimum Rod Diameter	MJ Hanger: Minimum Rod Diameter
1-1/2	3 m (9.8 ft)	---	M10 (3/8 in)
2	3 m (9.8 ft)	---	M10 (3/8 in)
3 to 4	3 m (9.8 ft)	M10 (3/8 in)	M10 (3/8 in)
6	3 m (9.8 ft)	M12 (1/2 in.)	M12 (1/2 in.)
8 to 12	3 m (9.8 ft)	M16 (5/8 in)	---
15	3 m (9.8 ft)	M20 (3/4 in)	---

- .4 Support vertical pipe and tube risers at the base (bottom) of the riser and as follows:
- .1 for cast iron drain and vent piping,
 - (a) support piping at every floor level with a pipe clamp, arranged so that the pipe clamp is above the pipe section center of gravity,
 - (b) support the pipe below a hub, or support the pipe with a riser fitting for hub-less joints.
 - (c) support the base of a riser at a fitting hub, or for mechanical joints support the riser pipe at a riser fitting,
 - (d) for pipe sizes NPS 5 and larger, provide sway braces at the base support to limit movement in both horizontal directions.
 - .2 for other piping, support piping at every other floor level with pipe riser clamps,
 - .3 for all piping and tubing, do not exceed a vertical spacing of more than 7.5 m (24.5 ft),
 - .4 in addition, for cast iron drainage piping provide lateral guides;
 - (a) at the base and top of the pipe riser,
 - (b) and at every 9 m (30 ft) except where the pipe riser clamp is restrained to prevent lateral movement.

3.5 Testing

- .1 Test drainage piping in accordance with the requirements of the plumbing code applicable at the project location.
- .2 Test before piping is concealed.
- .3 Cut-out and replace leaking soldered fittings, remake joints in cast iron piping, and retest.

END OF SECTION

SANITARY WASTE AND VENT PIPING - PVC

22 13 16.16

1.1 Scope

- .1 Provide PVC pipe and fittings for sanitary soil and waste drain and vent piping ("DWV"), for drainage services with a maximum continuous operating temperature of 60°C (140°F) or less.
- .2 Limitations for use:
 - .1 do not use PVC DWV piping in the following locations:
 - (a) for drain and vent piping located in vertical services spaces,
 - (b) for drain piping receiving waste water at temperatures above 60°C (140°F).
 - (c) for drain and vent piping located in an HVAC ventilation plenum, except where otherwise specified, and
 - (d) as otherwise shown.

1.2 Definitions

- .1 The following definitions apply to this section and referenced sections:
 - .1 **Vertical service space:** means a shaft that is oriented essentially vertically, extends through two or more floors, and that is provided in a building to facilitate the installation of building services.

1.3 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
 - .1 20 05 25 Excavation and Backfilling
 - .2 20 05 63 Safety Bollards and Machine Guards
 - .3 22 13 16.13 Sanitary Waste and Vent Piping – Cast Iron and Copper
 - .4 20 05 29 Common Hanger and Support Requirements for Piping

1.4 Applicable Codes and Standards

- .1 Product standards:
 - .1 CSA B181.2 PVC Drain Waste and Vent Pipe and Fittings from CSA B 1800 Plastic Non-Pressure Pipe Compendium
 - .2 ULC-S102.2 Standard Method of Test for Surface Burning Characteristics of Flooring, Floor Covering and Miscellaneous Materials
 - .3 ULC-S115 Fire Tests of Fire Stop Systems

1.5 Submittals

- .1 Shop drawings:
 - .1 submit shop drawings showing for firestop systems as applicable to each piping penetration of a fire separation, and include:
 - (a) firestop materials data sheets,
 - (b) ULC listing details of construction for each applicable firestop assembly,
 - (c) Firestop manufacturer installation instructions for each applicable firestop assembly type.
 - (d) Instructions on where each firestop assembly type is to be used.

2 PRODUCTS

2.1 PVC DWV Pipe and Fittings

- .1 PVC pipe, fittings, and jointing system to be a coordinated package supplied by pipe manufacturer with written installation instructions.
- .2 Pipe and fittings ("PVC Type 1"):
 - .1 listed to CSA-B181.2,
 - .2 flame spread rating ("FSR") of not more than 25 when tested to ULC-S102.2,
 - .3 materials marked for CSA B181.2 and to ULC-S102.2.

Standard of Acceptance

- IPEX - fig. System 15 DWV

- .3 Pipe and fittings ("PVC Type 2"):
 - .1 listed to CSA B181.2,
 - .2 flame spread rating ("FSR") of not more than 25 when tested to ULC-S102.2,
 - .3 smoke developed rating ("SDR") of not more than 50 when tested to ULC-S102.2.
 - .4 materials marked for CSA B181.2 and ULC-S102.2.

Standard of Acceptance

- IPEX - fig. XFR DWV

- .4 Joint cement:
 - .1 volatile Organic Content: maximum 510 g/L.
 - .2 pipe sizes NPS 1-1/2 to NPS 6:
 - (a) one-step (primer optional)

Standard of Acceptance

- IPEX - fig. System 15/System XFR One-Step PVC Cement

- .3 pipe sizes NPS 8 to NPS 12:
 - (a) Two-step primer and cement.

Standard of Acceptance

- IPEX - fig. System 15/System XFR Two-Step PVC Primer and Cement

- .4 pipe sizes NPS 14 and larger:
 - (a) pipe manufacturer specific PVC cement with primer.

Standard of Acceptance

- IPEX - fig. Xirtec19 PVC Cement.

2.2 Firestops

- .1 Firestop system for combustible piping with through-penetrations of horizontal and vertical fire separations, having a fire resistance equal to or greater than the fire resistance rating of the affected fire separation.
- .2 Listed to ULC S115:
 - .1 "F" rating of not less than the fire resistance rating of the applicable fire separation,
 - .2 "F" rating with a pressure differential of 50 Pa (0.20 in.w.c) for buildings more than 3 storeys in building height,
 - .3 "FT" rating of not less than the fire resistance rating of the applicable fire separation or firewall separating a parking garage from the rest of the building, or where passing through a horizontal service space horizontal fire separation.

Standard of Acceptance

- Hilti Canada
- 3M Canada

3 EXECUTION

3.1 Restrictions on Use

- .1 Do not install PVC piping in vertical service spaces.
- .2 Do not install PVC piping in locations where the ambient temperature can be less than 4°C (40°F) including but not limited to:
 - .1 outdoors,
 - .2 outdoor multi-storey parking garages,
 - .3 generator rooms,
 - .4 indoor parking garages,
 - .5 unheated loading docks.
 - .6 loading docks which are partially heated with local radiant heaters,
 - .7 ambulance bays even if fully enclosed,
 - .8 cold storage rooms,
 - .9 cold storage warehouses.
- .3 Only use PVC Type 2 piping materials in HVAC air distribution plenums including ceiling spaces and raised floors used as part of a supply or return air distribution system.
- .4 Do not use PVC drainage piping serving floor drains and other fixture drains located in mechanical service rooms containing steam boilers, or hot water boilers or other water heating devices operating at water temperature greater than 60°C (140°F). In these areas, use cast iron or copper DWV drain piping in accordance with specification section 22 13 16.13, and run cast iron or copper DWV drain piping until connected to the main building sanitary drain as shown.

3.2 Installation - General

- .1 Contact pipe manufacturer to provide training of contractors personnel for solvent weld training prior to installation of PVC DWV drainage piping materials.
- .2 Install soil, waste and vent piping in accordance with the requirements of the plumbing code applicable at the project location. Except as otherwise shown, venting of fixtures may use any method permitted in the plumbing code.

- .3 Install suspended piping to grade, parallel and close to walls and ceilings to conserve headroom and space. Install piping close to building structure to minimize furring. Group piping and run parallel to walls and ceilings.
- .4 Cut pipe squarely, remove burrs and loose material and chamfer pipe ends.
- .5 PVC joints for pipe size NPS 1-1/2 to NPS 6:
 - .1 apply joint cement to male end of pipe and to fitting socket.
- .6 .2 While the surfaces are still wet, insert the pipe into the fitting using sufficient force to ensure that the pipe bottoms into the fitting socket. Give the pipe one quarter turn during insertion. PVC joints for pipe sizes NPS 8 and larger:
 - .1 apply primer to fitting socket and to male end of pipe.
 - .2 immediately after priming, apply cement to fitting socket and to male end of pipe,
 - .3 while the surfaces are still wet, insert the pipe into the fitting using sufficient force to ensure that the pipe bottoms into the fitting socket. Give the pipe one quarter turn during insertion,
 - .4 hold the pipe and fitting together in position for 10 seconds to eliminate push out,
 - .5 wipe away excess cement.
- .7 Follow manufacturer published cure time schedules prior to testing the piping system.
- .8 In buildings with vehicles, material handling carts, forklifts or other similar equipment vehicles, protect PVC pipe located within 3 m (10 ft) of floor level with one of the following methods.
 - .1 Use cast iron or copper tube starting from 300 mm (12 in.) below top of floor surface and extending up to 3 m (10 ft) above floor level, or
 - .2 provide at least two (2) protection bollards in accordance with specification section 20 05 63, to separate PVC piping from contact with such equipment.

3.3 Pipe Supports

- .1 Support piping in accordance with specification section 20 05 29 except as specified herein.
- .2 Support horizontal piping in accordance with the manufacturer installation requirements, but with supports
 - .1 spacing not to exceed 1200 mm (47 in),
 - .2 provided at the ends of branches,
 - .3 provided at each change of direction or elevation, and
 - .4 provided as close to a fixture trap as possible for fixture drains more than 1000 mm (39 in) long.
- .3 Support vertical piping;
 - .1 at its base,
 - .2 at every other floor level with pipe riser clamps, but not to exceed a vertical spacing of more than 7.5 m (24.5 ft) between supports,
 - .3 arrange vertical piping so that a joint coupling bears on the top of the pipe riser clamp.

3.4 Buried Installation

- .1 Lay buried piping in bedding prepared in accordance with specification section 20 05 25. Support piping on 150 mm (6 in.) thick bed of clean sand, shaped to accommodate hubs and fittings, to line and grade as shown. Backfill with clean sand to 300 mm above top of pipe or to underside of floor slab whichever is less.

- .2 Support piping through foundation walls on backfill material as specified, and supported on 150 mm (6 in.) thick reinforced concrete pads. Dowel concrete pad into side of foundation walls and extend pad to obtain minimum bearing of 600 mm (2 ft) on undisturbed soil.

3.5 Firestop Collars

- .1 Seal combustible pipe and fitting system which penetrates vertical or horizontal fire separation, with a listed firestop assembly. Install firestop system in accordance with the manufacturer's instructions.

3.6 Testing

- .1 Test drainage piping in accordance with the requirements of the plumbing code applicable at the project location.
- .2 Test before piping is concealed.
- .3 Cut-out and replace leaking soldered fittings, remake joints in cast iron piping, and retest.

END OF SECTION

SANITARY WASTE AND VENT PIPING – CORROSIVE WASTE

22 13 16.19

1 GENERAL

1.1 Scope

- .1 Provide pipe and fittings for corrosive waste drainage and vent piping for the following functions:
 - .1 laboratory drains,
 - .2 acid waste drains,
 - .3 dialysis equipment drains.
- .2 For the purpose of this specification section, the above drainage and associated vent systems are classified as “corrosive waste” drainage systems.
- .3 Extent of corrosive resistant laboratory drain and vent piping:
 - .1 corrosive waste drainage piping as shown
 - .2 vent piping for corrosive waste drainage systems extends up to 150 mm (6 in) above the top-most connection between the vent stack and the stack vent; vent piping above this point and up through the roof may be cast iron or copper to specification section 22 13 16.13.

1.2 Definitions

- .1 The following definitions apply to this section and referenced sections:
 - .1 **Vertical service space:** means a shaft that is oriented essentially vertically, extends through two or more floors, and that is provided in a building to facilitate the installation of building services.

1.3 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
 - .1 20 05 25.13 Excavation and Backfilling for Building Services
 - .2 20 05 29 Common Hanger and Support Requirements for Piping
 - .3 22 13 16.13 Sanitary Waste and Vent Piping – Cast Iron and Copper
 - .4 22 13 16.23 Sanitary Sump Pump Discharge Piping

1.4 Applicable Codes and Standards

- .1 Product standards:
 - .1 ASTM C1053 Borosilicate Glass Pipe and Fittings for Drain Waste and Vent (DWV) Applications
 - .2 ASTM D2657 Standard Practice for Heat Fusion Joining of Polyolefin Pipe & Fittings.
 - .3 ASTM D3222 Unmodified Poly(Vinylidene Fluoride) (PVDF) Moulding, Extrusion and Coating Materials
 - .4 ASTM D4101 Polypropylene Injection and Extrusion Materials
 - .5 ASTM F1412 Polyolefin Pipe and Fittings for Corrosive Waste Drainage Systems
 - .6 ASTM F1673 Polyvinylidene Fluoride (PVDF) Corrosive Waste Drainage Systems
 - .7 CSA-B181.3 Polyolefin Laboratory Drainage Systems

.8 PPI TR-4

Plastic Pipeline Institute Technical Report No. 4 for plastic pipe pressure rating.

2 PRODUCTS**2.1 DWV Plastic – Polyvinylidene Fluoride (PVDF)**

- .1 Pipe size: NPS 4 and smaller.
- .2 Resin to ASTM D3222.
- .3 Pipe and fittings: Schedule 40 PVDF to CSA-B181.3 and ASTM F1673.
- .4 Joints: fusion to ASTM D2657, or proprietary mechanical joints.
- .5 Listed to CAN/ULC-S102.2 for flame spread rating less than 25 and smoke development rating less than 50.
- .6 Listed to CSA B181.3.
- .7 Pipe supports: proprietary pipe clips, allowing thermal axial movement of pipe.

Standard of Acceptance

- IPEX - Plenumline FR-PVDF
- Georg Fisher - Fuseal 25/50
- Zurn - Corrosive Waste Drainage Systems

2.2 DWV Plastic - Polypropylene (PP)

- .1 Pipe size: NPS 4 and smaller.
- .2 Resin: fire retardant treated to ASTM D4101,
- .3 Pipe and fittings: Schedule 40 PP to CSA-B181.3 and ASTM F1412
- .4 Joints: electro-fusion with embedded nickel/chrome wire heating elements embedded in the fitting socket.
- .5 Pipe supports : proprietary pipe clips, allowing thermal axial movement of pipe.

Standard of Acceptance

- IPEX - Enfield Industrial Corp
- Zurn - Corrosive Waste Drainage Systems
- Orion Fittings
- Georg Fischer

2.3 DWV Borosilicate Glass

- .1 Pipe and fittings - above ground: double tough tempered heavy schedule borosilicate glass drainline pipe to ASTM C1053.
- .2 Pipe and fittings - buried: as above with 12mm (½") thick polystyrene covering.
- .3 Joints: compression type coupling suitable for bead and/or plain end glass piping, 300 series stainless steel housing, BUNA-N compression liner, and TFE seal ring gasket, with stainless steel nut and bolt.

Standard of Acceptance

- Schott - Kimax
- Corning Glass
- Chem Flowtronics - Borodrain

2.4 Fire Stop Collars for PVDF and PP Piping

- .1 Galvanized steel housing with intumescent inserts to create a continuous firestop collar around combustible piping, with metal tabs for securing to horizontal or vertical fire separations.
- .2 Listed to ULC S115 for 50 Pa (0.2 in wg) pressure differential, with FT rating of at least two (2) hours , for pipe sizes NPS 4 and smaller

Standard of Acceptance

- Hilti - fig. CP 643 N

2.5 Pipe Supports for Plastic Piping

- .1 Plastic spring pipe clips:
 - .1 low friction to allow axial pipe movement, laterally rigid to limit and control lateral pipe movement, with retaining strap,
 - .2 pipe size: NPS 3/8 to NPS 6.

Standard of Acceptance

- IPEX - fig. Cobra Clip

2.6 Pipe Supports for Glass Drainage Piping

- .1 Horizontal pipe supports:
 - .1 galvanized or zinc plated steel, PVC coated, adjustable swivel ring to MSS SP-58.

Standard of Acceptance

- Kimax - fig. 7290
- Taylor - fig. 41PVC

- .2 Vertical pipe riser clamps:
 - .1 to specification section 20 05 29,
 - .2 carbon steel, PVC coated, riser clamps to MSS SP-58,
 - .3 with 3 mm (1/8 in) thick EPDM padding, minimum 50 mm (2 in) wide.

3 EXECUTION

3.1 Restrictions on Use

- .1 Do not use PVDF or PP piping in vertical service spaces. Only use borosilicate glass drainage and vent piping in vertical service spaces.
- .2 Do not use PP piping in ceiling plenums used as HVAC return air plenums.
 - .1 For clarity, the use of any kind of flexible insulation wrap, fire rated or not, in these locations is not acceptable as an alternative method.
- .3 Use borosilicate glass for drainage or vent piping if installed inside a vertical service space. Make branch connections inside of vertical service space with borosilicate glass and extend outside of the vertical service space for a distance of at least 200 mm (8 in.) before transition to a plastic drain or vent material.

3.2 Material Selection

- .1 Install laboratory corrosive drainage and vent piping in accordance with the following:

Table 1: Material Selection Based on Pipe Location	
Location	Material
Buried under building	Borosilicate Glass PVDF
Vertical Service Spaces	Borosilicate Glass
Ceiling space (not used as a return air plenum)	Borosilicate Glass, PVDF, PP
Ceiling space (used as HVAC return air plenum)	Borosilicate Glass, PVDF
Laboratory Benchwork	Borosilicate Glass, PVDF with mechanical joints.

- .2 Connections between different materials shall be made using specific-duty adaptors supplied by the piping system manufacturer.

3.3 Installation - General

- .1 Install corrosive waste and vent piping in accordance with the requirements of the plumbing code applicable at the project location. Except as otherwise shown, venting of fixtures may use any method permitted in the plumbing code.
- .2 Install piping and joints in accordance with manufacturer's instructions.
- .3 Install suspended piping to grade, parallel and close to walls and ceilings to conserve headroom and space. Install piping close to building structure to minimize furring.

3.4 Installation - Plastic Piping

- .1 Where plastic piping penetrates a horizontal or vertical fire separation with a fire resistance rating, seal the piping at the separation with a fire stop collar on both sides of the fire separation in accordance with fire stop product listing.
- .1 Do not install plastic piping through a fire rated separation that forms part of a vertical service shaft enclosure.
- .2 Provide for thermal expansion of piping in vertical pipe risers;
- .1 install an expansion joint at each floor level, immediately above the riser clamp, complete with pipe anchor attached to wall,
- .2 install 1st pipe guide 150 mm (6 in) to 200 mm (8 in) above the expansion joint, and a 2nd guide between 2100 mm (7 ft) and 2800 mm (8 ft) above the floor level.
- .3 Provide thermal expansion of horizontal drains using natural offsets, or addition of piping loops. Do not use expansion joints in horizontal piping.
- .4 Make pipe joints in accordance with the following:

Table 2: Plastic Piping Joint Selection
--

Pipe Location	Joint Type
Exposed in corridors	Thermal fusion or Mechanical joint
Above accessible ceilings in corridors	
In mechanical or other service rooms	
Laboratory rooms, class rooms – exposed or concealed	Mechanical joint
Inside of laboratory benchwork or casework	
Buried piping	Thermal fusion
Vertical Piping (Risers)	
Other concealed spaces	

3.5 Pipe Supports – Plastic Pipe

- .1 Support plastic piping in accordance with specification section 20 05 29 except as specified herein.
- .2 Support plastic piping, including anchors and guides, in accordance with the pipe manufacturer's requirements, based on an operating temperature of 60°C (140°F).
- .3 Provide pipe supports at intervals as recommended by pipe material manufacturer instructions and at the following locations:
 - .1 at the ends of branches,
 - .2 at each change of direction or elevation, and
 - .3 as close to a fixture trap as possible for fixture drains more than 1000 mm (39 in) long.
- .4 Support horizontal plastic piping by use of pipe clips attached to rigid support elements, such as trapezes equipped with sway braces, wall angle supports, or slotting channels rigidly mounted to the structure, to limit lateral pipe movement but to allow axial pipe movement,
 - .1 If a U-bolt is required at a pipe support, provide a galvanized steel insulation shield between the pipe and the U-bolt.
- .5 Support vertical (riser) piping:
 - .1 Support vertical piping;
 - (a) at its base,
 - (b) at every other floor level with pipe riser clamps, but not to exceed a vertical spacing of more than 7.5 m (24.5 ft) between supports.

3.6 Installation - Glass Piping

- .1 Where glass piping passes through a wall, provide wall sleeves with a diameter at least 50 mm (2 in) larger than the pipe outside diameter. Set the sleeve so that there is at least a 15 mm (0.6 mm) annular space at all locations between the pipe and the sleeve.
- .2 Replace glass that is chipped or cracked during or after installation. Protect piping installation from damage caused by any trade.
- .3 Terminate vent stacks with DWV cast iron pipe or copper tube, starting 300 mm (12 in) below roof, and extending up above roof. Provide a fabricated support anchor to bear weight of cast iron pipe or copper tube, attached to the building structure below the roof.
- .4 Provide pipe sleeves through non-fire rated walls 50 mm (2 in) greater diameter than pipe. Fill space between pipe and sleeve with mineral wool insulation.

- .1 For rated separations, use packing material in accordance with fire-stop listing requirements.
- .5 Where buried pipe extends up through slab-on-grade floor, provide sleeve with 50 mm (2 in.) greater diameter than pipe, and extend sleeve 100 mm (4 in) above floor level, and finish top of annular space with non-hardening mastic.

3.7 Pipe Supports – Glass Pipe

- .1 Support piping in accordance with specification section 20 05 29 except as specified herein.
- .2 Support piping in accordance with the pipe manufacturer's requirements.
- .3 Provide pipe supports at intervals as recommended by pipe material manufacturer instructions and at the following locations:
 - .1 at the ends of branches,
 - .2 at each change of direction or elevation, and
 - .3 as close to a fixture trap as possible for fixture drains more than 1000 mm (39 in) long.
- .4 Support horizontal piping with PVC coated swivel ring hangers.
- .5 Support vertical (riser) piping with PVC coated riser clamps, with an EPDM padding strip between the pipe and the clamp. Arrange pipe risers so that a pipe joint bears on the riser clamp.
 - .1 Support vertical piping;
 - (a) at its base,
 - (b) at every other floor level, unless manufacturer instructions requires shorter support intervals.
- .6 Do not support vertical piping from horizontal branch piping; do not locate a horizontal branch pipe support within 1.8 (6 ft) of the riser pipe.

3.8 Buried Installation

- .1 Lay buried piping in bedding prepared in accordance with Specification section 20 05 25.13 except/and as specified herein.
- .2 Support piping on 150 mm (6 in.) thick bed of clean sand, shaped to accommodate hubs and fittings, to line and grade as shown. Backfill with clean sand to 300 mm above top of pipe or to underside of floor slab whichever is less.
- .3 Support piping through foundation walls on backfill material as specified, and supported on 150 mm (6 in.) thick reinforced concrete pads. Dowel concrete pad into side of foundation walls and extend pad to obtain minimum bearing of 600 mm (2 ft) on undisturbed soil.
- .4 Wrap fittings on buried borosilicate glass drainage piping with 5 mil thick polyvinyl film of type recommended by glass drainage manufacturer.

3.9 Testing

- .1 Test drainage piping in accordance with the requirements of the plumbing code applicable at the project location.
- .2 Test before piping is concealed.
- .3 Cut-out and replace leaking soldered fittings, remake joints in cast iron piping, and retest.

END OF SECTION

SANITARY DRAINS 22 13 19.13

1 GENERAL

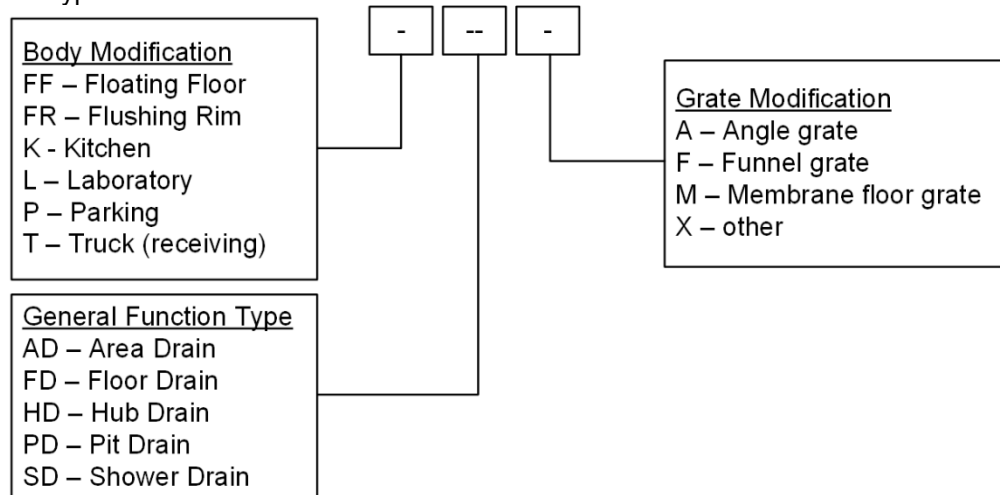
1.1 Scope

- .1 Provide sanitary waste piping accessories including floor drains, area drains and cleanouts.

1.2 Definitions

- .1 The following definitions apply to this specification section.
- .1 **Grate:** the finished exposed element of the floor or area drain which is suitable for heavy loads including vehicle loads.
 - .2 **Sheet waterproof flooring:** includes vinyl sheet or tiles, linoleum sheet or tiles, and rubber sheet or tiles, which have an installed thickness of 6 mm (1/4 in.) or less.
 - .3 **Strainer:** the finished exposed element of the floor or area drain which is suitable for foot traffic only.
 - .4 **Strainer shank:** the strainer supporting element which connects to the drain body. Grate shank has the same meaning.
 - .5 **Tile (floors):** includes ceramic or porcelain tiles and similar materials that are thicker than 6 mm (1/4 in.) including mortar/adhesive bed.
- .2 Load ratings of Light Duty, Medium Duty, Heavy Duty, Extra Heavy Duty and Special Duty: in accordance with CSA B72 / ASME A112.3.1 / ASME A112.6.3.

- .3 Drain type nomenclature:



1.3 Applicable Codes and Standards

- .1 Product standards:
- .1 ASME A112.3.1 Vacuum Stainless Steel Drainage Systems for Sanitary DWV, Storm, and Applications, Above-ground and Below Ground
 - .2 ASME A112.6.3 Floor and Trench Drains
 - .3 ASME A112.36.2M Cleanouts

.4 CSA B79

Commercial and Residential Drains and Cleanouts

1.4 Submittals

- .1 Submit product data sheets for materials specified herein.

2 PRODUCTS**2.1 Floor Drains (type "FD")**

- .1 Floor drains to be listed to CSA B79 and marked in accordance with ASME A112.3.1 (stainless steel floor drains), or ASME A112.6.3 (non-stainless steel floor drains).
- .2 The following requirements apply to all floor drains, combination drains, and hub drains except as otherwise specified.
- .3 Construction:
- .1 application: general purpose floor drains, for floors with or without a sub-floor membrane.
 - .2 loading: Light Duty to CSA B79, for foot traffic,
 - .3 body:
 - (a) coated cast iron with minimum Ø200 mm (8 in.) diameter anchor flange with primary and secondary drainage (seepage) openings,
 - (b) sub-floor membrane clamp,
 - (c) bottom hub outlet pipe connection.
 - (d) NPS ½ NPT trap seal primer connection.
 - (e) No-hub outlet.
 - .4 strainer:
 - (a) adjustable height, nickel bronze or stainless steel strainer secured with stainless steel tamper resistant (Allen key) screws,
 - (b) openings not exceeding 8 mm (5/16 in.) in any direction,
 - (c) round shape for poured monolithic floor finishes,
 - (d) square shape for tiled or similar floor finishes,
 - (e) minimum size: based on location in accordance with the following table.

Drain Pipe Size, NPS	Strainer/Grate Size mm (in.) diameter or square		
	General Purpose, Kitchens	Service Rooms, Wash Down Rooms, Emergency Fixtures	Parking, Loading Docks
2	125 (5)	125 (5)	---
3	175 (7)	200 (8)	---
4	200 (8)	250 (10)	250 (10)
6	250 (10)	250 (10)	250 (10)

- .5 Drain body pipe size as shown on drawings.

Standard of Acceptance

- Watts - fig. FD-100-C-A
- Zurn - fig. Z415 series
- Mifab - fig. F1100-C series
- Jay R. Smith - fig. 2005-C series

2.2 Floor Drain for Finished Membrane Floors (type “FDM”)

- .1 Application: general purpose rooms with sheet or liquid applied waterproof flooring.
- .2 Type FD floor drain and/except as follows:
 - .1 strainer: round, Ø180 mm (7 in.) nickel bronze strainer with surface membrane clamp.

2.3 Funnel Floor Drain (type “FDF-”) – General Purpose

- .1 Application: floors in general purpose spaces and service rooms.
- .2 Type FD floor drains and/except as follows:
 - .1 floor drains other than in service rooms: one piece integral funnel and open-throat strainer, Ø100mm (4 in. dia.) round funnel,
 - .2 floor drains in service rooms: one piece integral funnel and open-throat strainer, 100 mm x 225 mm (4 in. x 9 in.) elliptical funnel.

2.4 Hub Drains (type “HD-”)

- .1 Application: indirect waste hubs for floors in general purpose spaces and service rooms.
- .2 Type FD / FDM / LFD / LFDM floor drain (as applicable) and/except as follows:
 - .1 hub (no strainer):
 - (a) coated cast iron standing hub,
 - (b) minimum Ø100 mm (4 in. dia.) by a minimum height of 50 mm (2 in.) above finished floor level,

2.5 Hub Drain for Fire Protection (type “HDX1”)

- .1 Application: large capacity hopper for fire protection drain lines.
- .2 Type FD floor drain and/except as follows:
 - .1 drain pipe connection size: NPS 6.
 - .2 hub (no strainer):
 - (a) stainless steel hub, NPS 6 x minimum 150 mm (6 in.) long above finished floor level,
 - (b) threaded one end (for connection to floor drain body) and CI OD plain end (for connection to hopper).
- .3 Fabricated hopper:
 - .1 T304 stainless steel with No. 2B mill finish, all welded construction, and 12 mm x 12 mm angle reinforced top opening.
 - .2 dimensions: 150 mm (6 in.) wide, x 300 mm (12 in.) long x 375 mm (15 in.) high (including sloped bottom),
 - .3 45° sloped bottom to the bottom outlet connection.
 - .4 outlet connection: NPS 6, schedule 5 or 10 ASTM A312 stainless steel pipe, 200 mm long.
 - .5 brackets at top and bottom to secure hopper to wall or field-installed support frame,
 - .6 all welds mechanically ground to remove heat tint,

.7 No-Hub connector:

- (a) Shielded transition band-clamp, cast iron to steel IPS.

Standard of Acceptance

- Fernco - fig. Proflex 3000 series.

2.6 Shower Drains (type "SD")

- .1 Application: for tiled floor showers and other wet areas with sub-floor membrane,

- .2 Type FD floor drain and/except as follows:

- .1 Strainer: polished T304 stainless steel strainer and strainer shank.

2.7 Shower Drains with Angle Grate (type "SDA")

- .1 Application: for tiled floor showers and other wet areas with sub-floor membrane, for mounting at junction of floor and wall.

- .2 Type FD floor drain and/except as follows:

- .1 grate: nickel bronze angle grate, nominal 108 mm deep x 127 mm wide x 95 mm high (4.25 x 5 x 3.75 in.)

2.8 Cleanouts

- .1 Listed to CSA B79 and marked in accordance with ASME A112.36.2M.

- .2 In floors:

- .1 line size for NPS 2, NPS 3 and NPS 4, and NPS 4 in larger lines.

- .2 body: cast iron body with sub-floor membrane clamp, and with gas-tight plug.

- .3 head - unfinished floor areas including service rooms:

- (a) coated cast iron frame heavy duty scoriated cast iron round.

- .4 head - finished floor areas:

- (a) round, coated cast iron frame and polished nickel bronze adjustable head cover[.],

- (b) recessed for tile infill in tiled areas,

- (c) recessed for carpet infill in carpeted areas,

- (d) deeply recessed for terrazzo infill in terrazzo finished areas.]

Standard of Acceptance

- Watts - fig. C-100 series
- Zurn - fig. Z-1400 series
- Mifab - fig. C1100 series
- Jay R. Smith - fig. 4000 series

- .3 In exposed areas, ceiling spaces and accessible pipe chases,

- .1 cast iron caulking ferrule with neoprene jacket and plug secured to body with cap screws.

2.9 Back water valves

- .1 Backwater valve – suspended piping:

- .1 horizontal installation, coated cast iron body with Ø100 mm (4 in. dia.) bronze flapper valve.

Standard of Acceptance

- Watts - fig. BV-200
- Zurn - fig. Z1095
- Mifab - fig. BV1000
- Jay R. Smith - fig. 7012

.2 Backwater valve – buried piping:

- .1 horizontal installation, coated cast iron body with Ø100 mm (4 in. dia.) bronze flapper valve,
- .2 coated cast iron floor cleanout with gas and airtight plug, and cleanout cover, suitable for extension with field installed no-hub pipe risers.

Standard of Acceptance

- Watts - fig. BV-230-R
- Zurn - fig. Z1095-15
- Mifab - fig. BV1200-R

2.10 Access Pit Covers for Backwater Valves

- .1 Nominal 610 x 610 mm (24 x 24 in.), aluminum diamond plate access door, mill finish, and aluminum angle frame assembly, with hinged door and latch assembly,
- .2 Design live load: 14.4 kN/m² (300 lbf/sq.ft.)
- .3 Access door to be flush to top of angle frame.
- .4 Access door and frame designed for installation prior to floor pour, or installed into the rough floor opening (retrofit)

Standard of Acceptance

- Accudor - fig. FA-300, or FA-300 Retrofit

3 EXECUTION

3.1 Installation - General

- .1 Install sanitary drainage specialties in accordance with the applicable provincial plumbing code, and the requirements of the local authority having jurisdiction.
- .2 Install sanitary drainage specialties in accordance with the manufacturers installation instructions and as described herein.

3.2 Floor Drains and Area Drains

- .1 For floors constructed with a sub-floor membrane;
 - .1 install bodies flush to top of structural slab, and provide temporary coverings to protect top surface of anchor flange, receiver threads and body openings during concrete pour,
 - .2 after the sub-floor membrane is installed, install the membrane clamp and strainer and set the strainer top to be at the finished floor level or slightly lower,
- .2 For floors constructed as a single concrete pour without a sub-floor membrane, set the body and the strainer to suit the final floor elevation prior to concrete pour. Provide temporary covering of the strainer top surface.
- .3 For all types of floors, place clear pea gravel around the top of the anchor flange to protect the primary and secondary weeping drainage openings from being plugged with concrete or other flooring material.

- .4 Where shown on drawings for a combination floor drain, install a hub of specified type by attaching to the floor drain strainer.

3.3 Hub Drains

- .1 Install hub drain body as described above for floor drains.

3.4 Floating Floors

- .1 Install the lower drain body in the structural floor slab as specified above. During construction of the floating floor, install the hub pipe, flexible connector and upper body and strainer as described above for floor drains.

3.5 Cleanouts

- .1 Install cleanouts at the base of soil and waste stacks, at changes in direction of sanitary drainage piping, at intermediate locations on long runs of piping, and as shown.
- .2 Extend cleanouts flush to wall or up to finished floor above except as follows:
 - .1 clean-outs may be terminated in accessible ceiling spaces except where drawings indicate the clean-out is to be extended up through the floor.
- .3 Install cleanouts located in floors clear of obstructions.

3.6 Backwater valves

- .1 Install backwater valves in [main sewer lines][, where indicated][, and at weeping tile connections].
- .2 Install backwater valves in access pits where valves are buried below slab-on-grade floors. Provide access pit door. Coordinate with general trades work to confirm required floor opening dimensions as required to suit access door frame.
- .3 In electrical transformer rooms, where a floor drain is shown provide a backwater valve located outside of the transformer room.

END OF SECTION

RAINWATER LEADERS – CAST IRON AND COPPER

22 14 16.13

1 GENERAL

1.1 Scope

- .1 Provide cast iron pipe and fittings and/or copper tube and fittings for rain water leaders (storm drainage piping) and downspout collector piping for aboveground services.
- .2 This specification does not apply to downspouts; refer to Division 07.

1.2 Definitions

- .1 The following definitions apply to this section and referenced sections:
 - .1 Rainwater leader:** means the piping located inside of a building which conveys rainwater/snow melt water from a roof drain, patio drain or similar collection device, to the building storm sewer and includes the building storm drain (storm drainage piping has the same meaning.)

1.3 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
 - .1 20 05 29 Common Hanger and Support Requirements for Piping

1.4 Applicable Codes and Standards

- .1 Installation standards and codes:
 - .1 Cast Iron Soil Pipe Institute (CISPI) Technical Manual
- .2 Product standards:
 - .1 ASME B16.23 Cast Copper Alloy Solder Joint Drainage Fittings: DWV
 - .2 ASME B16.29 Wrought Copper and Wrought Copper Alloy Solder-Joint Drainage Fittings-DWV
 - .3 ASTM B32 Standard Specification for Solder Metal
 - .4 ASTM B306 Standard Specification for Copper Drainage Tube (DWV)
 - .5 ASTM C564 Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
 - .6 ASTM C1540 Standard Specification for Heavy Duty Shielded Couplings Joining Hubless Cast Iron Soil Pipe and Fittings.
 - .7 ASTM B828 Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings.
 - .8 CSA B70 Cast Iron Soil Pipe, Fittings, and Means of Joining
 - .9 CSA-B125 Plumbing Fittings.
 - .10 CSA B158.1 Cast Brass Solder Joint Drainage, Waste, and Vent Fittings
 - .11 CSA B602 Mechanical Couplings for Drain, Waste, and Vent Pipe and Sewer Pipe.

2 PRODUCTS

2.1 Copper DWV Pipe and Fittings

- .1 Application: inside of buildings only. Do not use for buried drain.

- .2 Pipe:
 - .1 copper DWV tube to ASTM B306
 - .2 certification markings made by testing agency accredited by Standards Council of Canada.
- .3 Fittings:
 - .1 copper or copper alloy to ASME B16.23, or ASME B16.29.
- .4 Solder
 - .1 tin-antimony 95/5 to ASTM B32 alloy Sb5.

2.2 Cast Iron DWV Pipe and Fittings

- .1 Application: inside of buildings and buried drain.
- .2 Pipe and fittings:
 - .1 cast to CSA B70,
 - .2 with heavy bituminous coating for buried service,
 - .3 riser fittings with integral riser support ring for hub-less piping installed in vertical risers.
- .3 Joints below grade:
 - .1 Plain end made up using mechanical sleeve joints to CSA B602 and ASTM C1540 with neoprene or butyl rubber compression gaskets to ASTM C564, with stainless steel sleeve and not less than four stainless steel drive clamps with stainless steel worm gears.
- .4 Joints above ground:
 - .1 Plain end made up using mechanical sleeve joints to CSA B602 and ASTM C1540 with neoprene or butyl rubber compression gaskets to ASTM C564, with stainless steel sleeve and not less than four stainless steel drive clamps with stainless steel worms.
 - .2 Hub and spigot made up neoprene gasket to ASTM C564 and lubricating compound.

3 EXECUTION

3.1 Installation General

- .1 Install rainwater leader drainage piping in accordance with the requirements of the plumbing code applicable at the project location.
- .2 Install suspended piping to grade, parallel and close to walls and ceilings to conserve headroom and space.
- .3 Install piping close to building structure to minimize furring. Group piping and run parallel to walls and ceilings.

3.2 Cast Iron Piping

- .1 Install cast iron drainage piping in accordance with Cast Iron Soil Pipe and Fittings (CISPF) Technical Manual.
- .2 For suspended piping, provide hangers within 450 mm (18 in.) of each joint, at each change of direction, and within 450 mm (18 in.) of the terminal end of each pipe run.
- .3 Assemble and tighten mechanical sleeve joints to coupling manufacturers recommended torque value with torque wrench.
- .4 Install cast iron hub-and-spigot joints with neoprene compression gasket and lubrication in accordance with manufacturer requirements.

- .5 Provide thrust restraints consisting of pipe clamps and restraint rods installed across tees, elbows, and blind plugs (cleanouts), for cast iron drainage piping NPS 5 and larger.
- .6 Provide sway braces on all horizontal piping where the hanger length is greater than 450 mm (18 in) measured from the top of the pipe to the structure connection point, as follows:
 - .1 transverse brace at 12 m (40 ft) intervals,
 - .2 longitudinal brace at 24 m (80 ft) intervals,
 - .3 a transverse brace of one pipe section may act as a longitudinal brace for a second pipe section connected perpendicular to the first section, provided the brace is located within 600 mm (24 in) of the connection.
 - .4 for clarity, these braces are required even where seismic restraint is not required.

3.3 Copper Tubing

- .1 Cut copper tube square, ream tube ends and clean tubing and tube ends before joint assembly.
- .2 Before assembling solder joints, clean inside of solder fittings and outside of mating pipe with emery paper and coat with flux.
- .3 Solder joints in copper pipe with blow torch or oxy-acetylene flame.

3.4 Pipe Supports

- .1 Support piping in accordance with specification section 20 05 29 except as specified herein.
- .2 Support horizontal copper DWV tubing in accordance with Table 1A:

Table 1A: Horizontal Pipe Support Spacing for Copper Tube		
Pipe Size NPS	Rod Diameter	Maximum Spacing
½	M10 (3/8 in)	1.5 m (5 ft)
¾ to 1¼	M10 (3/8 in)	1.8 m (6 ft)
1½	M10 (3/8 in)	2.4 m (8 ft)
2	M10 (3/8 in)	2.4 m (8 ft)
2½	M12 (½ in)	3.0 m (10 ft)
3	M12 (½ in)	3.0 m (10 ft)
4	M16 (5/8 in)	3.0 m (10 ft)

- .3 Support horizontal cast iron DWV piping in accordance with Table 1B and as follows;
 - .1 one pipe support for each end of the pipe, located at or within 150 mm (6 in) of each hub or mechanical joint,
 - .2 for mechanical joints, if the pipe length between adjacent fittings is 300 mm (12 in) or less, reduce the support spacing to a maximum of 1000 mm (39 in),
 - .3 where multiple joints occur within a 1000 mm (39 in) developed pipe length;
 - (a) support may be reduced to every other hub or mechanical joint, or

- (b) where the pipe run is made of multiple fittings connected end-to-end, provide a 1.6 mm (16 ga) galvanized steel half sleeve underneath the pipe and fittings, and support the sleeve with a support at each end of the sleeve.

Table 1B: Horizontal Pipe Support Spacing for Cast Iron Drainage Piping			
Pipe Size NPS	Maximum Spacing	Clevis Hanger: Minimum Rod Diameter	MJ Hanger: Minimum Rod Diameter
1-1/2	3 m (9.8 ft)	---	M10 (3/8 in)
2	3 m (9.8 ft)	---	M10 (3/8 in)
3 to 4	3 m (9.8 ft)	M10 (3/8 in)	M10 (3/8 in)
6	3 m (9.8 ft)	M12 (1/2 in.)	M12 (1/2 in.)
8 to 12	3 m (9.8 ft)	M16 (5/8 in)	---
15	3 m (9.8 ft)	M20 (3/4 in)	---

- .4 Support vertical pipe and tube risers at the base (bottom) of the riser and as follows:
- .1 for cast iron drain and vent piping,
 - (a) support piping at every floor level with a pipe clamp, arranged so that the pipe clamp is above the pipe section center of gravity,
 - (b) support the pipe below a hub, or support the pipe with a riser fitting for hub-less joints.
 - (c) support the base of a riser at a fitting hub, or for mechanical joints support the riser pipe at a riser fitting,
 - (d) for pipe sizes NPS 5 and larger, provide sway braces at the base support to limit movement in both horizontal directions.
 - .2 for other piping, support piping at every other floor level with pipe riser clamps,
 - .3 for all piping and tubing, do not exceed a vertical spacing of more than 7.5 m (24.5 ft),
 - .4 in addition, for cast iron drainage piping provide lateral guides;
 - (a) at the base and top of the pipe riser,
 - (b) and at every 9 m (30 ft) except where the pipe riser clamp is restrained to prevent lateral movement.

3.5 Testing

- .1 Test drainage piping in accordance with the requirements of the plumbing code applicable at the project location.
- .2 Test before piping is concealed.
- .3 Cut-out and replace leaking soldered fittings, remake joints in cast iron piping, and retest.

END OF SECTION

PLUMBING FIXTURES 22 42 00

1 GENERAL

1.1 Scope

- .1 Provide plumbing fixtures and trim, and temperature mixing valves for fixtures.
- .2 This specification section does not apply to temperature mixing valves located remote from individual plumbing fixtures, or for process equipment; refer to specification section 22 39 13 *Domestic Water Temperature Mixing Valves*.
- .3 This specification section does not apply to temperature mixing valves for emergency shower and eye-wash stations; refer to specification section 22 45 13 *Emergency Plumbing Fixtures*.

1.2 Definitions

- .1 The following definitions apply to this section.
 - .1 **Barrier-free:** has the same meaning as the applicable building code of the place of the Work, or in its absence, means, when applied to plumbing fixtures and emergency plumbing fixtures, the fixture can be approached, entered, and used by persons with physical or sensory disabilities.

1.3 Applicable Codes and Standards

- .1 Installation codes and standards:
 - .1 CSA Z317.1 Special Requirements for Plumbing Installations in Health Care Facilities.
 - .2 CSA Z318.3 Commissioning of Plumbing Systems in Health Care Facilities
- .2 Product standards:
 - .1 ASME A112.6.1 Supports for Off-the-Floor Plumbing Fixtures for Public Use
 - .2 ASSE 1016/ASME A112.1016/CSA B125.16
Performance Requirements for Automatic Compensating Valves for Individual Showers and Tub/Shower Combinations
 - .3 ASSE 1066 Performance Requirements for Individual Pressure Balancing Valves for Individual Fixture Fittings
 - .4 ASSE 1070 Performance Requirements for Water Temperature Limiting Devices
 - .5 CSA-B45 Series Plumbing Fixtures.
 - .6 CSA-B125 Plumbing Fittings.
 - .7 NSF/ANSI 61 Drinking Water System Components – Health Effects, including Annex G
 - .8 NSF/ANSI 372 Drinking Water System Components – Lead Content
 - .9 UL 1951 Electrical Plumbing Accessories

1.4 Fixture Count and Location

- .1 Determine the number and location of plumbing fixtures from Architectural drawings in the first instance, followed by the mechanical drawings.
- .2 In the event of a conflict as to location of plumbing fixtures between the architectural drawings and the mechanical drawings, the location as shown on the architectural drawings govern.

1.5 Submittals

- .1 Submit product data sheets for materials specified herein. Organize the submission in accordance with the following requirements:
 - .1 make one consolidated submission for all products specified,
 - .2 indicate the fixture type designation for each product on each submittal page,
 - .3 where a fixture type consists of multiple product components, organize the information in a cohesive presentation by fixture type designation,
 - .4 where a data sheet includes multiple figures/options, clearly mark the applicable model number and/or option that is being proposed as meeting the specification requirement.

2 PRODUCTS

2.1 General Requirements - Fixture Quality

- .1 Fixtures and trim of the same type to be the product of one manufacturer and must have proven hospital performance from previous installations.
- .2 Finished surfaces to be clear, smooth and bright, and guaranteed not to craze, discolour or scale.
- .3 Visible parts of faucets, escutcheons, wastes, strainers, traps, shower heads, supplies and stops to be chrome plated.
- .4 Do not include aerators in water supply faucets in healthcare facilities. Provide faucets with plain outlets with laminar flow control in the base of the spout.
- .5 Fixtures will not have an overflow.
- .6 All electronic sensor-activated fixtures shall be hardwired and on delayed vital emergency power.
- .7 Floor mounted water closets fitted with china bolt caps; plastic bolt caps are not acceptable.
- .8 Fixtures will be "lead-free" and meet or exceed the requirement of NSF/ANSI 61 & NSF/ANSI 372.
- .9 Faucet water discharge will not discharge directly in fixture drain grid strainer. As necessary, mock-up the proposed plumbing fixtures and associated faucets to verify this compliance requirement is being met. Submit written confirmation to the consultant that the compliance requirement has been met with the proposed plumbing fixtures and associated faucets.
- .10 Provide accessible cleanouts for all sinks and lavatories. Cleanouts for sinks and lavatories shall be located above the flood-level rim of the fixture. Include provisions for cleanouts for future sinks and lavatories where indicated on the architectural or mechanical drawings.
- .11 Compression fittings shall not be used except for connection of trap primer lines run in the slab.
- .12 Where fixtures and trim are identified by manufacturers' catalogue designation these references are to establish quality standards not otherwise specified. For the purposes of this section of the specification, fixtures or trim from manufacturers listed below are equally acceptable when conforming to the same level of quality.

Standard of Acceptance

- Delta Commercial
- Kindred
- Franke
- Moen Commercial

2.2 Lavatory Type "L-1"

- .1 Basin: Vitreous china wall hung basin modified with sealed overflow, ledge back, single center faucet hole and supplied with concealed arm carrier, complete with shroud/knee contact guard, mounting bracket and hardware

Standard of Acceptance

- Clayton 4610CHZ-SO with 4644CHZ shroud

- .2 Faucet: Heavy duty cast brass sink faucet, 203 mm (8") centers, two handle, polished chrome plated finish, Spout: R7 - Smooth End Gooseneck 9" (229mm) long, 12.7" (323mm) high (unmounted), Standard rigid/swivel field installation, vandal resistant .090" wall thickness, smooth spout end with laminar flow control in spout base, 1.0 GPM, 4 - 102 mm (4") wrist handles, ADA compliant, sanitary hoods, metal colour indexed vandal resistant screws

Standard of Acceptance

- Delta 26C3974-R7

- .3 Drain: NPS 1¼ chrome plated cast brass tailpiece with cleanout and open grid strainer

Standard of Acceptance

- Delta 33T260-1

- .4 Angle stops: Chrome plated NPS 3/8 rigid angle or flexible supplies with lockshield stops and associated supply kit components

Standard of Acceptance

- Brasscraft Supply Kit KTSCS400AX C

- .5 TMV: Point of use thermostatic mixing valve, nickel plated, bronze body, temperature adjusting spindle, 10mm (3/8") inlets and outlet FNPT connections, integral checks, high temperature limit stop set to a maximum 43 °C (109.4 °F), tempered water to hot water side of faucet,

Standard of Acceptance

- Delta R3270-MIXLF

- .6 P-trap: NPS 1¼ chrome plated brass "P" trap with cleanout

Standard of Acceptance

- Delta 33T311

- .7 Carrier: steel pipe legs, block base feet support, concealed arms and pedestal plate. For narrow wall installation provide 'Z' type sleeve for arms.

Standard of Acceptance

- Smith SQ-0-4437
- Zurn Watts CA-401-D for back to back carrier
- Installation height shall be barrier-free where required per architectural drawings.

2.3 Hand Hygiene Sink "HHS-1"

- .1 Basin: Vitreous china deep wall hung basin, white finish, with sealed overflow, single hole, faucet ledge, drilled for concealed arm carrier, fixture to include removable acrylic shroud, offset grid drain and p-

trap. Overall Dimensions: 508 mm (20") long, 432 mm (17") wide, 663 mm (26-3/32") high, Bowl Dimensions: 260 mm (10-1/4") long, 419 mm (16-1/2") wide, 235 mm (9-1/4") deep.

Standard of Acceptance

- American Standard ICU 9118.111.020

- .2 Faucet: Deck mounted remote faucet, polished chrome finish, single hole centerset, 5.7 LPM (1.5 GPM) maximum flowrate, gooseneck rigid/swivel spout, non-aerating, laminar flow control in base of spout, plain outlet, vandal proof, 133 mm (5-1/4") projection, 273 mm (10-3/4") high.

Standard of Acceptance

- Chicago Faucets 626-FCABCP

- .3 Foot Pedals: hot and cold water pedal box with extended pedals, chrome plated

Standard of Acceptance

- Chicago Faucets 834-EPSLOABCP

- .4 Drain: NPS 1¼ chrome plated cast brass tailpiece with plug and open grid strainer

Standard of Acceptance

- Cambridge Brass 33T260-1

- .5 Supplies: Chrome plated NPS 3/8 rigid angle or flexible supplies with lockshield stops.

Standard of Acceptance

- Cambridge Brass 47T312

- .6 P-trap: Cast brass body material, Chrome-plated finish, 1-1/4" x 1-1/4" PTrap, 279 mm (11") distance, With cleanout plug, Steel box flange, Neoprene gasket, Slipnuts, 17 gauge seamless tubular wall bend.

Standard of Acceptance

- McGuire 8872CBSAN

- .7 Mixing Valve: Point of Use and Master controlled fixtures, Thermostatic master water mixing control valve, The temperature is adjusted with the help of Spindle

Standard of Acceptance

- Lawler 570-86820

- .8 Carrier: steel pipe legs, block base feet support, concealed arms and pedestal plate. For narrow wall installation provide 'Z' type sleeve for arms.

Standard of Acceptance

- Watts – CA-421 for single carrier
- Watts – CA-401-D for back to back carrier
- Smith SQ-0-4437
- Zurn

2.4 Stainless Steel Sink Type "S-1" (single compartment)

- .1 Basin: Single compartment self rimming topmount sink with faucet ledge. 18 gauge (0.9 mm), type 304 (CNS 18/10) stainless steel. Exposed surfaces are #4 satin finished. Factory applied rim seal, cutout template, and factory installed EZ TORQUE fasteners. Centre back waste location. 3 1/2" (89 mm) crumb cup strainer with 1 1/2" (DN38) brass tailpiece.

Standard of Acceptance

- Franke LBS6808P-1

- .2 Faucet: Heavy duty cast brass sink faucet, 203 mm (8") centers, two handle, polished chrome plated finish, Spout: R7 - Smooth End Gooseneck 9" (229mm) long, 12.7" (323mm) high (unmounted), Standard rigid/swivel field installation, vandal resistant .090" wall thickness, smooth spout end with laminar flow control in spout base, 1.0 GPM, 4 - 102 mm (4") wrist handles, ADA compliant, sanitary hoods, metal colour indexed vandal resistant screws

Standard of Acceptance

- Delta 26C3974-R7

- .3 P-trap: NPS 1½ chrome plated brass "P" trap with cleanout, adjustable

Standard of Acceptance

- Delta 33T360

- .4 Supplies: Rough brass NPS ½ lockshield stop on each supply.

- .5 Mixing valve: Point of use thermostatic mixing valve, nickel plated, bronze body, temperature adjusting spindle, 10mm (3/8") inlets and outlet FNPT connections, integral checks, high temperature limit stop set to a maximum 43 °C (109.4 °F), tempered water to hot water side of faucet,

Standard of Acceptance

- Delta R3270-MIXLF

2.5 Thermostatic Mixing Valves – Lavatories, Under-Sink Mount ("TMV")

- .1 General:

- .1 application: temperature mixing valve at an individual lavatories or sinks, for under-basin mounting.
- .2 type: thermal actuated mixing valve,
- .3 listed to ASSE 1070,
- .4 listed to NSF 61+G or NSF 372.

- .2 Performance:

Primary Parameter	Secondary Parameter	Value
Cold water inlet temperature	Range	4 - 20°C (39 - 68°F)
Hot water inlet temperature	Range	49 - 82°C (120 - 180°F)
Maximum Approach Temperature	Hot Inlet to Mixed Temperature	+ 3.8°C (5°F) ΔT

Primary Parameter	Secondary Parameter	Value
Controlled Temperature Range	High temperature unit	27 to 49°C (80 to 120°F)
Temperature stability, at flow rate range	0 – 0.3 L/s (0 – 5 gpm)	± 1.7°C (±3°F)
	0.3 to 2.5 L/s (5 to 40 gpm)	± 2.8°C (± 5°F)
Maximum Flow Rate	at 100 kPa (15 psi)	0.03 L/s (0.5 gpm)
Minimum Flow Rate	---	0.016 L/s (0.25 gpm)
Maximum Differential Pressure	Between hot and cold supplies	20% of cold water pressure
Minimum design pressure	---	860 kPa at 93°C (125 psi at 200°F)

.3 Construction:

- .1 brass or bronze body, with corrosion resistant internals,
- .2 four port design - cold inlet and outlet, hot inlet, tempered outlet,
- .3 filed-convertible to be suitable for installation as a;
 - (a) dual-outlet for two-handle or single handle faucet, or
 - (b) single-outlet for tempered water to an automatic lavatory faucet,
- .4 thermal actuated movement, with adjustable temperature selection, and maximum temperature limiter,
- .5 tamper resistant setting handle,
- .6 pipe ends: NPS 3/8 compression fittings,
- .7 integral inlet debris screens.

Standard of Acceptance

- Watts (Powers) - fig. LFUSG-B
- Lawler - fig. TMM-1070T

2.6 Sealant Between Fixture and Wall Finish:

- .1 One-part acetoxysilicone sealant
- .2 White or clear colour.
- .3 Formulated with fungicide

Standard of Acceptance

- Tremco - fig. Tremsil 200
- Dow Corning
- GE

3 EXECUTION

3.1 Fixture Installation - General

- .1 Support fixtures level and square and connect with supplies, drains, traps and vents.
- .2 Where a faucet has separate hot and cold water handles, position the hot water handle on the left side of the faucet.
- .3 Where fixtures are located on exterior walls, run the water supplies up through the floor. For other fixture locations, run water supplies in the wall cavity.
- .4 Provide resilient, watertight and gas-tight seals for every joint in a floor flange or between a floor-outlet fixture and the drain.

3.2 Fixture Supports

- .1 Provide plates, brackets, wall carriers, cleats, and supports to secure fixtures in place.
- .2 Fasten wall brackets with bolts attached to double steel supporting plates.
- .3 Bolt fixture to wall through cored holes under lavatory wall flange, using chrome plated carriage bolts with integral washers, and expansion shields.
- .4 Install extra-heavy-duty chair carriers for fixtures not directly supported from floor.
- .5 Conceal vertical supports and baseplates in wall construction.
- .6 Apply sealant bead between wall mounted fixture and finished wall and finish with a smooth concave profile.
- .7 Set floor mounted water closet bowls in mastic, and seal the floor flange with a resilient, watertight and gas-tight flange seal.

3.3 Plumbing Fixture Installation Heights and Clearances

- .1 Install plumbing fixtures at heights as shown on architectural drawings and specifications. Where such information is not provided therein, install fixtures at heights as described in the following table.
 - .1 Mounting heights are in reference to the top of the finished floor level unless otherwise stated.

Fixture Type	Mounting Height Reference (above finished floor)	Mounting Height Mm (inch)	
		Barrier-Free	All Other
Water Closet	Top of seat	≥ 430 and ≤ 460 (≥ 17 and ≤ 18)	≥ 430 and ≤ 460 (≥ 17 and ≤ 18)
Urinal	Front rim	400 to ≤ 430 (16 to ≤ 16.5) [Note 1]	575 to ≤ 600 (22.5 to ≤ 23.5)
Lavatory	Rim	850 to ≤ 865 (33.5 to ≤ 34)	[850 to ≤ 865 (33.5 to ≤ 34)] [885 to ≤ 910 (35 to ≤ 36)]
Shower	Valve control handle	1150 to ≤ 1200 (45 to ≤ 47)	1150 to ≤ 1200 (45 to ≤ 47)
	Hand-held shower head: Two positions	1200 and 2300 (45 and 90) [Note 2]	1200 and 2300 (45 and 90) [Note 2, 3]

Fixture Type	Mounting Height Reference (above finished floor)	Mounting Height Mm (inch)	
		Barrier-Free	All Other
Bathtub	Faucet centerline (above tub rim)	425 to ≤ 450 (16.5 to ≤ 17.5)	425 to ≤ 450 (16.5 to ≤ 17.5)
	Hand-held shower head; Two positions	1200 and 2300 (45 and 90) [Note 2]	1200 and 2300 (45 and 90) [Note 2, 3]

Notes:

[1] Where there are two or more urinals in a washroom, one urinal is to be mounted at this height.

[2] An adjustable hand-held shower head mounted on a vertical shower bar, that can be set at these positions.

[3] If specified.

- .2 Mount manually-operated flushing control for water closets;
 - .1 between 500 and 900 mm above the finished floor, and
 - .2 for barrier-free water closets, located on the transfer side of the water closet.
- .3 Mount manually-operated flushing control for urinals;
 - .1 between 900 and 1100 mm above the finished floor level for barrier-free urinals, and
 - .2 at a height to suit the urinal fixture and flush-control valve for all other urinals.
- .4 For barrier-free lavatories not equipped with a fixture-skirt barrier, arrange piping beneath the lavatory so that the hatched area shown in figure 1 is clear of any obstruction.

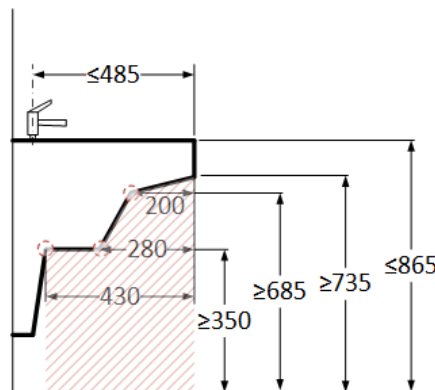


Figure 1: Barrier-Free Lavatory Clearances

3.4 Thermostatic Mixing Valve Installation

- .1 Install a fixture Thermostatic Mixing Valve at individual faucets where specified as an accessory for the fixture type, or as otherwise shown.
- .2 Provide field installed bass-bodied, in-line spring-loaded check valves on the hot and cold water supplies to each TMV unit, regardless of whether or not the TMV is equipped with integral check valves. For greater certainty, if the TMV unit is supplied with integral check valves they are deemed not to meet this requirement.

3.5 Protection

- .1 Cover plumbing fixtures and trim with plywood, cardboard or heavy paper and kept protected before, during and after installation and until work is completed and accepted.
- .2 Clean fixtures, and trim immediately prior to building completion.

3.6 Start-Up and Testing

- .1 Test, adjust and set high temperature limit stops on fixtures to supply a maximum water temperature, including faucets with integral or remote temperature mixing valves, as follows.

Fixture Type	Occupancy	Temperature Setpoint
Combination tub/shower, Showers	Healthcare, Long-Term Care, Retirement Homes	43°C (109°F)
	Other Occupancies	49°C (120°F)
Faucets	Healthcare, Long-Term Care, Retirement Homes	43°C (109°F)
	Other Occupancies	49°C (120°F)
Group (Sitz Baths)	Healthcare	40°C (105°F)

3.7 Commissioning Program

- .1 Comply with the project commissioning requirements in accordance with specification section 20 08 15.
- .2 The verification and testing requirements specified in this section may be concurrent with, or conducted separately from, the commissioning program, as coordinated with the Contractor and the commissioning agent.

3.8 Test and Installation Records

- .1 Provide a report of this testing and include:
 - .1 fixture reference,
 - .2 measured maximum temperature,
 - .3 date of test(s),
 - .4 signature of person(s) conducting test.
- .2 Submit a copy of each report to the Consultant and Owner for review and acceptance.
- .3 The above tests are subject to a demonstration test audit of up to 10% of the total fixture count to verify compliance. If audit tests are not satisfactory to the Consultant, additional testing and verification will be conducted by the Contractor until such time as a demonstration audit provides satisfactory results to the Consultant.

3.9 Plumbing Fixture Service Requirements

- .1 Unless otherwise shown on the drawings, plumbing fixture service requirements shall be in accordance with Table 1.

TABLE 1.

DRAWING TAG	DESIGNATION	MINIMUM SERVICE CONNECTION SIZE (mm)					QUANTITY OF FIXTURES SERVED BY A SINGLE BRANCH LINE					REMARKS
		TYPICAL DRAIN MATERIAL		VENT	COLD WATER	HOT WATER	1	2	3	4	5	
L-1	Lavatory	x	32	32	15	15	15	15	20	20	25	
HHS-1	Hand Hygiene Sink	x	40 per Z8000-11 requirements	32	15	15	15	15	20	20	25	
S-1	Sink	x	40	32	15	15	15	x	x	x	x	

END OF SECTION

EMERGENCY PLUMBING FIXTURES 22 45 00

1 GENERAL

1.1 Scope

- .1 Provide emergency plumbing fixtures and accessories including drench showers and eye/face wash fixtures.
- .2 Provide thermostatic mixing valves for emergency plumbing fixtures.

1.2 Definitions

- .1 The following definitions apply to this section.
 - .1 **Barrier-free:** has the same meaning as the applicable building code of the place of the Work, or in its absence, means, when applied to plumbing fixtures and emergency plumbing fixtures, the fixture can be approached, entered, and used by persons with physical or sensory disabilities.

1.3 Applicable Codes and Standards

- .1 Product standards:
 - .1 ANSI Z358.1 Emergency Eyewash and Shower Equipment
 - .2 ASSE 1071 Performance Requirements for Temperature Actuated Mixing Valves for Plumbed Emergency Equipment
 - .3 NSF/ANSI 61 Drinking Water System Components – Health Effects, including Annex G
 - .4 NSF/ANSI 372 Drinking Water System Components – Lead Content

1.4 Fixture Count

- .1 Determine number and location of emergency plumbing fixtures from mechanical drawings.

1.5 Submittals

- .1 Submit product data sheets for materials specified herein. Organize the submission in accordance with the following requirements:
 - .1 make one consolidated submission for all products specified,
 - .2 indicate the fixture type designation for each product on each submittal page,
 - .3 where a fixture type consists of multiple product components, organize the information in a cohesive presentation by fixture type designation,
 - .4 where a data sheet includes multiple figures/options, clearly mark the applicable model number and/or option that is being proposed as meeting the specification requirement.

2 PRODUCTS

2.1 General Requirements for Emergency Fixtures

- .1 Emergency fixtures listed to ANSI Z358.1.
- .2 Flow rates:
 - .1 Eye/face wash: 11.4 Lpm (3 gpm)
 - .2 Shower: 76 Lpm (20 gpm)
 - .3 Hand hose: 1.5 Lpm (0.4 gpm)

- .3 Each emergency fixture provided with signage in accordance with ANSI Z358.1.
- .4 Each emergency fixture provided with a thermostatic mixing valve suitable to its flow rate as specified herein.

2.2 Emergency Shower (type “ESH-1”)

- .1 Arrangement: barrier free, horizontal wall mounted, with exposed valve.
- .2 Shower:
 - .1 Ø250 mm (10 in. dia.) red or orange ABS plastic shower head,
 - .2 operating valve: NPS 1, nickel or chrome-plated brass “stay-open” ball valve with PTFE seats and seals,
 - .3 pipe and fittings: 915 mm (36 in.) long, NPS 1, schedule 40 galvanized steel pipe and fittings, epoxy or powder coat painted finish,
 - .4 stainless steel actuator arm and extended length stainless steel pull-rod valve actuator, of sufficient length so that bottom of pull-rod is not more than 1100 mm (43.3 in.) above the finished floor.

Standard of Acceptance

- Guardian Equipment - fig. GBF1643
- Bradley - fig. S19-120BF
- Haws - fig. 8122
- Stingray Systems - fig. S3035
-

2.3 Emergency Eye/Face Wash (type “EW-1”)

- .1 Arrangement: barrier-free, recess wall mounted.
- .2 Eye/Face wash:
 - .1 Recessed barrier free swing down, internal flow control and filter,
 - .2 Ø300 mm (12 in. dia.) stainless steel or ABS bowl with NPS 2-inch drain,
 - .3 operating valve: NPS 1/2 chrome-plated brass “stay-open” ball valve with PTFE seats and seals, and stainless steel combination cover and drain pan activate the water flow.
 - .4 offset indirect waste to direct drainage water back to wall.

Standard of Acceptance

- Guardian Equipment - fig. GBF1735DP
- Bradley -
- Haws -
- Stingray Systems -

2.4 Emergency Eye/Face Wash Drench Hose (type “EWH-1”)

- .1 Arrangement: wall mounted emergency drench hose.
- .2 Includes type “EW” eye/face wash unit and wash hose as follows.
- .3 Wash hose:
 - .1 one (1) spray head with flip-over dust cover, internal flow control and filter,

- .2 operating valve: forged brass squeeze valve activated by stainless steel lever handle. Valve closes when lever handle is released.
- .3 NPS 3/8 with MNPT hose end fitting, 3600 mm (12 ft.) long PVC hose, rated for a minimum of 1700 kPa (250 psi),
- .4 in-line dual check backflow preventor installed on inlet of hose,
- .5 wall-mounting plate and hook assembly.

Standard of Acceptance

- Guardian Equipment - fig. G5025BP
- Bradley -
- Haws -

2.5 Thermostatic Mixing Valves – Emergency Fixtures (“TMV-E”)

.1 General:

- .1 application: mixing valve for emergency plumbing fixtures, for eye/face wash, drench shower, and combination units.
- .2 type: thermal actuated mixing valve,
- .3 listed to ASSE 1071,
- .4 listed to NSF 61+G or NSF 372.

.2 Performance:

Primary Parameter	Secondary Parameter	Value
Cold water inlet temperature	Range	4 - 20°C (39 - 68°F)
Hot water inlet temperature	Range	49 - 82°C (120 - 180°F)
Controlled outlet temperature	---	29°C (85°F)
Maximum outlet temperature	Limit	32°C (90°F)
Shower Flow Rate	at 210 kPa (30 psi) inlet water pressure	2.1 L/s (33 gpm)
Eyewash/face wash Flow Rate	at 210 kPa (30 psi) inlet water pressure	0.41 L/s (6.5 gpm)
Maximum Differential Pressure	Between hot and cold supplies	5% of cold water pressure
Minimum design pressure	---	860 kPa at 93°C (125 psi at 200°F)

.3 Construction:

- .1 brass or bronze body, with corrosion resistant internals,
- .2 thermal actuated movement, with adjustable temperature selection, and fixed upper temperature limit.
- .3 fail-safe operation:
 - (a) hot water supply failure: internal bypass allows cold water flow.

(b) cold water supply failure: valve closes hot water inlet.

- .4 tamper resistant setting handle,
- .5 outlet temperature gauge,
- .6 pipe ends: NPT to ASME B1.20.1, with unions,
- .7 integral service stop-valves on inlet piping, inlet check valves and inlet debris screens.

Standard of Acceptance

- Guardian Equipment - fig. G6040, fig. G6020
- Bradley -
- Haws -
- Leonard -
- Watts -
- Lawler -

- .4 Cabinet for mixing valves (for finished spaces):
 - .1 1.6 mm (16 ga.), T304 stainless steel cabinet with 9.5 mm (3/8 in.) wide return flange for recessed mounting in wall, and hinged door with lock.
 - .2 supplied as an accessory part of the TMV.

2.6 Inspection Tags

- .1 Card stock inspection card for recording inspection and test dates.

Standard of Acceptance

- Bradley - fig. SAQ292
- Haws - fig. SP170.

2.7 Signage

- .1 Wall-mounted signs designating location of emergency showers and eyewash stations.
- .2 Size: 355 x 250 mm (14 x 10 in.)
- .3 Material:
 - .1 plastic, suitable for indoor and outdoor locations,
 - .2 exposure temperature: -40 to +80°C (-40 to +176°F), and UV stabilized,
 - .3 chemical and graffiti resistant,
 - .4 rounded corners with four (4) mounting holes.
- .4 Colour: white lettering on green background
- .5 Script: "Emergency Shower and Eyewash" / "Emergency Eyewash Station".

Standard of Acceptance

- Seton

3 EXECUTION

3.1 Emergency Fixture installation

- .1 Install emergency fixtures in accordance with manufacturer's instructions.

- .2 Fasten wall mounted emergency fixtures to concrete block or poured concrete walls with mechanical fasteners as recommended by manufacturer. Where fixtures are to be supported on partition walls, provide a floor mounted fixture carrier with mounting support plate installed inside the partition wall.
- .3 Fasten combination showers and eye/face wash fixtures to the floor.
- .4 Set the top of the bowl for an eye/face wash emergency fixture so that it is not more than 840 mm (33 in.) above the finished floor.
- .5 Set the pull-rod of an emergency shower so that the grasping part of the pull-rod is not more than 1100 mm (43 in.) above the finished floor.
- .6 For exposed eye/face wash fixtures, provide an offset drain back to the wall and down to 100 mm (4 in.) off the floor, terminating with a 45° elbow facing towards the floor drain. Construct this indirect waste of schedule 40 galvanized steel pipe and threaded fittings.
- .7 For type ESWCC fixtures, provide a direct drain connection to the recessed cabinet, with a p-trap and trap primer line and connect to the sanitary drainage system.

3.2 Thermostatic Mixing Valve Installation

- .1 Provide dedicated TMV-E units for each emergency fixture. Locate TMV-E as close as possible and to the side of the emergency fixture.
- .2 In finished spaces, provide TMV-E in a recessed cabinet.
- .3 Provide manual ball valves on the hot and cold water lines serving the emergency fixture.

3.3 Water Supply Piping Installation

- .1 Provide manual, full-ported ball valves with lockshield handle on the hot and cold domestic water supplies to each fixture, located as close as possible to the fixture and upstream of the thermostatic mixing valve. Provide ball valves even if thermostatic mixing valve has fixture stop valves.
 - .1 lock-shield handle to be arranged to allowing locking the valve in the open position.
- .2 Provide in-line, spring-loaded check valves on the hot and cold water supplies to each TMV-E unit, regardless of whether or not the mixing valve has integral check valves. For greater certainty, if the TMV unit is supplied with integral check valves, such check valves are deemed not to meet this requirement.
- .3 Prior to take-over of the Work by the Owner, install nylon tie-wraps to lock the service ball valves in the open position.

3.4 Floor Drains

- .1 Coordinate the location of emergency fixtures with a floor drain at the indicated position. Located the floor drain approximately 300 mm (12 in.) from the wall, and centered under the shower or eye/face wash bowl.

3.5 Signage Installation

- .1 Provide signage adjacent to each emergency shower and/or eyewash station, with top of sign mounted at 2100 mm (6.9 ft.) above floor level, permanently secured to the wall with mechanical fasteners.

3.6 Start-Up and Testing

- .1 Test, adjust and set temperature control on thermostatic mixing valves to supply a maximum water temperature of 29°C (85°F).
- .2 Test, adjust and set high temperature limit stops on thermostatic mixing valves to supply a tempered water not exceeding 32°C (90°F).

- .3 Flow water through each emergency fixture and TMV for at least two (2) minutes. Record the water temperature (as measured at the TMV) at 10 seconds from on-set of flow, at the time to reach the control setpoint, and again at the end of the test period.

3.7 Test and Installation Records

- .1 After completion of testing and at turn-over to the Owner, attach and fill out an inspection tag to each emergency fixture identifying the date of the test and the person who conducting the test.
- .2 Provide a report of this testing and include:
 - .1 fixture reference,
 - .2 measured temperatures,
 - .3 date of test(s),
 - .4 signature of person(s) conducting test.
- .3 Submit a copy of each report to the Consultant and Owner for review and acceptance.
- .4 The above tests are subject to a demonstration test audit of up to 10% of the total fixture count to verify compliance. If audit tests are not satisfactory to the Consultant, additional testing and verification will be conducted by the Contractor until such time as a demonstration audit provides satisfactory results to the Consultant.

END OF SECTION

MEDICAL GAS PIPING 22 60 13.70

1 GENERAL

1.1 Scope

- .1 Provide medical gas pipeline distribution systems including:
 - .1 piping, fittings, and valves,
 - .2 terminal units, including terminal units to be installed in Medical Supply Units.
 - .3 pipe hangers and accessories,
- .2 Applicable systems:
 - .1 Medical pressure gases intended for patient care:
 - (a) oxygen USP,
 - (b) medical air USP,
 - .2 Medical vacuum.

1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
 - .1 20 05 24 Welding and Brazing
 - .2 20 05 25 Excavation and Backfilling
 - .3 20 05 29 Common Hanger and Support Requirements for Piping

1.3 Definitions

- .1 The following definitions apply to this section and reference sections:
 - .1 **Certification Agency:** a testing organization of medical gas systems accredited to the requirements of ISO/IEC 17025 by Standard Council of Canada (has the same meaning as “testing body” as used in CSA Z7396.1).
 - .2 **Diameter index safety system (“DISS”):** threaded connections that comply with the requirements of CGA V-5.
 - .3 **Medical gas, medical support gas, medical vacuum and AGSS:** means all services within the scope of CAN/CSA-Z7396.1.
 - .4 **Medical supply unit:** means prefabricated equipment of Class I, Type B, that supplies medical gases, medical support gases, medical vacuum and AGSS singly or in combination with other services at the point of patient care and within the scope of CSA Z305.8. Commonly used terms such as headwall, ceiling mounted service column(s), ceiling column, ceiling pendants, articulating arms, boom arms are all types of Medical Supply Unit.
 - .5 **Pipe (piping):** has the meaning as defined in ASME B31.3 and is used interchangeable with “tube” or “tubing”, except where the context indicates otherwise.
 - .6 **Pipeline distribution system:** the portion of a medical gas, medical support gas, medical vacuum or AGSS located: (a) from and including the main supply shut off valve to (and including all terminal units), junction pints, or demarcation points; (b) intake piping from indoors or outdoors to medical air or instrument air compressors; and (c) exhaust piping from medical vacuum supply systems and AGSS supply systems to the outdoors.

- .7 **Qualified installer:** a competent person or company responsible for the installation of medical gas pipeline systems or components within a medical gas system.
- .8 **Terminal unit:** an outlet assembly (inlet for medical vacuum and AGSS) in a medical gas pipeline system at which the operator makes connections and disconnections.
- .9 **USP:** United States Pharmacopeia.
- .10 **USP-NF:** USP National Formulary
- .11 **Zone, zone alarm, and zone valve:** have the same meaning as defined in CAN/CSA-Z7396.1

1.4 Applicable Codes and Standards

- .1 Legislation:
 - .1 Ontario Regulation 220/01 Boiler and Pressure Piping Regulation
 - .2 Ontario Regulation 213/07 Fire Code
- .2 Installation codes and standards:
 - .1 ASME B31.3 Process Piping
 - .2 CSA B51 Boiler, Pressure Vessels and Pressure Piping Code.
 - .3 CSA Z7396.1-22 Pipelines for Medical Gases, Medical Vacuum, Medical Support Gases, and Anaesthetic Gas Scavenging Systems
 - .4 CAN/CSA Z15001 Anaesthetic and Respiratory Equipment - Compatibility with Oxygen
 - .5 CGA G-4.1 Cleaning Equipment for Oxygen Service.
- .3 Product standards:
 - .1 ASME B1.20.1 Pipe Threads, General Purpose, Inch
 - .2 ASME B16.22 Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
 - .3 ASME B16.50 Wrought Copper and Copper Alloy Braze-Joint Pressure Fittings
 - .4 ASTM B819 Standard Specification for Seamless Copper Tube for Medical Gas Systems.
 - .5 AWS A5.8 Brazing Filler Metal.
 - .6 CGA V-5 Diameter Index Safety System (Noninterchangeable Low Pressure Connections for Medical Gas Applications)
 - .7 CSA Z305.8 Medical Supply Units
 - .8 CAN/CSA-Z5359 Anaesthetic and respiratory equipment — Low-pressure hose assemblies for use with medical gases, medical vacuum, medical support gases, and anaesthetic gas scavenging systems
 - .9 CSA-Z9170-1 Terminal units for medical gas pipeline systems - Part 1: Terminal units for use with compressed medical gases, vacuum, and anaesthetic gas scavenging systems
 - .10 CAN/CSA-Z10524-2 Pressure Regulators for Use with Medical Gases - Part 2: Manifold and Line Pressure Regulators

1.5 Qualified Tradesperson

- .1 Work on medical gas systems to be performed by:

- .1 a specialist firm that: has experienced in this type of work; is knowledgeable of the applicable regulations, installation codes and standards pertaining to medical gas systems; has registered procedures for silver brazing; and regularly employs tradespersons qualified in pressure piping installation,
 - .2 a qualified, licensed and recognized firm which has the requisite license to perform medical gas piping installation, issued by the AHJ for boiler and pressure vessels where such licensing is required under applicable provincial legislation,
 - .3 tradespersons holding applicable certificates of competency for pressure piping and brazing work, and
 - .4 tradespersons who are certified in accordance with the *CSA Medical Gas Piping & Systems Installation Personnel Certification Program*.
- .2 Prior to commencing work on site,
- .1 supply copies of certification record to the Owner for each qualified tradesperson performing work on the medical gas system, and
 - .2 supply copies of tradespersons certificates of competency for brazing to the Owner for their records.
- .3 Installers of CMT shall complete and pass the manufacturer's training course and supply copies of the certificate to the Owner for their records.

1.6 Registration and Inspection

- .1 Pressure piping:
- .1 Before commencing work, make arrangements and pay for registration and inspection of pressure vessels and pressure piping by the AHJ responsible for Pressure Piping safety, unless otherwise exempt by regulation.
 - .2 All materials which operate with an internal gas pressure greater than 100 kPa (15 psi) above atmospheric pressure shall have a CRN in accordance with CSA B51.
 - .3 Collect and record CRNs for components and fittings and obtain and coordinate equipment CRNs or field registration of composite equipment.
 - .4 At the start of the Work, obtain existing pressure piping system registration numbers, if available, from the Owner and/or the AHJ.
- .2 Fire safety:
- .1 Before commencing work, make arrangements and pay for permits and inspection of medical gas piping systems by the AHJ responsible for fire safety where required by legislation in the place of the Work.

1.7 Design Criteria – Medical Gas and Vacuum Piping

- .1 Piping design and installation code:
- .1 to ASME B31.1
- .2 System design criteria:

System	Design Temp. °C (°F)	Maximum Operating Pressure kPa (psig)	Design Pressure kPa (psig)
Oxygen	38 (100)	415 (60)	700 (100)

System	Design Temp. °C (°F)	Maximum Operating Pressure kPa (psig)	Design Pressure kPa (psig)
Medical Air	38 (100)	415 (60)	700 (100)
Medical Vacuum	38 (100)	-70 (-20 in.Hg.)	-100 (-30 in.Hg.)

1.8 Submittals

- .1 Submit manufacturer catalogue cut-sheets for the following materials;
 - .1 piping/CMT,
 - .2 valves,
 - .3 terminal units,
 - .4 line pressure regulators, safety valves and assemblies,
 - .5 emergency oxygen inlet stations.

1.9 Quality Control

- .1 Site Acceptance Testing;
 - .1 Manufacturer to provide services of manufacturer's authorized service personnel to provide field services in accordance with the requirements of Part 3 of this specification.
- .2 Brazing Quality Control;
 - .1 Maintain records of in-process examination of not less than 5% of production brazed joints in accordance with ASME B31.3. Submit copies of examination records of selected joints (or nearest examined joint) when requested by the Certification Agency or the Consultant.
 - .2 Include a copy of in-process examination records in the maintenance and operations manual.
- .3 Commissioning and Certification;
 - .1 The medical gas installation contractor(s) shall be responsible for commissioning the medical gas systems in accordance with the requirements of CSA Z7396.1 and as specified herein.
 - .2 The medical gas systems will be certified by an independent Certification Agency, hired directly by the Owner, to verify that the installation is in accordance with CSA-Z7396.1. The medical gas installation contractor shall include labour, superintendence and all other costs associated with co-ordination, attendance and participation during certification testing of the medical gas systems.

1.10 Material Shipping, Handling and Storage

- .1 Valves, piping, CMT and terminal units shall be cleaned in accordance with CGA G-4.1 or CAN/CSA Z15001, capped and sealed in a plastic bag, labelled to state that the product has been so cleaned and visually inspected, and shipped to the project site in packaging to prevent contamination by dirt, grease, or other foreign matter.
- .2 Where such material protection is damaged prior to installation, including damage to the packaging, the material shall not be installed and shall be removed from the site.
- .3 Store materials in clean and dry conditions.

1.11 Operating and Maintenance Data

- .1 In addition to the requirements of Division 01, submit operating and maintenance data including:
 - .1 equipment list identifying components used in each system,
 - .2 equipment manufacturer's names and addresses,
 - .3 wiring diagrams of alarms and electrical components,
 - .4 detailed drawings of equipment and components,
 - .5 manufacturers service manuals, including recommended maintenance tasks and frequency, and recommended spare parts,
 - .6 manufacturers' warranties,
 - .7 valve schedule listing valves in system with location.
 - .8 Canadian Registration Numbers (CRN) for components and fittings.
 - .9 manufacturer instructions for the non-destructive and non-invasive procedures for testing of alarms,

2 PRODUCTS

2.1 Copper Tube

- .1 Hard drawn copper to ASTM B819;
 - .1 type "L" except as follows:
 - (a) type "K" for tube size NPS 3 and larger with design pressures in excess of 1275 kPa (185 psi),
 - (b) type "K" for buried (underground) services.
 - .2 factory cleaned and marked with classification symbols for medical gas use,
 - .3 cleaned for oxygen service,
 - .4 shipped with pipe end sealed.

2.2 Fittings

- .1 Wrought copper or copper alloy to ASME B16.22 or ASME B16.50, and
- .2 For pipe sizes NPS 1/2 or less, fittings that are not made especially for soldered or brazed connections may be used, provided that the fitting as installed is visible in the room or is readily accessible for maintenance.
- .3 Dielectric fittings may be used where required by the manufacturer of special medical equipment to electrically isolate the equipment from the pipeline distribution system.
- .4 Axially swaged, elastic strain preload fittings providing metal-to-metal seal may be used provided that the fittings have pressure and temperature ratings not less than that of a brazed joint and, when complete, are permanent and non-separable.
- .5 All fittings to be cleaned for oxygen service.

Standard of Acceptance

- LOKRING Technology

2.3 Flanges and Gaskets

- .1 Flange:

- .1 ASME Class 150 or 300 carbon steel flange, Van-stone style with copper tube adapter tailpiece, suitable for brazed connection to copper tubing. Flange designed to prevent contact of carbon steel material and copper material.
- .2 flange provided with a powder coated finish, and an EPDM insulator to isolate the copper tailpiece from contact with the flange.
- .3 minimum MCPR:
 - (a) Class 150: 1400 kPa (250 psi) at 38°C (100°F)
 - (b) Class 300: 2800 kPa (400 psi) at 38°C (100°F)

Standard of Acceptance

- CTS Flange Canada - fig. BF / WBG

.2 Flange gaskets:

- .1 full flat-faced style to ANSI B16.21.
- .2 material: PTFE with silica, suitable for use in oxygen service and nitrous oxide.
 - (a) thickness: 1.6 mm (1/16 in.).
 - (b) required working pressure: 7000 kPa (1000 psi), from -268°C (-450°F) to +260°C (500°F)

Standard of Acceptance

- Garlock - fig. Gylon 3502

2.4 Joints

.1 Brazed joints:

- .1 for copper-to-copper joints: silver brazing alloy to AWS A5.8 classification BCuP-3 or BCuP-5, and no flux.
- .2 for brazing dissimilar metals: silver brazing alloy to AWS A5.8 classification BCUP-5 with brazing flux No. 3A.

Standard of Acceptance

- Handy Harmon "SIL-FOS"
- All-State Welding Alloys "SILFLO 15"

.2 Threaded joints:

- .1 for connections to valves and other equipment: NPT to ASME B1.20.1.
- .2 thread sealant: oxygen compatible Teflon tape.

Standard of Acceptance

- Masters - Oxygen compatible T-Tape

2.5 Pipe Hangers and Supports

- .1 Refer to section 20 05 29 except as specified herein.
- .2 Trapeze Hangers:
 - .1 12 ga galvanized steel channel frames, solid backs.

Standard of Acceptance

- Taylor Figure TS
- Unistrut

.3 Pipe/Tubing Clamps:

- .1 two piece, epoxy coated clamp, with thermoplastic liner to separate piping from clamp.

Standard of Acceptance

- Taylor Figure 8500 Strut-Clamp
- Unistrut

.4 Spacers:

- .1 U-shape splice plates used as spacer control between adjacent piping clips.

Standard of Acceptance

- Taylor UF series
- Unistrut

2.6 Ball Valves

.1 NPS 4 and under – general requirements:

- .1 to MSS SP-110, 600 CWP, three-piece forged brass or bronze body, full port, stainless steel ball or chrome plated bronze ball, PTFE seat rings, and blow-out resistant with Viton seals, solder ends.
- .2 required MCPR: 4100 kPa (600 psig) at 38°C (100°F).
- .3 lever handle with locking device.
- .4 factory assembled with type K" copper tube extensions to ASTM B819, complete with 1/8" FNPT inlet purge port, and an outlet purge/gauge ports.
- .5 cleaned for oxygen service and with tube ends capped.

Standard of Acceptance

- Amico - fig. VV-ISO-G2L series
- Class I - fig. 7300 series
- Beacon Medaes - fig. 21160 series

.2 Additional requirements for Zone Valves, up to NPS 3:

- .1 application: ball valves installed inside of zone valve boxes/stations.
- .2 ball valves as specified above. and as follows:
 - (a) copper tube extensions to a minimum of 100 mm (4 in) beyond sides or back of zone valve box,
 - (b) an additional 1/8" FNPT port on the discharge end for connection of pressure transducers,
 - (c) identification bracket bolted over valve body for application of medical gas identification label,
 - (d) fitted with line pressure gauges suitable for each gas or vacuum service,

2.7 Butterfly Valves

.1 NPS 2-1/2 and over:

- .1 application: for medical vacuum and AGSS services only.

- .2 to MSS-SP-67, ductile iron lug body style, with flange bolt holes drilled and tapped for ANSI 150 flange pattern.
- .3 stainless steel shaft, aluminum bronze or 316 stainless steel or ductile iron/nickel plated disc, and replaceable EPDM or BUNA-N resilient seat to provide bubble tight shut-off under system pressure from either side with flange removed from un-pressurized side.
- .4 required MCPR: 1200 kPa (174 psi) at 93°C (200°F).
- .5 ISO 5211 mounting pad.
- .6 locking handles up to NPS 4, and gear operators for NPS 6 and over.
- .7 cleaned for oxygen service.

Standard of Acceptance

- Class 1 - fig. BFC-Lug
- Nibco - fig. LD-2000
- Apollo - fig. LD 141, LD 145
- Kitz - fig. 6122EL

2.8 Check Valves

.1 In-line Silent Check, NPS 4 and under:

- .1 three-piece bronze body with swing out core, spring-loaded duo-disc, EPDM seat, socket ends.
- .2 factory assembled with type "K" copper tube extensions to ASTM B819, complete with 1/8" FNPT inlet purge port, and an outlet purge/gauge ports.
- .3 cracking pressure less than 3.5 kPa (1/2 psi).
- .4 required MCPR: 2000 kPa (300 psi) at 93°C (200°F).
- .5 cleaned for oxygen service and with tube ends capped.

Standard of Acceptance

- Amico - fig. Medical Check Valve with Extensions
- Class 1 - fig. CVE series
- US Valve - fig. Medical Check Valve with Extensions

.2 In-line Silent Check Valves, NPS 2 and over:

- .1 to ASME B16.34, Class 150, ASTM A351 grade CF8M stainless steel wafer body, stainless steel trim and spring-controlled dual-disc check, EPDM or PTFE seat.
- .2 required MCPR: 1800 kPa (260 psig) at 38°C (100°F).
- .1 cleaned for oxygen service.

Standard of Acceptance

- Dezurik - fig. APCO CDD-9000T
- Crane - fig. Duo-Chek
- Mueller - fig. Sure Check 72D

2.9 Pipeline Distribution System Terminal Units

- .1 Connector type: Diameter Index Safety System (DISS) to CGA V-5.
- .2 Main body:
 - .1 rough-in mounting box or plate,

- .2 one-piece brass body:
 - (a) with secondary check valve rated for 1380 kPa (200 psig) for positive pressure gasses,
 - (b) designed to swivel 360° for multi-direction connection,
 - (c) O-ring seal or seats.
- .3 type K copper tube to ASTM B819 inlet connection stubs;
 - (a) NPS 1/2 for pressure gasses,
 - (b) NPS 3/4 for medical vacuum and AGSS.
 - (c) gas service identified on tube stub.
- .4 provided with dust-cover to protect body during construction after rough-in installation.
- .3 Primary valve body style:
 - .1 gas specific latch or cartridge type with serviceable primary check valve.
 - (a) do not mix latch and cartridge styles on the same project.
- .4 Outlet cover:
 - .1 gas specific 1.5 mm (16 ga) mounting plates, and modular design to allow on-site ganging of multiple outlets, with a minimum center-to-center spacing of 127 mm (5 in.),
 - .2 colour coded front plate with English language printed service identification, and indexing pins for safety keying gas specific cover plate to appropriate steel rough-in mounting plate.
 - .3 chrome plated, satin finish, or epoxy powder-coated fascia plate,
 - .4 outlet to be adjustable for variable wall thickness at least between 12 mm (1/2 in.) and 25 mm (1 in.) wall thickness,
 - .5 pressure test plug for medical vacuum and AGSS outlets, rated for 1000 kPa (150 psi).
- .5 Model variants:
 - .1 terminal units designed for various installation locations including:
 - (a) recess wall mount for concealed piping,
 - (b) surface wall mount for exposed piping,
 - (c) recess mount for ceilings,
 - (d) recess mount for medical supply units,
 - (e) non-ferrous material compatible for installation in MRI Rooms.
 - (f) recess mount in tamper-proof enclosure for psychiatric mental health rooms
 - .2 Listed to CAN/CSA-Z9170-1.
 - .3 Each unit tested for pressure-leak tested and flow tested.
 - .6 Cleaned for oxygen service and tube ends capped.

Standard of Acceptance

- Amico - fig. O-DIS series
- Class 1 - fig. M series
- BeaconMadaes - fig. B series

2.10 Valve Identification

- .1 Valve tags:
 - .1 plastic valve tags, nominally 115 mm x 80 mm (4-5/8 x 3-1/8 in.), rounded corners with pre-punched fastening holes, orange colour, suitable for application of a printed adhesive label.

Standard of Acceptance

- Brady - fig. 87695

.2 Valve tag label marking system:

- .1 labels: 50 mm (2 in.) high, low-shrinkage vinyl labels for indoor and outdoor use, high tack permanent adhesive, black lettering on white background.
- .2 printer: portable printer with LCD display and full QWERTY keyboard, capable of multiline printing on 50 mm (2 in.) wide labels.

Standard of Acceptance

- Brady - fig. BMP71

3 EXECUTION

3.1 Field Cleaning

- .1 Field cleaning of copper tubing, CMT, valves, pressure regulators, safety valves and terminal units is not permitted. If factory shipping packaging is damaged or tube ends are missing prior to installation, these materials shall not be used and shall be removed from site.
- .2 Keep cutting and reaming tools scrupulously clean and free from oil or grease.
- .3 Do not use organic solvents such as carbon tetrachloride under any circumstances.

3.2 Piping Fabrication

- .1 Install piping in accordance with CSA Z7396-1.
- .2 Make pipeline joints by brazing or mechanical swage coupling except as follows:
 - .1 butterfly valves and pressure relief valves: threaded or flanged,
 - .2 connections to source equipment: threaded or flanged,
 - .3 pressure sensors and switches: DISS connector,
 - .4 pipeline DISS check bodies for pressure sensors and switches: threaded,
 - .5 pressure gauges and other instruments including instrument isolation valve: threaded.
- .3 For threaded joints;
 - .1 use Sweat x NPT adapters for connection to equipment with threaded joints.
 - .2 make-up threaded joints with Teflon tape.
- .4 Use ells, tees, caps and couplings to make offsets and changes in direction and to route piping between connections. Do not bend hard drawn tubing except for long sweep cold bending with minimum bending radius of 20 x OD, without deformation or reduction in pipe diameter.
- .5 Cap off open ends of piping at the end of each work shift, using shipping dust caps overlaid with plastic and held in place with tape.

3.3 Pipe Supports

- .1 Support piping in accordance with specification section 20 05 29 except as specified herein.
- .2 For multi-service support, provide tubing clips on trapeze channels to secure piping to channel. Install U-plates or similar on each side of pipe clamp to prevent horizontal movement of each pipe,

- .3 For individual horizontal support, provide adjustable PVC coated clevis hangers, rods and anchors as specified,
- .4 Support horizontal piping at intervals in accordance with the following Table 1:

Table 1: Horizontal Tube Support for Medical Gas Piping		
Pipe/Tube Size NPS	Support Horizontal Spacing m (ft)	Support Vertical Spacing m (ft)
1/2	1.8 (6)	1.8 (6)
3/4	2.4 (8)	1.8 (6)
1	2.4 (8)	2.4 (8)
1-1/4	3.0 (10)	2.4 (8)
1-1/2	3.0 (10)	2.4 (8)
2 and larger	3.0 (10)	3.0 (10)

- .5 Support vertical tubing risers:
 - .1 at the base (bottom) of the riser by a support that is independent of any adjacent horizontal pipe supports,
 - .2 at every other floor level with pipe riser clamps, but not to exceed a vertical spacing of more than 10 m (33 ft).
- .6 Do not support medical gas piping from other building services. Do not support other building services from medical gas piping.

3.4 Brazed Joints

- .1 Make brazed joints in accordance with specification section 20 05 24 and as specified herein.
- .2 Make up joints between copper and copper materials without the use of flux. Joints between dissimilar metals may use flux as follows:
 - .1 use AWS brazing flux No. 3A,
 - .2 brush flux over end of fitting and keep inside of pipe and fittings free from flux,
 - .3 after brazing dissimilar metals, wash exterior surfaces with hot water to remove residual flux,
 - .4 wire brush joints after brazing.
- .3 During brazing, continuously purge the inside of the pipe to maintain a nitrogen atmosphere. Prior to brazing, purge air from the tube with nitrogen so that the oxygen content inside the pipe does not exceed 1% by volume (10,000 ppm) before brazing commences.
- .4 Where connections of new piping are made to an existing system, for the final connection to the existing system;
 - .1 in the new piping portion, relieve the nitrogen purge gas pressure down to atmospheric pressure before making tie-in connection to the existing piping systems,
 - .2 during brazing of the tie-in joint, do not introduce nitrogen purge gas to the pipeline system.

3.5 Valves

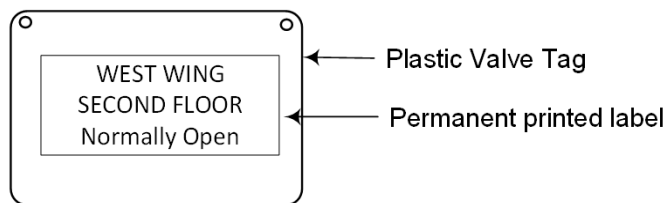
- .1 Provide valves as shown.
- .2 Provide zone valves and/or combination zone valves/zone alarm panels in accordance with specification section 22 63 26. Install zone valves or combination zone valve/zone alarm panels so that the height of the center-most valve is approximately 1500 mm (5 ft.) above floor level.
- .3 For pipeline distribution system valves other than those located in zone valve boxes, provide common-keyed padlocks on each valve. Leave valves padlocked in the open position and turn five (5) copies of the common-key over to the owner. Padlocks are not required on valves located in a locked service room containing the medical gas source equipment.

3.6 Safety Valves

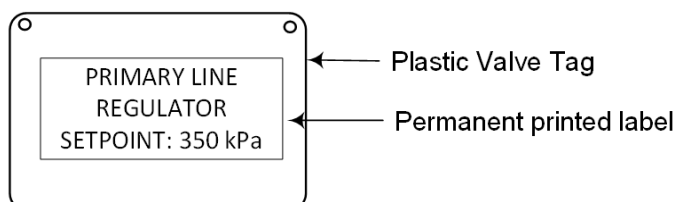
- .1 Install safety valve vent piping in copper tube with brazed joints.
- .2 Except for medical air and instrument air, pipe safety valves discharge piping for all medical gases and medical support gases to outside of the building as follows:
 - .1 locate a minimum of 3 m (10 ft) from any door, operable window, or ventilation intake,
 - .2 terminate at a height of at least 1 m (3 ft) above roof or adjacent grade level,
 - .3 terminate relief pipe with a down-turn facing outlet, and increase relief pipe size at termination point by one NPS trade size and terminate with screened outlet fitted with T304 stainless steel plain weave 2x2 mesh, 9.3 mm (0.365 in.) opening size

3.7 Identification

- .1 Label medical gas systems in accordance with CSA Z7396-1.
- .2 Label piping progressively on a daily basis as piping is installed.
- .3 For service valves and line pressure regulators, provide a gas specific pipeline marker identifying the gas immediately adjacent to the inlet or outlet side of the valve or regulator with no visible obstruction between the valve/regulator and the marker. For zone valves, provide the pipe marker inside the zone valve cabinet.
- .4 For service valves, provide a valve tag with a machine printed label identifying the area or zone served, and "Normally Open" or "Normally Closed" as applicable to the valve. Secure the valve tag to the valve with stainless steel tie-wire to the valve body, not the valve handle.



- .1 For line pressure regulators, provide a valve tag with a machine printed label identifying whether the regulator is the Primary or Secondary regulator, and the regulator setpoint valve in kPa units.

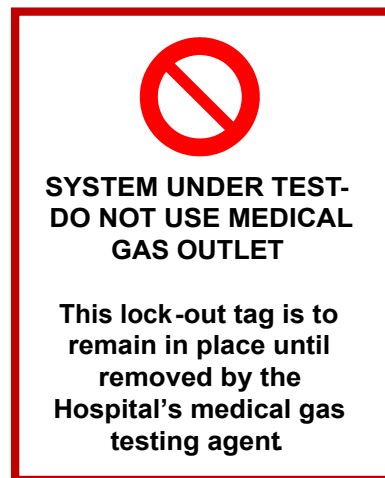


3.8 Terminal Units

- .1 Install terminal units in accordance with manufacturer's instructions. Protect backbody openings during rough-in stage to prevent contamination of main body.
- .2 Refer to architectural drawings for set-out heights of wall mounted individual or ganged terminal units. In the absence of such information, set wall mounted terminal outlets at a height of 1500 mm (5 ft) above the floor as measured to the center of the DISS outlet.

3.9 Commissioning

- .1 Conduct commissioning on piping systems in accordance with CSA Z7396-1 as summarized herein, prior to 3rd party certification testing by the independent certifier retained by the Owner,
- .2 Prepare a written commissioning test plan which verifies and documents the completed commissioning work. Provide a copy of the completed test plan/report to the Owner upon completion.
- .3 Conduct commissioning after the terminal units are installed, but before medical gas piping is concealed in walls, above ceilings or in vertical service spaces.
- .4 Tag-out / Lock-out requirements:
 - .1 Tag-out each terminal unit outlet prior to testing of associated piping system with a tag as shown or similar:



- .5 Brazing quality test:
 - .1 When requested by the hospitals inspection body (agent), cut-out a brazed joint as selected by the inspection body who will review the inside of the joint for soundness and evidence of oxidation.
 - .2 If samples show improper brazing or oxidation, cut-out the joints immediately upstream and downstream of the first joint, plus three other joints randomly selected by the inspection body. If any of these joints fail the inspection, the Contractor shall then remove additional joints as directed by the Owner until the inspection body is satisfied with the quality of the brazing work. Make good all joints which were removed.
- .6 Pressure testing and cross connection testing:

- .1 Pressure testing and cross connection testing of pipeline distribution system piping shall conform to CSA Z7396.1, as summarized and as amended in the following articles. Perform this testing in the following order:
 - (a) disconnect flexible hoses inside of Medical Supply Units (as applicable) and install test caps on medical vacuum and AGSS DISS terminal units,
 - (b) perform the "Initial pressure test",
 - (c) perform the "Final pressure test".
 - (d) perform the "Purge test",
 - (e) perform the "Cross connection test",
 - (f) perform the "Combined Medical Supply Units test".
- .2 Test gas for all tests: oil-free dry air or oil-free dry nitrogen.
- .7 Initial pressure test:
 - .1 Conduct a standing 24 hour initial pressure test as follows:
 - (a) perform the test before terminal unit outlet covers are installed, and disconnect the pressure transducers and switches from their DISS bodies,
 - (b) disconnect flexible hoses inside of Medical Supply Units (as applicable) and install test caps on medical vacuum and AGSS DISS terminal unit,
 - (c) do not manifold piping systems together - test each system independently,
 - (d) charge each piping system with the test gas to the required test pressure, and then isolate the test gas source,
 - (e) test pressure for medical gases and medical support gases: 150% of design pressure or 1035 kPa (150 psi) whichever is greater,
 - (f) test pressure for medical vacuum and AGSS: minimum 415 kPa (60 psig),
 - .2 Acceptance criteria: no change in pressure during the test period except due to change in ambient temperature around the piping.
 - .3 If leaks exist, identify and repair any detected leaks and retest pipe system. Use an oxygen compatible leak detector at each joint,

Standard of Acceptance

- Swagelock Snoop
- American Gas & Chemical Co. Ltd Leak-tec

- .4 An acceptable initial test shall be completed before final acceptance pressure testing can occur.
- .8 Acceptance pressure test:
 - .1 Conduct the final standing 24 hour acceptance pressure test as follows:
 - (a) install terminal unit outlet covers, and reconnect pressure transducers and switches,
 - (b) keep flexible hoses inside of Medical Supply Units (as applicable) disconnected and keep test caps on medical vacuum and AGSS DISS terminal units,
 - (c) do not manifold piping systems together - test each system independently,
 - (d) charge each piping system with the test gas to the required test pressure, and then isolate the test gas source,
 - (e) test pressure for medical gases and medical support gases: at system design pressure.
 - (f) test pressure for medical vacuum and AGSS: at system design vacuum. Medical vacuum pumps and AGSS source equipment may be used to create the vacuum conditions, and then source equipment to be isolated during the 24 hour test period.

- .2 Acceptance criteria: no change in pressure during the test period except due to change in ambient temperature around the piping.
- .3 Submit a report to the Owner documenting the test methodology and test results.
- .9 Purging test:
 - .1 After acceptance of pressure testing, reconnect the flexible hoses inside of Medical Supply Units (if applicable) and purge the pipeline distribution system piping. Purge terminal units until test gas is clear of particulate matter and visible moisture as droplets or mist.
- .10 Particulate filter test:
 - .1 At completion of purging, test medical gases and medical support gases for particulate matter:
 - (a) fabricate the test-flow apparatus in accordance with Annex D of CSA Z7396.1, including a 0.3 µm particulate filter connected to the outlet of the apparatus,
 - (b) apply the test to at least one terminal unit for each medical pressure gas in each zone,
 - (c) adjust the test apparatus to provide a flow rate of 120 l/min (4 SCFM) for 15 seconds per test, and then remove the filter.
 - .2 Acceptance criteria: when examined under good light, the filter shall be free of visible particulate matter.
 - .3 Maintain a test record of each outlet tested (the room and a description to identify the terminal unit), the date of the test and the name of the person who performed the test.
- .11 Cross-connection tests:
 - .1 Conduct cross-connection tests in accordance with Cross-connection Test - Method 2 of CSA Z7386.1, as summarized and as otherwise specified herein.
 - (a) Test special gas mixtures individually in accordance with Cross-connection Method 1 of CSA Z7396.1, with all other piping systems depressurized.
 - .2 Disconnect flexible hoses inside of Medical Supply Units (as applicable) and install test caps on medical vacuum and AGSS DISS terminal units.
 - .3 Isolate vacuum transducers and vacuum switches from the test gas pressure.
 - .4 Use a set of pressure gauges with each gauge equipped with a DISS nut and nipple specific for each pipeline distribution system.
 - (a) Label each gauge with the applicable pipeline distribution system name and provide a colour coded tape around the body perimeter in accordance with the following table.
 - (b) Mark each gauge to indicate the expected test pressure for each specific pipeline distribution system terminal unit.
 - .5 Apply the test gas to all systems at the same time, to pressurize each system in accordance with the following table. Use the medical vacuum pumps for medical vacuum.

Piping System	Test Pressure kPa (psi)	Gauge Marking Tape Colour
Medical vacuum	-35 (10 in.Hg.)	Yellow
AGSS	0 (0)	Red or Orange
Helium	70 (10)	Brown
Carbon Dioxide	140 (20)	Grey
Nitrogen	205 (30)	Black
Nitrous Oxide	275 (40)	Blue

Oxygen	345 (50)	Green
Medical Air	415 (60)	Half Black, Half White
Instrument Air	550 (80)	4 stripes Black, 4 stripes White

- .6 Connect the applicable pressure gauges to each terminal outlet in each room based on DISS connector at each unit, Confirm that each terminal unit is correct for DISS connector, test gas pressure, terminal unit name and colour code.
 - .7 Periodically check the distribution system test pressure. If the test pressure drops by more than 14 kPa (2 psi) in any system due to loss of test gas during application of pressure gauges, re-establish required test pressure before continuing with the test.
 - .8 If the testing indicates the presence of cross-connected terminal units or piping distribution, correct the cross-connection and re-test the system. Continue re-testing until it is demonstrated there are no cross-connections.
 - .9 Maintain a record log of each room, listing each outlet and the test confirmation results and provide a copy to the inspection body, the Owner and the Consultant (see Exhibit B).
- .12 Combined test for Medical Supply Units:
- .1 After completion and acceptance of the main cross-contamination test (including correction of any cross-connection defects), reconnect the internal flexible hoses in the Medical Supply Units (as applicable) and perform a final pressure test and cross-contamination test of the Medical Supply Units.
 - .2 Charge each piping system with the test gas to the required test pressure described above under "Acceptance pressure test" and then close the zone valves serving each applicable Medical Supply Unit. Perform a six (6) hour standing pressure test and confirm there is no loss in test pressure at the end of the test, using the zone valve pressure gauge. If a pressure loss occurs, notify the General Contractor/Construction Manager of the defective Medical Supply Unit.
 - .3 After completion of the Medical Supply Unit pressure test, individually test each pipeline distribution system service to the Medical Supply Units, with only the one specific pipeline distribution system being pressurized for each test. This can be performed with the applicable zone valves in the closed position.
 - .4 Confirm that each terminal unit is correct for DISS connector, test gas pressure, terminal unit name and colour code, and record the results in the cross-connection test record.

3.10 Contractor Responsibilities During Certification Testing

- .1 Pipeline distribution system certification testing will be performed by an independent accredited medical gas testing and certification company ("inspection body") directly retained by the healthcare facility. The certification shall be in accordance with CAN/CSA Z7396.1, including Annex C for source equipment, and Annex D for pipeline distribution. As a summary, certification testing of the medical gas pipeline distribution system includes:
 - .1 Source equipment tests.
 - .2 Supply system alarm tests.
 - .3 Inspection of pipelines, valves and terminal units.
 - .4 Inspections and testing of zone alarms.
 - .5 Qualitative particulate contamination testing.
 - .6 Terminal unit gas identity/cross-contamination test.

- .7 Terminal unit performance tests including gas quality, quantitative particulate matter and flow rates.
- .2 Pipeline distribution system installation contractor shall provide qualified representative who are knowledgeable in pipeline distribution system installations in general and the Work specifically, to witness certification testing and to assist the Certification Agency in locating pipe runs, valves, alarm sensors, alarm wiring and other components of pipeline distribution systems and repair defects in equipment, workmanship or materials discovered during certification testing.
- .3 Provide a copy of the completed commissioning test reports and as-built drawings to the independent certifier prior to certification testing.
- .4 Arrange and pay for representatives of pipeline distribution system equipment vendor to provide technical support and operating instructions during the certification process.
- .5 After completion of the contractor's commissioning tests described above and while the inspection body is present, purge the medical gas pipeline system with applicable medical gases or, medical support gases sufficiently to remove the test gases. Purge airflow through each terminal unit.
- .6 Assist the inspection body in any subsequent retesting.

3.11 Authority Inspections

- .1 Arrange and pay for AHJ inspections for pressure piping and fire safety. Provide a copy of the AHJ inspection report to the Owner and Consultant; if the AHJ does not issue a report, provide a written record of the AHJ inspection recording the AHJ name, AHJ personnel, contractor personal, date of inspections, a description of what was inspected, and any comments provided by the AHJ.

3.12 Training and Instruction

- .1 Comply with the training requirements of specification section 20 01 01.
- .2 Arrange for manufacturers' representatives to provide instructions of Owners staff in use and maintenance of medical gas equipment.

3.13 Records and Reports

- .1 At completion of commissioning, provide the healthcare facility with the following documents:
 - .1 as-built drawings,
 - .2 completed CSA Z7396.1 form L.1 *Pipeline installation test report*, (sample form follows).
 - .3 copy of installing firm's certification for installation of medical gas systems under regulatory requirements for pressure piping systems,
 - .4 copies of each brazer's certificate of competency (license) who performed all or part of the work,
 - .5 copies of each tradesperson's certificate issued under the CSA *Medical Gas Piping & Systems Installation Personnel Certification Program*,
 - .6 quality assurance program for pressure piping certificate number, or contractor pressure piping licence number (as applicable to the requirements of the provincial AHJ for boilers and pressure vessels),
 - .7 in-process examination records of brazed joints,
 - .8 pressure test reports,
 - .9 particulate matter test report,
 - .10 cross-contamination test records,
 - .11 operating and maintenance manuals which
 - .12 filled out, signed and dated commissioning test plant reports,

- .13 AHJ inspections reports.
- .2 The submittal and acceptance by the Owner of the records and reports described herein is a condition precedent for obtaining substantial completion of the project.

Exhibit A – Pipeline Installation Test Report

The following is a sample report for installation contractor installation test report (CSA Z7396.1)

CSA Z7396.1:22		Medical gas pipeline systems — Part 1: Pipelines for medical gases, medical vacuum, medical support gases, and anaesthetic gas scavenging systems	
Annex L (informative) Pipeline installation test report Note: This Annex is not a mandatory part of this Standard. Figure L.1 Pipeline installation test report (See Clauses 11.4.1.4, 12.3, and 12.5.2.)			
Health care facility:		Area/floor:	
Medical gas installation report			
Task		Action required	Complete
24-hour standing pressure test as per Clause B.2.2		Provide test report	
Perform final leak test as per Clause B.2.3		Verify performed	
Purge terminal units as per Clause B.2.4		Verify performed	
Perform cross connection test as per Clause B.3		Verify performed	
Perform particulate filter test as per Clause D.4		Verify performed	
CSA medical gas piping & installation personnel certification number (Each installers individual number to be submitted) As per Clause 11.4.1.2		1. 2. 3. 4. 5.	
Brazing qualification licence number (Each installers individual licence to be submitted) As per Clause 11.4.1.3		1. 2. 3. 4. 5.	
Quality assurance program certification number as per Clause 11.4.1.6			
Installer:		Date:	
Witnessed by:			
Notes:			
Note: As per Clause 12.3, all of the above tests must be performed and a copy of this form is to be submitted to the health care facility before the inspection body commences commissioning.			
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Exhibit B – Cross-connection Test Report

The following is a sample report for cross-connection testing.

Medical Gas Cross-contamination Test Record

Project Name: _____

Date of Test: _____

Contractor Name: _____

Test performed by: _____

Wing	Floor	Room	Number of Outlets Verified (No. outlets in rooms / No. outlets correct)								Remarks
			Ox	MA	MV	NOx	N2	CO2	IA	AGSS	
			/	/	/	/	/	/	/	/	
			/	/	/	/	/	/	/	/	
			/	/	/	/	/	/	/	/	
			/	/	/	/	/	/	/	/	
List of cross-connections discovered and corrected											
(Installation contractor) Results verified by:											

END OF SECTION

EFFLUENT DECONTAMINATION SYSTEM

22 66 86

1 GENERAL

1.1 Scope

- .1 Provide packaged, skid mounted effluent decontamination system and accessories for handling of waste water from;
 - .1 contaminated laboratory waste drainage ("LDC"),

1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections;
 - .1 20 05 12 Common Electrical Requirements for Mechanical Services
 - .2 20 05 49.23 Seismic Qualification for Mechanical Equipment

1.3 Definitions

- .1 The following definitions apply to this specification section:
 - .1 **BAS** – Building Automation System, a distributed direct digital control system for supervision and control of building services.
 - .2 **HMI** – Human Machine Interface including electronic displays and/or electronic command input devices.
 - .3 **PLC** – programmable logic controller

1.4 Applicable Codes and Standards

- .1 Installation codes and standards:
 - .1 CSA B51 Boiler, pressure vessel, and pressure piping code.
 - .2 ANSI/ISA 5.1 Instrumentation Symbols and Identification
- .2 Product standards:
 - .1 ASTM B88 Standard Specification for Seamless Copper Water Tube
 - .2 ASME B16.15 Cast Bronze Threaded Fittings, Classes 125 and 250
 - .3 ASME B16.18 Cast Copper Alloy Solder Joint Pressure Fittings
 - .4 ASME B16.22 Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
 - .5 AWS A5.8 Brazing Filler Metal.
 - .6 CSA C22.2 No. 14 Industrial Control Equipment
 - .7 CSA C22.2 No. 94.1 Enclosures for Electrical Equipment, Non-Environmental Considerations
 - .8 MSS SP-110 Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends

1.5 Registration and Inspection

- .1 Before commencing work, make arrangements and pay for registration and inspection by the AHJ responsible for boiler and pressure vessel safety for the following pressure piping systems:

- .1 thermal reduction pressure vessel equipment and associated pressure piping, fittings and accessories which penetrate the pressure boundary.

1.6 Design Criteria

- .1 Piping design and installation code:
 - .1 To CSA B51 and ASME B31.3 for Normal Fluid service.
- .2 System design criteria:
 - .1 Design Temperature: ●°C(●°F)
 - .2 Design Pressure: ● kPa (● psi)
 - .3 Operating Pressure: ● kPa (● psi)
- .3 Inlet effluent conditions;
 - .1 Flow rate: refer to equipment schedule at the end of this section.
 - .2 Maximum temperature: 5°C (41°F)
 - .3 Contaminant type: ●
- .4 Outlet effluent condition;
 - .1 Maximum temperature: 60°C (140°F).
- .5 Ambient temperature; 35°C maximum.

1.7 Seismic Qualification

- .1 Seismically qualify (certify) the following equipment specified herein:
 - .1 packaged equipment with structural support frame, piping and related piping components (Level III),
 - .2 storage tank(s), process tank(s), and inter-tank transfer pump(s) (Level III),
 - .3 motor controllers (Level III),
 - .4 main system control panel and instrumentation (Level III).
- .2 The seismic qualification of the above-listed equipment is to conform to Specification section 20 05 49.23 for the following seismic qualification level and certification method:
 - .1 Functional seismic qualification (Level III) for atmospheric liquid fuel storage tanks: by static analysis with sloshing effect or by dynamic analysis,
 - .2 Functional seismic qualification (Level III) for electrical control equipment: by shake table testing,
 - .3 Functional seismic qualification (Level III) for non-vibration isolated equipment: by static analysis, dynamic analysis or shake table testing,
- .3 The following equipment specific seismic force parameters are to be used:

C_p	A_r	R_p	h_x/h_n
1.00	1.00	1.25	1.0

1.8 Submittals

- .1 Submit manufacturer catalogue cut-sheets for the materials specified herein.
- .2 Submit project specific shop drawings to include;

- .1 general arrangement drawings, including overall equipment dimensions,
- .2 piping and wiring interconnection details where packaged equipment utilizes multiple support frames for shipping purposes,
- .3 piping flow diagrams including identification of all process piping,
- .4 process and instrumentation drawing (P&ID), prepared in conformance with ISA 5.1,
- .5 electrical panel interior wiring schematics (motor power and control power),
- .6 electrical field wiring interconnection and termination drawings,
- .3 ☐[Submit certification test certificate for seismic qualification in accordance with Specification section 20 05 49.]

1.9 Quality Control

- .1 Manufacturer Factory Acceptance Testing ("FAT");
 - .1 FAT to be performed in the presence of contractor's representative(s) for each tested equipment or system.
 - .2 FAT are in addition to manufacturer's standard production tests.
 - .3 Deficiencies discovered during FAT will be corrected prior to shipping of product.
 - .4 Before shipping of equipment from the factory to the place of the Work, perform factory testing in accordance with the manufacturer quality control program and as follows;
 - (a) electrical circuit test including motor operation,
 - (b) fail-safe operation and safe shut-down of equipment with no power to PLC,
 - (c) automatic restart of equipment after a power failure.
 - .5 Include a signed and dated factory performance test with the shipped equipment and submit a copy of the test directly to the Owner at time of shipping.
- .2 ☐[Site Acceptance Testing
 - .1 Manufacturer to provide services of manufacturer's authorized service personnel to in accordance with the requirements of Part 3 of this specification.]

2 PRODUCTS

2.1 Packaged Effluent Decontamination System

- .1 General;
 - .1 Factory assembled and tested packaged effluent decontamination system including;
 - (a) structural support frame,
 - (b) storage tank(s), process tank(s), and inter-tank transfer pump(s),
 - (c) [steam injection heater][water heater and circulating pump],
 - (d) ☐[UV reactors,]
 - (e) Interconnection piping, fittings and valves,
 - (f) service piping connection with service isolation valves,
 - (g) motor controller,
 - (h) main system control panel and instrumentation,
 - (i) accessories.

Standard of Acceptance

- Newterra
 - BioSafe Engineering
- .2 Pressure vessels, pipe fittings and flanges, safety devices, and piping accessories that have a design pressure or maximum allowable working pressure greater than 103 kPa (15 psi) are to have Canadian Registration Numbers ("CRN") in accordance with CSA B51.
- (a) where equipment or piping in a packaged system are subject to requiring a CRN, either the assembled unit or the individual components shall have the CRNs.
- .3 Arrange equipment to allow maintenance access, including replacement of components or equipment, without requiring removal of any other equipment.
- .4 [[Design equipment, piping and supporting frame to withstand the design seismic forces in accordance with Specification section 20 05 49. Design equipment support frame to allow attachment of seismic restraint hold-down bolts.]
- .5 Refer to the equipment performance schedule(s) at the end of this Specification section.

2.2 Support Frame

- .1 Arrangement;
- .1 A single common frame system, or multi-frame systems to suit shipping and handling requirements depending on size of the packaged system.
 - .2 Maximum outside dimensions for each frame system assembly: ● mm wide x ● mm long x ● high.
- .2 Structural frame:
- .1 full continuously welded connections, square shape, carbon steel tubing to ASTM A500, with forklift pockets and mounting tabs to secure frames to the floor, and carbon steel checker-plate deck,
 - .2 designed to support all equipment loads under operating and seismic conditions plus an additional live load of 3 kN (675 lbf),
- .3 Finish:
- .1 bottom of skid: primer coated with epoxy finish coat,
 - .2 all other surfaces: prime coated with epoxy, urethane or powder coated finish coat;
- .4 Interconnecting piping and wiring:
- .1 where packaged equipment uses multiple separate structural frames, design any interconnecting piping and wiring to allow simple field connections,
 - .2 include any required spool piping or wiring harnesses for field connection.

2.3 Inlet Storage Tank

- .1 Tank:
- .1 open-vented atmospheric tank (non-pressurized tank),
 - .2 UV resistant high density polyethylene (HDPE), with;
 - (a) bulkhead fittings for waste inlet, vent, drain and outlet connections,
 - (b) pressure-rated threaded fittings for instrumentation, recirculation line, sample line and chemical injection line,

- (c) removable gasketed tank-lid with NPS 3 vent connection,
- (d) sloped bottom for complete positive drainage.

.2 Accessories:

- .1 High level alarm switch (for each tank),
- .2 Low level alarm switch (for each tank),
- .3 tank level transmitter (for each tank),
- .4 valved manual drain.

2.4 Pipe/Tube, Fittings, Valves and Accessories

.1 Tube:

- .1 copper to ASTM B88, type K hard drawn.

.2 Fittings:

- .1 cast bronze fittings to ASME B16.18, or wrought copper and bronze fittings to ASME B16.22,
- .2 threaded fittings including unions to ASME B16.15, Class 250.

.3 Joints:

- .1 silver brazing alloy to AWS A5.8 classification BCUP-5.

.4 Valves:

- .1 NPS 2 and under:
 - (a) to MSS SP-110, 600 CWP/150 SWP, three-piece bronze or DZR brass body, full port, stainless steel ball, PTFE seat and seals, threaded ends.
 - (b) minimum pressure rating: 2300 kPa (335 psig) at 121°C (250°F).
- .2 NPS 2-1/2 to 4:
 - (a) to MSS SP-110, 1500 CWP/150 SWP, three-piece type, ASTM A351 CF8M stainless steel body, full port, stainless steel ball, PTFE gaskets and seat, threaded ends.
 - (b) minimum pressure rating: 2300 kPa (335 psig) at 121°C (250°F).

.5 Accessories:

- .1 valved sample ports provided with caps for storage tank, process tank and after UV reactors.

2.5 Main System Control Panel

.1 General;

- .1 PLC based control system with integral motor controllers (starters) in a common control panel, factory mounted on the package skid and factory wired to motors, instrumentation, and control valves,
- .2 Listed to CSA C22.2 No. 14,
- .3 Designed for single point power supply for controls, pumps, and water heater;
 - (a) power supply: [208][600]/60/3 V/Hz/Ph
 - (b) minimum circuit ampacity: refer to equipment schedule at end of this section.
 - (c) maximum available fault current: [10] kA RMS
- .4 Factory tested prior to shipping.

.2 Enclosure:

- .1 to CSA C22.2 No. 94.1 Type 2, 3, 3R or 4 with tool-lockable front panel door and cooling fans,
- .2 fused main panel disconnect switch,
- .3 120 VAC/24 VDC power supplies for PLC and HMI, with fused secondary,
- .4 output relays for remote monitoring, form C, rated 2 A @ 120 VAC,
- .5 branch circuit protection with circuit breakers for powered devices and control system power,
- .6 surge and lightning protection equipment,
- .7 numbered terminals for connection of external power and control wiring,
- .8 enclosure door mounted devices:
 - (a) HMI display,
 - (b) main system power On/Off control switch,
 - (c) motor HOA switches,
 - (d) emergency Stop button (push and maintained stop position),
 - (e) motor run indicating light – green (each motor),
 - (f) summary alarm indicating light – red.
- .3 Motor starters:
 - .1 soft-start or full voltage non-reversing motor starter with electronic motor overload protection,
 - .2 unfused disconnect switch with door interlock,
 - .3 branch circuit protection with circuit breakers,
 - .4 120 VAC control transformer with line and load circuit protection,
 - .5 “Hand-Off-Auto” selector control switch, and green indicating light for motor run indication.
- .4 Programmable Logic Controller (PLC):
 - .1 compact, modular, programmable logic controller with sufficient memory to perform all performance requirements and to maintain trend log history,
 - .2 local, direct coupled or expanded I/O modules,
 - .3 built-in removable terminal blocks with finger safe cover over connections,
 - .4 input filtering and output surge suppression,
 - .5 digital (discrete) and analog inputs and outputs of a number to suit functional requirements and remote control and monitoring functions,
 - .6 control system capability: discrete control, Boolean logic control, and proportional/ integral/ derivative (PID) mode control.
 - .7 factory programmed for operating control and graphic display, including operating status and alarms of dryers using data transfer via Ethernet TCP/IP.
 - .8 trending information available from Ethernet port or downloadable to a flash drive.
- .5 Building Automation System interface:
 - .1 interface type: [hardwired][network communications by MODBUS RTU].
 - .2 inputs (control):
 - (a) System enable/disable.
 - .3 outputs (monitoring):
 - (a) storage tank level,

- (b) process tank temperature,
 - (c) process tank low temperature alarm (not at temperature at end of heating time),
 - (d) process tank high temperature alarm,
 - (e) process tank level alarms (Low, High)
 - (f) chemical container low level alarm,
 - (g) pump status (On/Off, and Alarm)
 - (h) heater status (On/Off, and Alarm)
 - (i) discharge control valve failed open (= valve open when discharge pumps are OFF)
 - (j) cold water cooling valve failed open (= valve open after expected time duration),
- .6 Operator interface:
- .1 HMI display: nominal 175 mm (7 in) touchscreen, TFT colour display, with graphical and numeric display:
 - (a) P&ID display with active status and measured valued conditions,
 - (b) motor run time display,
 - (c) chemical container level indication.
 - (d) audible alarm with silence switch.
- .7 Instrumentation:
- .1 effluent storage tank:
 - (a) level transmitter,
 - (b) high and low level switches,
 - .2 process tank:
 - (a) liquid temperature transmitter,
 - (b) high and low level switches,
 - .3 pump run status,
 - .4 valve position switches (open, closed),
 - .5 electric heater operating status,
 - .6 chemical container: discrete input only for owner supplied chemical container low level switch.
- .8 Sequence of Operation:
- .1 Programmed control sequence to include the following automated functions:
 - (a) chemical injection to storage tank;
 - (b) transfer pump operation to fill process tank;
 - (c) control of water heater to maintain the required time-at-temperature process;
 - (d) addition of cooling water prior to discharge;
 - (e) discharge pumps operation to drain the process tank;
 - (f) activation of UV units.

2.6 Control and Power Wiring

- .1 Conform to the requirements of Specification section 20 05 12.

3 EXECUTION

3.1 Installation

- .1 Install effluent decontamination skid in accordance with the manufacturer installation instructions.
- .2 Complete installation startup checks in accordance with the manufacturer's written instructions.

3.2 Electrical Supply and Wiring

- .1 [Power supply will be provided under Electrical Division 26 at the required voltage and will be terminated in the main control panel.][Provide power feeders from the designated power distribution panel to the main control panel.]

3.3 Building Automation System Integration

- .1 Coordinate with the contractor under Division 25 for [termination of hardwired interface connections] [configuration of Modbus RTU-to-BACNet MSTP communications].

3.4 Manufacturer Services

- .1 Provide the services of the system manufacturer factory-trained service representative or their authorized agent to provide on-site assistance for inspection, start-up, commissioning and testing of the equipment, and for training operators personnel in the use of the system.
- .2 Provide a written commissioning procedure that includes pre-start verification checklists, and functional performance validation of the equipment that includes at a minimum;
 - .1 chemical dosing rates,
 - .2 time-at-temperature tests in the thermal process tank,
 - .3 heater water temperatures,
 - .4 process control logic checks.
- .3 Provide an installation and start-up report on completion of commissioning of the equipment.

3.5 Training and Instruction

- .1 Comply with the training requirements of specification section 20 01 01.
- .2 Arrange for manufacturers' representatives to provide instructions of Owners staff in use and maintenance of the equipment. Include instructions for conducting sample testing, including frequency of tests during the first two months of in-service operation to verify performance of the system.

3.6 Equipment Performance Tables

- .1 The following table(s) identify the performance requirement for the compressor-based medical air systems.

Table 1 – Equipment Schedule			
Equipment Tag	ME-●		
Parameter		Rating	Units
Inlet Storage Tank	Capacity	●	Litres

	Diameter	●	mm
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End of Section

COMMON WORK RESULTS FOR HVAC PIPING

23 05 01

1 GENERAL

1.1 Scope

- .1 Provide heating and cooling piping systems in accordance with the referenced piping materials, standards, specifications and piping codes described herein.

This specification applies to;

- .1 water based piping systems, including glycol/water mixtures, for building hydronic heating and cooling systems.

1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
 - .1 20 05 24 Welding and Brazing.

1.3 Applicable Codes and Standards

- .1 Legislation:
 - .1 Ontario Regulation 220/01 Boiler and Pressure Piping Regulation
- .2 Installation standards and codes (as adopted and amended by the AHJ for pressure vessels):
 - .1 CSA B51 Boiler, pressure vessels, and pressure piping code
 - .2 ASME B31.1 Power Piping
 - .3 ASME B31.3 Process Piping
 - .4 ASME B31.9 Building Services Piping

1.4 Qualified Tradesmen

- .1 Work to be performed by qualified, licensed and recognized firm with an established reputation in this field, using tradesmen holding applicable certificates of competency as applicable to the work.

1.5 Registration and Inspection

Before commencing work, make arrangements and pay for registration and inspection by the AHJ responsible for boiler and pressure vessel safety for the following pressure piping systems:

- .1 Service water piping for heating a building, at design temperatures greater than 121°C (250°F) or at design pressures greater than 1100 kPa (160 psig),
- .2 HVAC water systems (other than building heating water systems), including chilled water and condenser water systems, at design temperatures greater than 65°C (150°F) or design pressures greater than 1717 kPa (250psig).
- .2 At the start of the Work, obtain existing pressure piping system registration numbers, if available, from the Owner and/or the AHJ.

1.6 Design Criteria - Hot Water Heating Systems

Piping design and installation code:

- .1 To ASME B31.9 for piping system not subject to boiler and pressure vessel regulations.
- .2 To ASME B31.1 for piping systems which are subject to boiler and pressure vessel regulations.

Issued For Tender

- .2 System includes but is not limited to;
 - .1 Boilers,
 - .2 Heat exchangers,
 - .3 Pumps,
 - .4 Expansion tanks,
 - .5 Convector, s,
 - .6 Radiators,
 - .7 Radiant panels,
 - .8 Finned radiation,
 - .9 Unit heaters,
 - .10 Heating coils,
 - .11 Controls,
 - .12 Water treatment.
- .3 System design criteria:
 - .1 Design temperatures and pressures:

System Type	Supply Temp. °C (°F)	Return Temp. °C (°F)	Design Temp. °C (°F)	Maximum Operating Pressure kPa (psig)	Design Pressure kPa (psig)
Constant temperature heating	82 (180)	71 (160)	96 (205)	900 (125)	1030 (150)
Radiant ceiling panels	82 (180)	71 (160)	96 (205)	900 (125)	1030 (150)
Finned Radiation with enclosure	82 (180)	71 (160)	96 (205)	900 (125)	1030 (150)
Terminal Reheat System	82 (180)	71 (160)	93 (200)	900 (125)	1030 (150)

2 PRODUCTS

- .1 Not used.

3 EXECUTION

3.1 Pipe Installation General Requirements

- .1 General layout of mains, risers, run-outs and connection details of piping systems are shown.
- .2 Install concealed pipes close to building structure to keep furring spaces to minimum and minimize obstruction to other services in ceiling spaces.
- .3 Run exposed piping parallel to walls and conserve headroom and space. Group piping wherever practical.

- .4 Ream pipe after cutting to length and clean off scale and dirt inside and outside of pipe before threading, grooving or welding.
- .5 Provide clearance for installation of insulation and access for maintenance of equipment, valves and special fittings such as expansion joints.
- .6 Cap ends during construction to prevent entry of foreign matter.
- .7 Provide bends, expansion loops, hoses or joints to compensate for pipe expansion and contraction.
- .8 Anchor, guide and laterally support vertical and horizontal piping to support filled weight and absorb thrust under operating conditions.
- .9 Erect piping so that expansion forces, gravity forces and thrust from changes in direction do not stress connections to apparatus.
- .10 Refer to piping system specifications for additional requirements.
- .11 All HVAC equipment, valves, and any other items requiring periodic maintenance must be installed in locations that are accessible for maintenance;
 - .1 where these items are installed inline with piping in an inaccessible location (high level above obstructions, etc.) offset and/or jog piping as required to install in an accessible location,
 - .2 provide access doors in accordance with Section 20 05 01 *Basic Materials and Methods*, and
 - .3 provide valve kit enclosure box in accordance with Section 23 21 16 *Hydronic Piping Specialties*.

3.2 Drainage Piping, Drain Valves and Air Vents

- .1 Provide drain valves at low points in water piping systems and in valved run-outs from risers so that system or isolated parts of system can be drained. Locate piping system drain valves as close to the system pipe as possible.
- .2 Provide an additional drain valve at the drain termination point where;
 - .1 the drain valve is not accessible from a floor with or without the use of a 2.4 m (8 ft) high ladder, or from an elevated work platform,
 - .2 upstream of each isolation valve,
 - .3 and as otherwise specified herein.
- .3 Provide drain valves on equipment drains, including but not limited to refrigeration equipment, boilers, heat exchangers and water treatment and filtration equipment.
- .4 For copper tube drains, connect copper drain tubing to the outlet side of equipment drain valves or piping system drain valves; do not make connections of copper drain tubes directly to carbon or stainless steel HVAC liquid piping.
- .5 Drain sizes:
 - .1 NPS 2 for large water-filled equipment including refrigeration equipment, boilers, and heat exchangers.
 - .2 NPS ¾ for other equipment drains, including integral or field installed condensate and drip pans.
 - .3 NPS 2 for piping system drains, unless otherwise shown.
- .6 Run other equipment drains to nearest floor drain unless otherwise shown to terminate in a specific location. Where NPS ¾ drains terminate at a floor drain, provide a funnel of at least 200 mm x 100 mm (8 in x 4 in) on the floor drain cover.
- .7 Install piping system drains as follows;
 - .1 In mechanical service rooms and permanently accessible service spaces, extend drains down along a wall or column and terminate approximately 1000 mm (40 in) above the floor level in the service room, or above the lowest accessible level in a vertical service space.

- .2 In other service rooms including non-accessible service spaces, electrical rooms, telecom rooms or data rooms, extend drains to a location outside of these service room to a location agreed with by the Engineer unless otherwise shown and provide a drain valve at the termination point.
- .3 Where piping system drains are located in finished areas above accessible ceilings that are not more than 3 m (10 ft) high, terminate the drains approximately 200 mm (8 in) above the top of the ceiling and provide a drain valve at this termination point.
- .4 Where piping system drains are located above non-accessible ceilings, or where an accessible ceiling is more than 3 m (10 ft) high, extend the drain tubing to a location agreed with by the Engineer unless otherwise shown and provide a drain valve at this termination point.
- .8 Terminate drain ends with a 45° elbow and a brass body, male-end, cam-and-groove (Camlock) coupling fitting with dust cap. Supply the matching hose-end female connector and turn over to the owner.
- .9 Provide air vents with isolation ball valves at high points to allow effective drainage of the system and to facilitate removal of air from the system.

3.3 Pressure and Leak Testing - Liquid Service Piping

- .1 This test procedure applies to piping normally containing water, including HVAC and process water and glycol/water mixes, and steam-condensate piping.
- .2 Pressure test liquid piping systems unless otherwise specified in other sections of Division 23.
- .3 Initial pneumatic leak test:
 - .1 Conduct an initial pneumatic leak test to locate and repair major leaks.
 - (a) test pressure for ASME B31.1 systems: 175 kPa (25 psig),
 - (b) test pressure for ASME B31.9 systems: 70 kPa (10 psig).
 - .2 Remove compressed air source and maintain this pressure for the time necessary to inspect for leaks, but not less than 2 hours.
 - .3 Maintain pressure and examine each joint with commercial leak detector solution.

Standard of Acceptance

- Snoop
 - Leak-tec
- .4 Repair leaks where found prior to performing hydrostatic pressure tests.
- .5 During pneumatic pressure tests, comply with the site safety requirements for notification and guarding during testing with compressed gasses.
- .4 Final hydrostatic pressure test:
 - .1 Use the system design pressure for the entire installation, unless different design pressures are indicated for each floor.
 - .2 Pressure test condensate piping to the same test conditions as the steam system to which they are connected.
 - .3 Fill the system with water and gradually increase the system pressure to 150% of the design pressure and hold for 10 minutes, then reduce pressure to the design pressure.
 - .4 Inspect each pipe joint for leaks.
 - .5 As an alternative to inspection of each joint for leaks, conduct a 24 hour standing pressure test:
 - (a) raise the water pressure to 150% of the design pressure for 10 minutes, then reduce pressure to design pressure,

- (b) record the test pressure one (1) hour after establishing the system hydrostatic test pressure at the design pressure. Record ambient air temperature at the same time.
- (c) at the end of the 24 hour standing test period, record the test pressure and ambient air temperature. Make adjustments to the measured end-of-test pressure to account for change in fluid density due to change in ambient air temperature,
- (d) acceptance criteria: maximum pressure loss over 24 hours not to exceed 1% of test pressure, corrected for ambient temperature,
- (e) where acceptance criteria is not met, inspect pipe joints for leaks.

.6 Where leaks are found, repair leaks and retest piping as specified above.

3.4 Pressure Test Report

- .1 Maintain a log of all pressure tests, including locating of where leaks have been repaired. Submit the log to the Consultant for review when requesting prior to substantial completion of the Work. Where a piping system is subject to AHJ inspection, provide evidence of such inspection by means of an AHJ inspection report or name of the AHJ inspector and the date they witnessed the pressure test.

3.5 Piping Material Selection Schedule

- .1 Provide piping material in accordance with schedule Table 1 at the end of this specification section.

Table 1: Piping and Valve Material and Specification by System Type				
Piping System	Abbrev	Pipe Material	Pipe Specification	Valve Specification
Hydronic heating and cooling - closed loop (with or without glycol)	HTS/R HS/R LTS/R GHS/R CHS/R GCS/R RV	Carbon Steel	23 21 13.23	23 05 23.13
		Copper	23 21 13.33	23 05 23.13
		Stainless Steel Tube	23 26 16	
Equipment and piping system drainage for HVAC liquid systems	DR	Galvanized Steel	23 21 13.23	23 05 23.13
		Copper	23 21 13.33	23 05 23.13

END OF SECTION

GENERAL-DUTY VALVES FOR HVAC WATER PIPING

23 05 23.13

1 GENERAL

Scope

- .1 Provide valves for general duty service in HVAC water piping systems, including shut-off valves, check valves, and manual balancing valves, for piping systems with a design pressure of 3500 kPa (507 psig) or less and a design temperature of 121°C (250°F) or less.
- .2 This specification applies to hydronic heating and cooling water systems (with or without glycol additives) and other piping systems required to be carbon steel pipe, galvanized steel pipe, and/or copper tubing as specified in section 23 05 01, except as otherwise required for specific duty valve in other specification sections.

1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section integrates with or refers to the following specification sections:
 - .1 20 05 23 General Requirements for Valves
 - .2 23 05 01 Heating and Cooling Piping Systems

1.3 Submittals

- .1 Conform to the requirements of Specification section 20 05 23 except/and as follows.
- .2 For double regulating valves, in addition to manufacturer data sheets, submit a schedule listing all double regulating valves and include the following information:
 - .1 a valve reference number,
 - .2 valve service (e.g. associated equipment, or distribution piping service by drawing, room, etc.)
 - .3 associated pipeline size, NPS
 - .4 valve body size, NPS
 - .5 specified design flow rate,
 - .6 valve minimum and maximum flow rate limits,
 - .7 valve pressure drop at specified design flow rate,
 - .8 expected valve open position (number of valve turns open, percent valve stroke, etc.)

1.4 Applicable Codes and Standards

- .1 Refer to section 20 05 23 and as specified herein.
- .2 Where an HVAC liquid piping system is subject to registration as a pressure piping system as identified in specification section 23 05 01, all valves shall have Canadian Registration Numbers in accordance with CSA B51. In the following valve specifications, where the identified model does not have a current CRN, provide a valve of equal or greater performance which has a current CRN from the same manufacturer.
- .3 For the purpose of this article, "current CRN" means a registration which does not expire for at least 12 months from the date of submittal of shop drawings.

2 PRODUCTS

2.1 Ball Valves – bronze/brass body

.1 NPS 2 and under:

- .1 To MSS SP-110, 600 CWP/150 SWP, two-piece bronze or DZR brass body, full port, solid stainless steel or chrome plated bronze ball, PTFE seat and seals.
- .2 Handle extensions suitable to clear 50 mm (2 in) pipe insulation thickness.
- .3 Required MCPR: 2300 kPa (335 psig) at 121°C (250°F).
- .4 Solder ends:

Standard of Acceptance

- Kitz - fig. 59, 69AM-LL
- Apollo - fig. 77-200
- Nibco - fig. S-585-70
- Anvil - fig. 171S

.5 NPT threaded ends.

Standard of Acceptance

- Kitz - fig. 58, 68AM-LL
- Apollo - fig. 77-100
- Nibco - fig. T-585-70
- Anvil - fig. 171N

2.2 Ball Valves – carbon steel body

.1 NPS 2 and under:

- .1 To MSS SP-110, 1500 CWP/150 SWP, carbon steel body, regular port, stainless steel or chrome plated carbon steel ball, PTFE seat and seals.
- .2 Handle extensions suitable to clear 50 mm (2 in) pipe insulation thickness.
- .3 ISO 5211 mounting pad.
- .4 Required MCPR: 3500 kPa (507 psig) at 121°C (250°F).
- .5 Two-piece body style, NPT threaded ends:

Standard of Acceptance

- Apollo - fig. 89-100
- MAS - fig. CSCR-2
- Velan - fig. S-M1102-SSGA

.6 Three-piece body style, NPT threaded ends:

Standard of Acceptance

- Apollo - fig. 83A-140
- Nibco - fig. TM-590-CS-R-66-FS-LL
- MAS - fig. CSS-F-3N
- Velan - fig. S-K1802-SSGA

.7 Three-piece body style, socket weld ends:

Standard of Acceptance

- Apollo - fig. 83A-240
- Nibco - fig. KM-590-CS-R-66-FS-LL
- MAS - fig. CSS-F-3N-SW
- Velan - fig. W-K1802-SSGA

.2 NPS ½ to NPS 4:

- .1 To MSS SP-72, ASME Class rated, carbon steel two-piece split body, full port, stainless steel or chrome plated carbon steel ball, PTFE seat and seals, ASME Class 150 flanged ends.
- .2 Handle extensions suitable to clear 50 mm (2 in) pipe insulation thickness.
- .3 ISO 5211 mounting pad.
- .4 Class 150:
 - (a) Required MCPR: 1600 kPa (230 psig) at 121°C (250°F).

Standard of Acceptance

- Kitz - fig. 150SCTDZM-N
- Apollo - fig. 88A-200
- Nibco - fig. F-515-CS-F-66-FS
- Velan - fig. SB-150

.5 Class 300:

- (a) Required MCPR: 3500 kPa (507 psig) at 121°C (250°F).

Standard of Acceptance

- Kitz - fig. 300SCTDZM-N
- Apollo - fig. 88A-900
- Nibco - fig. F-535-CS-F-66-FS
- Velan - fig. SB-300

2.3 Globe Valves

.1 NPS 2 and under:

- .1 To MSS SP-80, Class 150, bronze body, renewable PTFE composition disc, union bonnet, and lockshield handles where shown.
 - (a) Required MCPR: 1600 kPa (230 psig) at 121°C (250°F).
 - (b) Solder ends.

Standard of Acceptance

- Kitz - fig. 10
- Crane - fig. 1310 (class 300)
- Jenkins - fig. 106BPJ (class 300)
- Nibco - fig. S-235-Y

- (c) NPT threaded ends.

Standard of Acceptance

- Kitz - fig. 09
- Crane - fig. 7TF

- Jenkins - fig. 106BJ
- Nibco - fig. T-235-Y

- .2 To MSS SP-80, Class 300, bronze body, hardened stainless steel plug, renewable seat and union bonnet, with NPT threaded ends.

(a) Required MCPR: 3500 kPa (507 psig) at 121°C (250°F).

Standard of Acceptance

- Kitz - fig. 17S
- Crane - fig. 382P
- Jenkins - fig. 592J
- Nibco - fig. T-276-AP

- .3 To ASME B16.34, Class 800, forged steel body, bolted bonnet, hard faced disc and seat ring, with NPT threaded ends.

(a) Required MCPR: 12 MPa (1740 psig) at 121°C (250°F).

Standard of Acceptance

- Crane - fig. B3644XU-T
- Powell - fig. LG08TA58GB
- Beric - fig. 502-T-X-8-A-08

- .2 NPS 2½ and over, flanged:

- .1 To MSS SP-85, Class 125, cast iron body, bronze trim, OS & Y bolted bonnet, bronze disc and seat ring, flat faced flanges,

(a) Required MCPR:

- i) NPS 2-12: 1200 kPa (174 psig) at 121°C (250°F).
- ii) NPS 14-24: 860 kPa (125 psi) at 121°C (250°F).

Standard of Acceptance

- Kitz - fig. 76
- Crane - fig. 351
- Jenkins - fig. 2342J
- Nibco - fig. F-718-B

- .2 To ASME B16.34, Class 300, ASTM A216 Gr WCB cast steel body, 13% chrome stellite trim, OS & Y, bolted bonnet, and raised face flanges.

(a) Required MCPR: 3500 kPa (507 psig) at 121°C (250°F).

Standard of Acceptance

- Kitz - fig. 300SCJS
- Crane - fig. 151XU
- Jenkins - fig. J1042B2
- Powell - fig. 3031-FC8G
- Beric - fig. 203-RF-EA08-H

2.4 Gate Valves

- .1 NPS 2 and under:

- .1 To MSS SP-80, Class 150 with bronze body, OS&Y rising stem, bronze wedge disc and union or screw-in bonnet, and NPT threaded ends.

(a) Required MCPR: 1600 kPa (230 psig) at 121°C (250°F).

Standard of Acceptance

- Kitz - fig. 42
- Crane - fig. 431UB
- Nibco - fig. T-131

.2 To MSS SP-80, Class 300, bronze body, OS&Y rising stem, copper nickel alloy or stainless steel trim, solid wedge disc, union bonnet, and NPT threaded ends.

(a) Required MCPR: 3500 kPa (507 psig) at 121°C (250°F).

Standard of Acceptance

- Kitz - fig. 37
- Crane - fig. 622E
- Jenkins - fig. 2280UJ
- Nibco - fig. T-174-A

.3 To ASME B16.34, Class 800, forged steel body, standard port, OS&Y rising stem, solid wedge disc, bolted bonnet, and NPT threaded ends.

(a) Required MCPR: 12 MPa (1740 psig) at 121°C (250°F).

Standard of Acceptance

- Bonney Forge - fig. HL-11-T
- Crane - fig. B-3604XU-T
- Powell - fig. GA08TA58GB
- Beric - fig. 501-T-X-8-A-02

.2 NPS 2½ and over, flanged:

.1 To MSS SP-70, Class 125, cast iron body, OS&Y rising stem, flat faced flanges, bronze trim, and bolted bonnet, and flat-faced flanges.

(a) Required MCPR:

- i) NPS 2-12: 1200 kPa (174 psig) at 121°C (250°F).
- ii) NPS 14-24: 860 kPa (125 psi) at 121°C (250°F).

Standard of Acceptance

- Kitz - fig. 72
- Crane - fig. 465½
- Jenkins - fig. 454J
- Nibco - fig. F-617-O

.2 To ASME B16.34, Class 300, ASTM A216 Gr WCB cast steel body, OS&Y rising stem, flexible disc, 13% chrome stellite trim, bolted bonnet, and raised face flanges.

(a) Required MCPR: 3500 kPa (507 psig) at 121°C (250°F).

Standard of Acceptance

- Kitz - fig. 300SCLS
- Crane - fig. 33XU-F
- Jenkins - fig. J1010B8F
- Powell - fig. 3003-FC8G
- Beric - fig. 103-RF-AA08-H

2.5 Butterfly Valves – Low Pressure (type “LP”)**.1 NPS 2½ to NPS 24, for flange installation:**

- .1 To MSS SP-67, ductile or cast iron flange-less lug body style, flange holes drilled and tapped for ANSI 150 flange pattern.
- .2 Stainless steel shaft, bronze or ductile iron disc with nickel chrome seating edge and replaceable EPDM resilient seat to provide bubble tight shut-off under system pressure from either side with flange removed from un-pressurized side.
- .3 ISO 5211 mounting pad.
- .4 Locking handles up to NPS 4, and gear operators for NPS 6 and over.
- .5 Required MCPR:
 - (a) NPS 2 to 12: 1380 kPa (200 psig) at 107°C (225°F).
 - (b) NPS 14 to 24: 1030 kPa (150 psig) at 107°C (225°F).

Standard of Acceptance

- Nibco - fig. LD-2000
- Crane - fig. Center Line RS-200
- Kitz - fig. 6100 series
- DeZurik - fig. BOS-US
- Bray - fig. 31H
- Watts - fig. BF-03-M2
- MAS - fig. D series

.2 NPS 2½ to 12, for grooved end pipe:

- .1 To CSA B242, malleable or ductile iron body with corrosion inhibitor finish, with grooved ends.
- .2 Stainless steel shaft, aluminum-bronze or nickel plated ductile iron or EPDM encapsulated ductile iron disc, and replaceable EPDM resilient seat for bi-directional flow and bubble tight shut-off under system pressure.
- .3 ISO mounting pad.
- .4 Locking handles up to NPS 4, and gear operators for NPS 6 and over.
- .5 Required MCPR: 1380 kPa (300 psig) at 107°C (225°F).

Standard of Acceptance

- Victaulic - fig. 761 Vic-300
- Gruvlok - fig. 7700 series

2.6 Inline Silent Check Valves**.1 NPS 2 and under, bronze, threaded:**

- .1 To MSS SP-80, Class 125, bronze body, spring-controlled inline style (non flapper), body guided disc, resilient EPDM or PTFE seat or disc; bronze, Inconel or stainless steel spring; with NPT threaded ends.
- .2 Required MCPR: 1200 kPa (174 psig) at 121°C (250°F).

Standard of Acceptance

- Kitz - fig. 36
- Nibco - fig. T-480-Y
- Apollo - fig. CVBB 61-500

- Valmatic - fig. 1400THR

.2 NPS 2 ½ to NPS 12, wafer style:

- .1 To MSS SP-125, Class 125 or 150, cast or ductile iron body, stainless steel trim and spring-controlled inline globe-style (non flapper), body guided disc, resilient BUNA-N seat, wafer body style for installation between flat-faced flanges.
- .2 Valve design provides both a metal-to-metal and metal-to-resilient seat for zero leakage sealing.
- .3 Required MCPR: 1200 kPa (174 psig) at 65°C (150°F).

Standard of Acceptance

- Dezurik - fig. APCO 300 Series
- Valmatic - fig. 1400A series
- Mueller - fig. 101MAT
- Nibco - fig. W-910

.3 NPS 2 ½ to NPS 24, flanged ends:

- .1 To MSS SP-125, Class 125 or 150, cast or ductile iron body, stainless steel trim and spring-controlled inline globe-style (non flapper), body guided disc, resilient BUNA-N seat, with Class 125/150 flanges.
- .2 Valve design provides both a metal-to-metal and metal-to-resilient seat for zero leakage sealing.
- .3 Required MCPR:
 - i) NPS 2-12: 1200 kPa (174 psig) at 65°C (150°F).
 - ii) NPS 14-24: 860 kPa (125 psi) at 65°C (150°F).

Standard of Acceptance

- Dezurik - fig. APCO 600 Series
- Valmatic - fig. 1800 series
- Mueller - fig. 107MAT
- Nibco - fig. F-960

.4 NPS 2 ½ to NPS 24, carbon steel, flanged:

- .1 To MSS SP-126, Class 150 and 300, ASTM A216 WCB carbon steel body, stainless steel trim and spring-controlled inline globe-style (non flapper), body guided disc, stainless steel seat, with Class 150 / 300 flanges.
- .2 Valve design provides both a metal-to-metal and metal-to-resilient seat for zero leakage sealing.
- .3 Required MCPR: 3500 kPa (507 psig) at 121°C (250°F).

Standard of Acceptance

- Dezurik - fig. APCO 600 Series
- Durabla - fig. GLC
- Mueller - fig. 109MDT

2.7 Swing Check Valves

.1 NPS 2 and under:

- .1 To MSS SP-80, Class 125, bronze body, bronze swing disc, screw in cap, regrindable seat.
 - (a) Required MCPR: 1200 kPa (174 psig) at 121°C (250°F).
 - (b) Soldered ends

Standard of Acceptance

- Kitz - fig. 23
- Crane - fig. 1342
- Jenkins - fig. 4093J
- Nibco - fig. S-413-B

(c) NPT threaded ends:

Standard of Acceptance

- Kitz - fig. 22
- Crane - fig. 37
- Jenkins - fig. 4037J
- Nibco - fig. T-413-B

- .2 To MSS SP-80, Class 300, bronze body, bronze swing disc, screw in cap, regrindable seat, with NPT threaded ends.

(a) Required MCPR: 3500 kPa (507 psig) at 121°C (250°F).

Standard of Acceptance

- Kitz - fig. 19
- Crane - fig. 76E
- Jenkins - fig. 4962J
- Nibco - fig. T-473-B

- .2 NPS 2½ to NPS 10, cast iron, flanged

- .1 To MSS SP-71, Class 125, cast iron body, flat faced flange, renewable bronze seat ring, bronze disc, bolted cap, with ASME Class 125 flanged ends.

(a) Required MCPR: 1200 kPa (174 psig) at 121°C (250°F).

Standard of Acceptance

- Kitz - fig. 78
- Crane - fig. 373
- Jenkins - fig. 587J
- Nibco - fig. F-918-B

- .3 NPS 2 to NPS 30, carbon steel, flanged:

- .1 To ASME B16.34, Class 300, ASTM A216 Gr WCB cast steel body, renewable stainless steel seat ring, stainless steel or 13% Cr overlay disc, bolted cap.

(a) Required MCPR: 3500 kPa (507 psig) at 121°C (250°F).

Standard of Acceptance

- Kitz - fig. 300SCOS
- Crane - fig. 159XU
- Beric - fig. 303-RF-EA08

2.8 Double Regulating Valves ("DRV")

- .1 NPS 3 and under:

- .1 Bronze or DZR brass body, plug type stem with flow measurement ports and tamper-proof setting.

- .2 NPT threaded or soldered ends.
- .3 Required MCPR: 1500 kPa (215 psig) at 121°C (250°F) water temperature.

Standard of Acceptance

- S.A. Armstrong - fig. CBV
- Victaulic - fig. 787
- Bell and Gossett - fig. Circuit Setter Plus
- Preso - fig. B-Plus
- Nexus - fig. UltraMB(NL)
- Red White - fig. 9517

.2 NPS 2½ to NPS 12:

- .1 Cast or ductile iron body, copper alloy trim, with flow measurement ports, tamper-proof setting, with groove or Class 250/300 flanges.
- .2 Required MCPR: 1720 kPa (250 psig) at 110°C (230°F)

Standard of Acceptance

- S.A. Armstrong - fig. CBV II
- Victaulic - fig. 788/789
- Preso - fig. B-PLUS
- Nexus - fig. UltraMB
- Red White - fig. 9519

.3 Flow meter for DRVs

- .1 Differential pressure gauge with calibrated charters or direct digital flow meter type.
- .2 Hose and fittings to suit manual double regulating valves.
- .3 In addition to equipment and materials used during start-up and testing, supply one complete set of clean un-used calibrated flow charts or one (1) digital flow meter, to the owner at the completion of the project.

2.9 Plug Valves with Flow Balancing Ports

.1 NPS 6 to 24, flanged:

- .1 To MSS SP-78, cast or ductile iron body, lubricated bronze or nickel plated cast iron plug, lubrication assembly, short pattern, with Class 125 flat-face flange ends.
- .2 Two pressure test ports with pet cocks for differential pressure measurement, and calibrated flow charts.
- .3 Worm gear operator with memory stop.
- .4 Class 125:
 - (a) Required MCPR:
 - i) NPS 2-12: 1200 kPa (174 psi) at 121°C (250°F)
 - ii) NPS 14-24: 1000 kPa (145 psi) at 121°C (250°F)

Standard of Acceptance

- Hattersley - fig. 611
- DeZurik - fig. Hilton Balancing Valve

.5 Class 250:

(a) Required MCPR:

- i) NPS 2-12: 2700 kPa (390 psi) at 121°C (250°F)
- ii) NPS 14-24: 1700 kPa (245 psi) at 121°C (250°F)

Standard of Acceptance

- ° Hattersley - fig. 602
- ° DeZurik - fig. Hilton Balancing Valve

3 EXECUTION**3.1 General**

- .1 Refer to section 20 05 23 and as required herein.

3.2 Valve Selection Based on Pressure Rating

- .1 Unless otherwise specified herein or shown, select valves that have a Minimum Component Pressure Rating (MCPR) which exceed the applicable piping system Design Pressure and Design Temperature specified in section 23 05 01.
- .2 Where drawings indicate either: (a) a pressure rating; or (b) a pressure rating and Class rating, by floor level then select valves as follows:
 - .1 For all valves, select a valve with a MCPR rating equal to or greater than the pressure rating indicated on the drawings for each floor level.
 - .2 For clarity, even if a valve has an ASME Class rating, do not select a valve based on its Class to match any Class rating shown on the drawings.

3.3 Check Valves

- .1 Provide an inline silent check valve on the pump discharge under any of the following conditions:
 - .1 at locations as shown on drawings.
- .2 Provide an inline silent check valve where a check-valve is shown on drawings other than at a pump discharge.
- .3 Provide swing check or silent check valves at other locations.

3.4 Double Regulating Valves Installation

- .1 Consult with double regulating valve manufacturer to ensure correct valve selection. Balancing valves to be sized according to design flow rate.
- .2 Size and select valves for flows as shown, based on at 6 kPa (2 ft) pressure drop across the valve in the fully open position, and in accordance with manufactures recommendation. Table 1 identifies the nominal valve size selection:

Table 1: Double Regulating Valve Nominal Sizing				
Valve Size NPS	Nominal Flow			
	Min.	Max.	Min.	Max.
	L/s	L/s	gpm	gpm
½	0.038	0.177	0.6	2.8
¾	0.126	0.379	2.0	6.0
1	0.246	0.631	3.9	10.0

Table 1: Double Regulating Valve Nominal Sizing				
Valve Size NPS	Nominal Flow			
	Min.	Max.	Min.	Max.
	L/s	L/s	gpm	gpm
1-¼	0.316	0.947	5.0	15.0
1-½	0.416	1.262	6.6	20.0
2	0.795	2.272	12.6	36.0
2-½	2.398	6.310	38.0	100.0
3	1.956	8.203	31.0	130.0
4	4.291	12.620	68.0	200.0
5	5.679	20.192	90.0	320.0
6	11.48	28.395	182.0	450.0
8	23.16	51.742	367.0	820.0
10	34.07	82.030	540.0	1300.0
12	60.58	94.650	960.0	1500.0

- .3 Install double regulating valves with five pipe diameters of straight pipe on inlet side, two pipe diameters on outlet side and 10 pipe diameters from any pump.
- .4 Install double regulating valves with ports facing horizontal or facing up. Do not install with ports facing down to prevent debris from falling and accumulating inside the ports.
- .5 Where double regulating valves are installed, provide an isolation valve either upstream (supply piping) or downstream (return piping). Double regulating valves shall never be used in lieu of isolation valves.

End of Section

TESTING ADJUSTING AND BALANCING FOR HVAC 23 05 93.13

GENERAL

1.1 Scope

- .1 Test, adjust, and balance ("TAB") air handling systems and hydronic systems installed, modified or extended as part of this work, including:
 - .1 air handling systems, including air handling units and ventilation fans,
 - .2 hydronic systems:
 - (a) heating and cooling equipment and piping systems,
 - (b) liquid piping systems.
- .2 Test existing HVAC systems to record existing operating conditions, at the start of the Work but before any demolition or new construction work is performed.
- .3 Refer to Specification section 22 05 93 for TAB for plumbing systems.

1.2 Related Sections

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

22 05 93	Testing Adjusting and Balancing for Plumbing
.2	23 05 93.16 Testing, Adjusting and Balancing for Smoke Management Systems
.3	23 05 93.23 Testing, Adjusting and Balancing Supplement for Healthcare
.4	23 05 93.26 Testing, Adjusting and Balancing Supplement for Laboratories
.5	23 33 05 Duct Accessories

1.3 Definitions and Abbreviations

- .1 The following definitions apply to this section.
 - .1 **Induction units** – means a room air distribution device which uses primary supply air at high pressure to entrain room air into the primary airflow to create a room mixed supply airflow and may or may not include a cooling or heating coil.
 - .2 **Process cooling (loads)** – means cooling equipment dedicated to a specific process equipment cooling load, and such cooling is not intended for human comfort.
 - .3 **Terminal inlet** – means a room or space return air or exhaust air grille, or other exhaust air inlet connection.
 - .4 **Terminal outlet** - means a room or space supply air grille or diffuser,
 - .5 **Terminal unit** – means a manufactured automatic airflow control-damper unit intended to control airflow to a space or a zone, with or without a reheat coil.
 - (a) **Constant Air Volume terminal unit (CAV)** – means a terminal unit where the airflow control damper is automatically controlled to maintain a constant supply airflow, and space temperature control is by other means.
 - (b) **Exhaust Air Volume terminal unit (EAV)** – means a terminal unit used to control return or exhaust air flow from a room or space, where the automatic control damper is operated to regulate space pressure.

- (c) **Variable Air Volume terminal unit (VAV)** – means a terminal unit where the airflow control damper is automatically controlled to vary supply airflow to maintain space temperature.
- (d) **Limited VAV terminal unit (VAVLM)** – a terminal unit that operates as a VAV at maximum cooling or heating demand under temperature control, and as a CAV at other times to maintain a minimum airflow rate to the room or space. For clarity, the CAV function occurs during normal occupancy times.

.6 **Zone** – means rooms or spaces, or portion thereof, that defines the supply air and return/exhaust air flow being evaluated.

.2 The following abbreviations apply to this section:

- .1 **CAABC** Canadian Associated Air Balance Council
- .2 **NEBB** National Environmental Balancing Bureau

1.4 Applicable Codes and Standards

.1 Installation codes and standards:

- .1 ANSI/ASHRAE 41.2 Standard Methods for Air Velocity and Airflow Measurement
- .2 ANSI/ASHRAE 111 Measurement, Testing, Adjusting, and Balancing of Building HVAC Systems
- .3 SMACNA HVAC Systems Testing, Adjusting, & Balancing
- .4 AABC National Standards for Total System Balance
- .5 NEBB Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems

1.5 Qualified Tradesperson

- .1 Work to be performed by qualified, licensed and recognized firm with an established reputation in this field, using tradesperson holding applicable certificates of competency.
- .2 Balancing to be performed under supervision of recognized expert with an established reputation in this field.
- .3 TAB contractor to be a member of CAABC or NEBB.

Standard of Acceptance

- Air & Water and Precision Balancing – Matthew Crittenden matt@awpbgroup.com – 647-896-5353

1.6 Quality Control

- .1 Perform testing and balancing in accordance with procedures as published by ASHRAE, SMACNA, AABC or NEBB except/and as specified herein.

1.7 Accuracy

- .1 Adjust systems until operating values are within the acceptance criteria stated for each system type. Where an acceptance criterion is not stated, balance the system so that measured values are within $\pm 5\%$ of design value.
- .2 Measurement device accuracy:

Measurement	Application	Device	Accuracy
Air Flow	Plenums	Revolving Vane Anemometer, direct reading digital type	$\pm 5.0\%$ of reading over 1 m/s
Air Flow	Ducts	Pitot-tube duct traverse with electronic gauge	$\pm 10.0\%$ of reading over 5 m/s
Air Flow	Grilles and Diffusers	Revolving Vane Anemometer, direct reading digital type	$\pm 5.0\%$ of reading
Air Flow	Room air currents, Hoods (0.05 to 3.0 m/s)	Thermal Anemometer	$\pm 10.0\%$ of reading
Liquid Flow	Piping	Installed meter	As per meter rating
Liquid Flow	Equipment	Differential Pressure and equipment data	See below
Temperature	Air, Liquids	Digital Electronic Thermometer	$\pm 0.2^{\circ}\text{C}$ over 0 to $+40^{\circ}\text{C}$
Temperature	Air, Liquid	Digital Electronic Thermometer	$\pm 0.4^{\circ}\text{C}$ $< 0^{\circ}\text{C}$ and $> +40^{\circ}\text{C}$
Relative Humidity	Air	Digital Electronic Humidity Sensor	$\pm 1.5\%\text{RH}$ over 0 to 90%RH range
Pressure	Air	Magnahelic	$\pm 2.0\%$ of reading
Pressure	Liquid, Gas, Steam	Bourbon type	$\pm 1.0\%$ of reading
RPM	Motor, fans	Chronometer tachometer	$\pm 1.0\%$ of reading
Voltage	All	Portable	$\pm 2.5\%$ of reading
Current	All	Portable clamp-on ammeter	$\pm 2.5\%$ of reading

Audit Verification

- .1 After review of the draft TAB report by Consultant, the Consultant may at their sole discretion require re-measurement of TAB results on an audit sample rate of 30 percent of all measured equipment, at no cost extra to the Contract Price or change to project schedule.
- .2 If audited results indicate a variance of more than 10% between the original reported value and the audit measured value for a piece of equipment, re-balance the audited device. If this excessive variance condition occurs at more than 25% of the number of audited equipment samples, re-balance the entire affected system at no cost extra to the Contract Price or change to project schedule.

1.9 Preparatory Work

- .1 Develop a TAB work plan to communicate TAB requirements to other trades:
 - .1 Review design drawings and specifications, shop drawings, interference drawings and other related documentation to become familiar with their intended performance.
 - .2 Prior to commencement of piping and ductwork installation, mark-up Consultant's Contract Drawings or contractor's fabrication drawings to identify locations where balancing damper and valve devices, temperature wells, pipe pressure gauges and pressure test plugs are to be installed.

Provide a copy to the trade contractor responsible for installation of balancing devices. Make a copy available for review when requested by Consultant.

- .2 Carry out site visits during later stages of construction to ensure that arrangements for TAB are incorporated. Confirm proper placement of thermometer wells, test ports, pressure gauge cocks, balancing valves, balancing dampers and splitter dampers, and access doors.
- .3 TAB measurements to commence when building is “closed in” and work is sufficiently advanced including;
 - .1 installation of ceilings, doors and windows is completed,
 - .2 application of sealing, caulking, and weather stripping is completed,
 - .3 allowing normal operation of mechanical systems.

1.10 Pre-Construction Air and Water Measurement Audit

- .1 Conduct an HVAC air and water audit of existing HVAC systems prior to commencement of demolition or new construction work.
- .2 Measure existing air conditions for the systems affected by the Work:
 - .1 measure airflow, pressure, and temperature at main supply and return ducts on each floor where Work is to be performed,
 - .2 for fans, measure airflow, motor amps, motor HP rating, motor volts, inlet and discharge static pressure, sheave position,
 - .3 for air handling unit systems including air conditioning units, measure total airflow, outdoor airflow, return airflow; outdoor, return air and supply air temperatures.
- .3 Measure existing service water conditions for the systems affected by the Work:
 - .1 measure water flow at on each floor where Work is to be performed,
 - .2 for each source equipment including chillers and boilers, measure inlet and outlet water pressure, inlet and outlet water temperature, water flow rates,
 - .3 for each pump, measure water flow rate, inlet and outlet static pressures, motor amps, motor rated HP, motor voltage.
- .4 Submit a report to Consultant to record all as-found measured values.

1.11 Measurement Parameters

- .1 Reporting units of measure:

Parameter	Unit	Abbreviation
Mass	kilogram	kg
Length	metre	m
Volume	litre	L
Volume flow rate	Litres per second	L/s
Time	seconds	s
Temperature	Celsius	°C
Pressure	pascal	Pa (air)
	kilopascal	kPa

Parameter	Unit	Abbreviation
		(liquid, vapour, compressed gas)
Pump Head	metre	m
Pump Pressure	kilopascals	kPa
Fan pressure	pascal	Pa
Mass flow rate	kg per second	kg/s
Heat flow rate	kilowatts	kW
Cooling flow rate	Kilowatts cooling	kWc
Electrical Power	kilowatts	kW
Voltage	Volts	V
Electrical Current	amps	A
Rotation speed	Rotations per minute	RPM
Vibration	Cycles per second	CPS or Hz

1.12 Submittals

- .1 Submit TAB reports in accordance with Part 7 of this section.

2 PRODUCTS

2.1 Ductwork Probe Test Plugs

- .1 Conform to Specification section 23 33 05.

3 EXECUTION - AIR MOVING SYSTEMS

3.1 Measurement Parameters

- .1 The following measurement parameters identify the minimum requirements for inclusion in the TAB process:
 - .1 Air flow parameters;
 - (a) air velocity,
 - (b) flow cross sectional area,
 - (c) static pressure,
 - (d) velocity pressure.
 - .2 Temperature parameters;
 - (a) wet bulb,
 - (b) dry bulb.
 - .3 Pressure parameters;
 - (a) gauge pressure,
 - .4 Equipment parameters;
 - (a) rotational speed (rpm),
 - (b) electrical power, kW

- (c) voltage, V
- (d) current, A,
- .2 Measurement are required at and around equipment to establish air side performance of;
 - .1 fans,
 - .2 coils,
 - .3 filters,
 - .4 dampers - outdoor, return, recirculating, and relief,
 - .5 humidifiers.
 - .6 terminal units.
- .3 Measurement are required to characterize system performance;
 - .1 at main ducts,
 - .2 at submain ducts,
 - .3 at branch ducts.
 - .4 at each supply air outlet diffuser or grille, and exhaust and return air inlet grille,
 - .5 in each thermostatically controlled zone.

3.2 General Requirements

- .1 Balance systems so that fans operate at lowest possible speed and static pressure consistent with delivery of specified air quantity at most remote terminal point.
- .2 Measure air quantities at each exhaust system inlet and supply system outlet.
- .3 Balance supply fans and associated return fans with their respective outdoor air dampers and exhaust air dampers at their minimum airflow position.
- .4 Be responsible for supply and installation of ductwork test plugs.

3.3 Setting Grill and Diffuser Airflow Patterns

- .1 Adjust the throw and pattern at each supply outlet as shown on drawings. Where a specific pattern is not shown, set the supply outlet grills and diffusers in accordance with the following;
 - .1 for rectangular and circular cone diffusers, set for a uniform 360° dispersion,
 - .2 for rectangular perforated-plate diffusers, set the flow pattern plates for four-direction horizontal dispersion,
 - .3 for rectangular wall-mount grilles with horizontal front blades, set the blades at an approximate 15° upward facing angle,
 - .4 for linear diffusers at exterior windows or walls, set the flow pattern blades for a downward flow towards the floor and parallel to the windows or wall,
 - .5 for linear diffusers in interior spaces within 300 mm (12 in.) of a wall, set the flow pattern blades for horizontal dispersion away from the wall,
 - .6 for linear diffusers in interior spaces other than close to a wall, set the flow pattern blades for bi-directional horizontal dispersion,
 - .7 for light-troffer diffusers, set the flow pattern blades for horizontal dispersion away from the light fixture.

3.4 Use of Terminal Unit Flow Stations for Balancing Purposes

- .1 Where terminal units are equipped with integral air flow stations, do not use these air velocity stations as a proxy for manual duct traverse measurements of the zone airflow.
 - .1 for each terminal unit model size, randomly select the greater of 10% of all terminal units or 10 units, with representative units that are closest to the fan, farthest from the fan, and uniformly distributed at intermediate locations,
 - .2 measure airflow through the selected terminal units in accordance with the following procedure:
 - (a) set the terminal unit control damper at a damper open position between 60 and 70% open,
 - (b) adjust the duct balancing damper located ahead of the terminal unit under test so that the airflow rate is within $\pm 10\%$ of the design airflow is achieved when measured by a duct traverse reading downstream of the terminal unit or by measurement of terminal outlets,
 - (c) record the duct/room measured value and the concurrent terminal unit flow station airflow measured value,
 - (d) **individual unit acceptance criteria:** the measured variance of the terminal unit air flow station measurement compared to the duct traverse reading is within $\pm 8\%$ of the duct traverse reading,

$$\text{Individual variance acceptance criteria} = \frac{Q_{\text{traverse}} - Q_{\text{terminal unit}}}{Q_{\text{traverse}}} \leq 8.0\%$$

- (e) if the individual acceptance criteria is not met, reject the selected terminal unit and select two adjacent terminal units and qualify those units,
 - (f) repeat for all sampled terminal units.
- .3 **overall field-qualification acceptance criteria:** the measured airflow variance summated in quadrature ("SiQ") as a percentage of aggregate terminal unit duct traverse measurements does not exceed 2.5%.

$$\text{Summation in Quadrature} = \sqrt{\sum_{i=1}^n (Duct_i - TB_i)^2}$$

and

$$\text{Aggregate Acceptance Criteria} = \frac{SiQ}{\sum_{i=1}^n Duct\ traverse_i} \leq 2.5\%$$

- (a) do not include disqualified terminal units that do not meet the individual variance acceptance criteria.
- .4 if the aggregate variance criteria is not met, then field qualification of terminal unit flow measurement devices is not acceptable,
- .5 if the aggregate variance criteria is met, calculate a correction factor for each terminal unit model size as follows:
 - (a) calculate a correction factor for each individual terminal unit based on duct traverse reading and terminal box flow rate reading, expressed as a multiplier to the terminal unit airflow station measured value,
 - (b) calculate the average of the individual correction factors to determine the average correction factor for each terminal unit size,
 - (c) do not include terminal units which do not meet the individual variance acceptance criteria.

$$\text{Correction Factor} = \frac{(\sum_1^n \frac{Q_{Duct_i}}{Q_{Terminal Unit_i}})}{n}$$

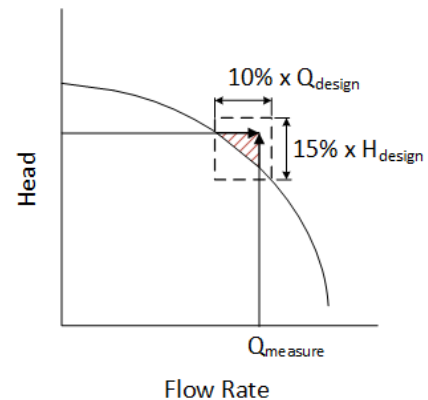
- (d) coordinate with the Division 25 controls vendor to include these correction factors in the terminal box DDC controllers to report the corrected airflow values.

3.5 Transient Operating Conditions Preparation

- .1 Set-up supply fans with sufficient speed to deliver design air flow when filters are loaded to manufacturers recommended maximum pressure drop (dirty filter condition) and condensing coil air-pressure drop is at its wet coil condition;
- .2 Temporarily block portions of filter banks to achieve maximum pressure drop at design air flow, to simulate dirty filters.
 - .1 only apply blanking material to the highest MERV rated filter in the air handling unit. If there is more than one filter bank, test the remaining filter banks in their clean condition.
- .3 Temporarily block portions of cooling coils to achieve rated wet coil pressure drop at design air flow, to simulate summer condensing operation.
- .4 Uniformly distribute blocking media across filter face and coil face to minimize disruption to overall airflow pattern through the filter and coil bank.
- .5 Remove blanking material at completion of system TAB.

3.6 Fan Performance Assessment

- .1 Obtain the measured duct leakage for each system prior to balancing the duct systems and record in the TAB report. An additional 5% of terminal outlet design airflow rates may be included for balancing effects on the fan delivered airflow rate.
- .2 Measure air quantity by taking anemometer traverses across a coil or at a filter bank, or by pitot tube traverse in a straight section of duct at fan suction or discharge.
- .3 Measure static pressure difference between fan inlet and discharge, motor amperage and fan rotation speed. Determine motor input power from a curve showing power output as a function of motor amperage for the particular motor.
- .4 Plot results of measurements on fan characteristic curve supplied by fan manufacturer; the measured air volume, static pressure and fan speed lines should form a triangle enclosed by a rectangle having a dimension of not more than 15% of the design static pressure by a dimension of not more than 10% of the design airflow rate. Input power taken from the fan characteristic should be within 10% of the power determined from the motor amperage readings.
- .5 If required precision is not obtained, repeat measurements. If subsequent testing shows that the required precision is unobtainable, then fan manufacturer is to submit written report explaining actual fan performance and provide new characteristic curve showing actual performance for fan "as installed".
- .6 Measure static pressure loss across cooling coils, heating coils and individual filter banks and tabulate readings with manufacturers published pressure loss figures for the actual measured air volume.



3.7 Branch Air Quantity Measurement Procedure

- .1 Determine branch air quantities using pitot tube traverses in accordance with the procedures defined in ASHRAE 111 and ANSI/ASHRAE 41.2.

- .2 Take measurements at each riser as it is connected to fan discharge or suction header and at each floor where branches are taken from the riser. Repeat measurement until sum of branch air quantities is within 10% of fan delivery.

Constant Volume System Balancing Procedure

- .1 Application:
 - .1 single zone systems with constant airflow,
 - .2 constant volume systems using CAV terminal units,
 - .3 constant volume systems with terminal reheat coils,
 - .4 exhaust systems, constant airflow,
- .2 Where a system has CAV units, or a system has a mixture of no units and CAV units, set the CAV units for 100% design airflow at all times.
- .3 Where a system has EAV units, set EAV units to 100% design airflow prior to balancing the supply air system.
- .4 First step - balance the branch ducts:
 - .1 open all supply air terminal outlets and return/exhaust air terminal inlets to 100% full open,
 - .2 starting with the submain duct closest to the fan or the submain duct that has the highest percentage airflow, measure and balance airflow on each branch duct off that submain duct,
 - .3 repeat on other submain ducts in descending order of percent of total airflow, until all branch ducts are balanced,
 - .4 verify supply and return fans are delivering 100% design airflow.
 - .5 acceptance criteria:
 - (a) branch airflow measurement: $\pm 5\%$ of design flow.
 - (b) fan airflow measurement: $\pm 5\%$ of design flow.
- .5 Second step - balance airflows at zones:
 - .1 starting at the most remote zone, balance terminal outlets and inlets using duct balancing dampers ahead of the outlet or inlet device. Only use any integral balancing device in the terminal outlet or inlet to adjust the final airflow rate by not more than 10% of design flow,
 - .2 for supply grilles and diffusers, adjust airflow pattern controllers to prevent airflow impinging on adjacent walls.
- .6 Acceptance criteria:
 - .1 total of terminal outlets/inlets airflow measurement in each zone: $\pm 10\%$ of design flow.

VAV System Balancing Procedure

- .1 Applicable systems:
 - .1 variable volume supply air systems using VAV terminal units, with minimum flowrate setpoint set equal to zero airflow.
- .2 Obtain from Consultant the expected diversity value or determine the percent diversity by dividing the fan design air flow rate by the sum of all supply outlets or return/exhaust inlet flow rates as applicable.
- .3 First step: balance the branch ducts:
 - .1 set all interior terminal units to 100% design flow rate (full cooling), and proportionally adjust all perimeter terminal units so that the design fan air flow rate is achieved at the supply and return fans,

- .2 starting with the submain duct closest to the fan or the submain duct that has the highest percentage airflow, measure and balance airflow on each branch duct off that submain duct/
- .3 repeat on other submain ducts in descending order of percent of total airflow, until all branch ducts are balanced.
- .4 verify supply and return fans are delivering 100% design airflow.
- .5 acceptance criteria:
 - (a) branch airflow measurement: $\pm 5\%$ of design flow.
 - (b) fan airflow measurement: $\pm 5\%$ of design flow.
- .4 Second step: balance airflows at terminal units:
 - .1 open sufficient VAV terminal units having the highest airflow demand to 100% maximum design flow rates, and close a random selection of other terminal units, equally distributed throughout the system, to obtain the design fan flow rates.
 - .2 set system to operate with 100% return air, set room thermostats at design indoor temperature, set fan discharge temperature at design point.
 - .3 set thermostat in the most remote zone (the "first zone") to full cooling, open the duct balancing damper serving the terminal unit to full open, and adjust the fan static pressure controller until required airflow is delivered by the terminal unit;
 - (a) reset the first zone room thermostat to full heating and check performance of terminal unit controller,
 - (b) after completion of balancing, reset zone thermostat to design temperature and balance next terminal unit.
 - .4 on the next terminal unit, set thermostat to full cooling, adjust the duct balancing damper serving the terminal unit to obtain the design airflow rate for that unit such that the terminal unit control damper is not less than 60% open at design airflow rate;
 - (a) do not use the terminal unit controller to consume excess air pressure.
 - (b) if zone air quantity is less than design, increase fan static pressure controller setting to achieve design air quantity and rebalance previously checked zones.
 - (c) reset thermostat to design temperature and repeat procedure for remaining terminal boxes,
 - .5 if the required airflow adjustment to any terminal unit airflow rate is $\pm 5\%$ or less to meet the acceptance criteria for terminal units, then no adjustment is required to nearby terminal units, If the adjustment is greater than 5%, check nearby terminal units and adjust as require to obtain airflow rate at the acceptance criteria.
- .5 Acceptance criteria:
 - .1 VAV terminal unit airflow measurement: $\pm 10\%$ of design flow.

VAVLM Balancing Procedure

- .1 Applicable systems:
 - .1 partial variable volume supply air systems using VAVLM terminal units, where the terminal unit's minimum airflow rate setpoint is between zero and the design maximum flow rate setpoint, but is not zero.
- .2 Where a system has EAV units, set EAV units to 100% design airflow prior to balancing the supply air system.
- .3 Same procedure as for all VAV system specified previously except as follows:

- .1 where a VAVLM has minimum airflow setpoint = maximum airflow setpoint, set these units to 100% design airflow at all times,
- .2 balance the constant volume VAVLM units first, then balance the modulating VAVLM units per the procedure described above.
- .4 After balancing the zone supply terminal units at maximum cooling, adjust the space temperature setpoint to full heating, and verify that modulating VAVLM reduces the airflow to its design minimum airflow setpoint.
- .5 Acceptance criteria for VAVLM terminal unit airflow rates:
 - .1 healthcare facilities: $\pm 5\%$ of design flow.
 - .2 laboratory facilities: $\pm 5\%$ of design flow.
 - .3 art galleries: $\pm 5\%$ of design flow.
 - .4 other facilities: $\pm 10\%$ of design flow.

3.11 Terminal Unit Balancing Procedure

- .1 For spaces or zones with ducted return, close the doors to the space and then first balance return/exhaust terminal inlets to design flow rates.
- .2 Balance terminal outlets and inlets downstream of terminal units after the associated terminal units and supply, return and exhaust fans have been balanced.
- .3 Set system to operate with 100% return air, set zone thermostats at indoor design temperature and set fan discharge temperature at design value. Where a ducted return system is used, open any doors to adjacent spaces in the room under test.
- .4 Set thermostat in each zone being balanced to full cooling. Verify terminal unit airflow is supplying 100% design airflow.
- .5 Adjust each terminal outlet grille or diffuser to design airflow rates.
- .6 Repeat for all other terminal unit zones.
- .7 After all terminal unit zones are balanced, check fan performance and adjust fan static pressure controller as required to operate the fans at the minimum static pressure required to achieve terminal unit design airflow rates.

3.12 VFD Setpoint and Fan-Motor Sheave Change

- .1 For fans with VFD motor controllers, at completion of system balancing, if the maximum VFD control point is more than 15% below the motor rated operating speed (< 50 Hz on a 60 Hz rated motor frequency), replace the drive sheaves and pulleys so that the motor is operating within 10% of motor rated speed at full load operating conditions.

4 EXECUTION - HYDRONIC SYSTEMS

4.1 Measurement Parameters

- .1 The following measurement parameters identify the minimum requirements for inclusion in the TAB process:
 - .1 volume flow rate,
 - .2 temperature,
 - .3 pressure (gauge),
 - .4 equipment related;
 - (a) rotational speed (rpm),

- (b) electrical power, kW
 - (c) voltage, V
 - (d) current, A,
- .2 Measurement are required at and around equipment to establish fluid side performance of;
- .1 heat exchangers (primary and secondary sides),
 - .2 coils,
 - .3 refrigeration equipment (water side),
 - .4 boilers,
 - .5 pumps,
 - .6 PRVs,
 - .7 makeup (water) systems,
 - .8 domestic hot water heaters,
 - .9 humidifiers.
- .3 Measurement are required to characterize system performance;
- .1 at floor branch connections (where measurement devices are installed),

4.2 General Requirements

- .1 Use calibrated venturi tubes, orifices or other metered fittings and pressure gauges in conjunction with permanent and portable type flow meters to determine flow rates for system balance.
- .2 Effect system balancing with automatic control valves open to heat transfer elements and bypasses closed.
- .3 Check and clean strainers prior to balancing.
- .4 Check expansion tanks are not waterlogged, and record expansion tank pressure before and after system pumps are turned On, and again when the system is at design operating temperatures.
- .5 Base flow balance on (in order of preference):
 - .1 double regulating valves, or globe valves associated with flow measuring elements (flow meters),
 - .2 temporary non-invasive flow meters,
 - .3 differential pressure measurement across heat transfer elements, with flowrate determined from manufacturer's literature, or
 - .4 temperature difference across various heat transfer elements in the system where flow metering devices are not installed. This method may only be used at design heat transfer conditions and at least one flow rate is known.
- .6 Adjust systems to provide specified pressure drops and flows through heat transfer elements prior to thermal testing.
- .7 Perform balancing by measurement of temperature differential in conjunction with air balancing.
- .8 Adjust water distribution systems by means of double regulating valves, globe valves, balancing cocks, valves and fittings. Do not use shut-off valves for balancing unless indexed.
 - .1 Butterfly valves on discharge side of pumps may be used if they are one trade size smaller than system pipe size. Include Cv values and flow vs valve position curve with balancing report.

4.3 Variable Flow Rate Balancing Procedure

- .1 Obtain from Consultant the expected diversity value or determine the percent diversity by dividing the pump design flow rate by the sum of all connected loads.
- .2 Where available pump capacity is less than total flow requirements of individual system parts, full flow in any part may be simulated by temporary restriction of flow to other parts.
- .3 First step - Balance pipe riser floor branches:
 - .1 applies where floor-branch riser connections are provided with measurable pipe balancing devices,
 - .2 open all load control valves to 100% open,
 - .3 run all system pumps and balance the most remote floor-branch balancing device; floor-branch balancing devices on other floors may be partially closed. Adjust pump static pressure controller to supply the minimum required pressure to obtain required flow rate at the floor.
 - .4 repeat with other floors progressing towards the floor closest to the pump.
 - .5 acceptance criteria: $\pm 5\%$ of total design flow rate of the branch.
- .4 Second step – Balance loads:
 - .1 balance the most remote load from the branch balancing valve, with other loads on the same branch throttled at the estimated system diversity.
 - .2 repeat with other load valves on the same branch moving towards the floor balancing device.
 - .3 Acceptance criteria: $\pm 10\%$ of design flow rate at each load.

4.4 Pressure-Independent Control Valves Balancing Procedure

- .1 Where all load connections on a system are equipped with a pressure-independent balancing valve, the preceding balancing procedure may be modified as follows:
 - .1 open all control valves to 100% open and adjust pump speed or balancing valve to limit pump discharge to not exceed the maximum design flow rate,
 - .2 starting at the closest valve to the pump, set the pressure-independent control valve to the required flow rate,
 - .3 proceed with succeeding valves, moving towards away from the pump(s) towards the most remote control valve,
 - .4 if necessary, manually reduce flow rates through some control valves to obtain sufficient flow for the most hydraulically remote pressure-independent valves,
 - .5 after the pressure-independent control valves are set, reduce pump speed or adjust pump discharge balancing valve to provide the lowest differential pressure to achieve required total design flow rate.

5 EXECUTION - EQUIPMENT TESTING

5.1 Performance Data

- .1 Submit the following data as a minimum. If contractor's standard forms provide for additional data, also submit such additional data.
- .2 Some equipment tests may need to be performed during the alternate season testing.
- .3 Include nameplate data and as-tested results.
- .4 Water chillers:
 - .1 manufacturer and model,

- .2 refrigerant type and weight,
- .3 cooling rating (refrigeration tons),
- .4 condenser:
 - (a) entering and leaving water temperature,
 - (b) entering and leaving water pressure,
 - (c) flow rate (minimum, maximum),
 - (d) pressure rating (MAWP),
- .5 evaporator:
 - (a) entering and leaving water temperature,
 - (b) entering and leaving water pressure,
 - (c) flow rate (minimum, maximum),
 - (d) pressure rating (MAWP),
- .6 motor real power (kW),
- .7 motor apparent power (kVA) or power factor (PF).
- .5 Hydronic Heating Equipment (Boilers, Heaters, etc.):
 - .1 manufacturer and model,
 - .2 heat output rating (kW),
 - .3 electric power input rating (kW),
 - .4 gas and fuel oil input flow rating,
 - .5 gas and fuel oil input pressure rating (minimum, maximum),
 - .6 gas pressure regulator inlet and outlet pressure,
 - .7 heat performance:
 - (a) entering and leaving water temperature,
 - (b) entering and leaving water pressure,
 - (c) liquid flow rate (minimum, maximum),
 - (d) steam flow rate and pressure,
 - (e) pressure rating (MAWP),
 - .8 pressure relief valve rating (pressure setpoint, heat rating, steam rating).
 - .9 combustion efficiency test at maximum rated capacity; including flue gas analysis corrected to 3% O₂, for fuel input ratings exceeding 2930 kW (10 MMBtu/h),
 - .10 thermal efficiency test at maximum rated capacity, based on ASME PTC 4 for steam boilers with fuel input ratings exceeding 2930 kW (10 MMBtu/h),
- .6 Condenser water cooling towers:
 - .1 manufacturer and type,
 - .2 inlet and outlet air temperature, dry and wet bulb,
 - .3 inlet and outlet water temperature,
 - .4 motor, pump and fan information.
- .7 Motors:
 - .1 manufacturer,

- .2 model or serial number,
- .3 amperage and voltage,
- .4 power rating,
- .5 service factor,
- .6 RPM,
- .7 corrected full load amperage,
- .8 measured amperage and voltage,
- .9 calculated BHP (kW).
- .8 Fans:
 - .1 manufacturer,
 - .2 model or serial number,
 - .3 flow rate,
 - .4 static pressures (suction and discharge),
 - .5 RPM,
 - .6 pulley size, type and manufacturer,
 - .7 belt size and quantity.
- .9 Pumps:
 - .1 manufacturer,
 - .2 model or serial number,
 - .3 flow rate,
 - .4 developed pump head,
 - .5 RPM.
- .10 Heat transfer equipment:
 - .1 manufacturer and type,
 - .2 inlet and outlet temperatures,
 - .3 pressure drop,
 - .4 design pressure rating (MAWP),
 - .5 flow rate,
 - .6 pressure relief valve rating (pressure setpoint, heat rating).

6 EXECUTION – MISCELLANEOUS

6.1 Balance Position Marking

- .1 Mark the balance position of dampers and valves at the completion of the final testing:
 - .1 ductwork: indicate with arrow using paint or permanent marker,
 - .2 exposed ductwork in public areas: self-adhesive label, placed adjacent to balancing damper, neatly filled in with % open or degree open value.
 - .3 valves: self-adhesive label, placed on piping (insulated or not) adjacent to valve, neatly filled in with either % valve open, or number of valve turns to open.

- .2 Additional requirements for circuit-balancing valves with test ports:
 - .1 remove valve handle or other protective device, and set memory stop to limit valve open travel. Replace valve handle or protective cover.

7 EXECUTION - REPORT PRESENTATION AND VERIFICATION

7.1 Required Reports

- .1 Provide the following reports:
 - .1 Air and water balancing report,

7.2 Record Keeping

- .1 Keep records of trial and final balance and submit preliminary report as each system is completed.
- .2 Do not submit the final TAB report until all audit verification re-measurements, and any required re-balancing, is completed to the satisfaction of Consultant.

7.3 Report Format

- .1 Reports to incorporate approved standard forms, with values expressed in the same units as shown on Contract Documents.
- .2 Include "as-built" system schematics, marked-up to show as-measured flow quantities and measurement points. Use as-built drawings and ventilating line diagrams for reference.
- .3 Submit an electronic PDF copy of the draft TAB report for review by Consultant. Where a report page length is more than 20 pages, include bookmarks in the PDF document organizes by system number and/or name.
- .4 After any revisions requested by Consultant have been made and final review accepted by Consultant, submit the final TAB report in the following formats:
 - .1 two (2) hard copies of the completed report, each with index tabs and bound in "D" ring binders,
 - .2 electronic file PDF copies by email or drop-box as coordinated with Owner and Consultant.

7.4 Completion

- .1 Continue TAB until reports are approved.
- .2 The Substantial Performance of the Mechanical Work will be considered reached when the initial Start-Up and Performance Testing report is accepted by the Consultant and in the opinion of the Consultant all systems have been satisfactorily installed, operated tested, balanced, and adjusted to meet the specified and intended performance.
- .3 The substantial performance of the Work is not dependent upon alternate season testing.
- .4 The total performance of the Work will not be considered reached until the alternate season testing and balancing is completed and the final report submitted has been reviewed by Consultant and accepted by the Owner.

END OF SECTION

TESTING, ADJUSTING & BALANCING SUPPLEMENT FOR HEALTHCARE 23 05 93.23

GENERAL

1.1 Scope

- .1 Test, adjust, and balance ("TAB") airflows for rooms and spaces in healthcare facilities.

This section is supplementary to Specification section [23 05 93.13][23 05 93.14] and is to be read in conjunction with that section.

1.2 Related Sections

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

23 05 93.13 Testing, Adjusting & Balancing for HVAC

1.3 Definitions and Abbreviations

- .1 The following definitions apply to this section.
 - .1 **Differential airflow** – means the difference in the aggregate airflow rates of supply terminal outlets in a room or space minus the aggregate airflow rates of return air and exhaust air terminal inlets in the room or space, for design or measured flow rates.
 - .2 **Differential pressure** – means the design or measured air pressure of an enclosed room relative to the adjacent corridor, room or space.
 - .3 **Negative pressure (room)** – means a room where the net airflow movement is from adjacent spaces into the room.
 - .4 **Neutral pressure (room)** – means a room where the net airflow movement into/out from the room is essentially zero but may be have limited airflow into or out from the room.
 - .5 **Positive pressure (room)** – means a room where the net airflow movement is from the room to adjacent spaces,
 - .6 **Specialty Rooms** – means those room types as listed in Schedule A of this Specification section.

2 PRODUCTS

2.1 Not Used

3 EXECUTION

3.1 General

Balance air systems in accordance with Specification section 23 05 93.13 before performing room differential pressure balancing as specified herein.

- .2 For differential pressure, measure the room air pressure relative to the adjacent connecting corridor or room unless otherwise shown.
- .3 Where a space has dynamic differential pressure control, coordinate with the Division 25 contractor and supply measured data to allow configuration of Division 25 control sequences.

3.2 General Room and Space Differential Pressure Balancing Process

Issued For Tender

- .1 Application: all rooms and spaces that are not Specialty Rooms or Odour/Vapour Generating rooms specified herein.
- .2 For the purpose of this balancing process, the following definitions apply;
 - .1 A “positive pressure room” is one in which the design supply airflow rate exceeds the design return/exhaust airflow rates by 25 L/s (53 cfm) or more,
 - .2 A “negative pressure room” is one in which the design return/exhaust airflow rate exceeds the design supply air flow rate by 25 L/s (53 cfm) or more,
 - .3 A neutral pressure room is one that where the difference between the design supply airflow rate and the design return/exhaust airflow rate is less than 25 L/s (53 cfm).
- .3 Calculate the design differential airflow rates from design supply and return/exhaust airflow rates as shown on drawings. Record the design differential airflow rates in the TAB report.
- .4 Adjust room pressurization based on differential airflow:
 - .1 for positive and negative pressure rooms, adjust exhaust airflow rate until a balanced differential airflow of not less than 25 L/s (53 cfm), positive or negative as applicable to the room design differential airflow rate, is achieved unless a greater value is calculated or is as otherwise shown,
 - (a) acceptance criteria: measured differential airflow is within -0/+15% of design differential airflow.
 - .2 for neutral pressure rooms, adjust exhaust airflow rate until it is within the lessor of $\pm 5\%$ or 10 L/s (22 cfm) of the measured supply airflow rate,
- .5 Alternate method for rooms which are fully enclosed and provided with doors: balance room to achieve a differential pressure relative to adjacent connecting corridor or room, measured across the closed door;
 - .1 for positive pressure rooms, adjust exhaust airflow rate until a positive pressure of between +1.5 to +2.5 Pa (+0.006 to +0.01 in.w.c) is achieved and maintained for a time period of one (1) minute,
 - .2 for negative pressure rooms, adjust exhaust airflow rate until a negative pressure of between -1.5 to -2.5 Pa (-0.006 to -0.01 in.w.c) is achieved and maintained for a time period of one (1) minute,
 - .3 for neutral pressure rooms, adjust exhaust airflow rate until a relative pressure between -1.5 and +1.5 Pa (-0.006 and +0.006 in.w.c.) is achieved and maintained for a time period of one (1) minute.

3.3 Odour or Vapour Generating Rooms Differential Pressure Balancing Process

- .1 Application: washrooms, utility rooms, bathing rooms, shower rooms, wash-down rooms, waste storage rooms, and other contaminated storage rooms.
 - .1 Adjust room exhaust airflow rates to achieve a negative room differential pressure of not less than 2.5 Pa (0.03 in.w.c.) and maintained for a time period of two (2) minutes,
- .2 Acceptance criteria: measured differential pressure is within -0/+15% of design differential pressure.

3.4 Specialty Room Differential Pressure Balancing Process

- .1 Application: all rooms with permanent differential pressure sensors used for differential pressure control (directly or indirectly) as listed in Schedule A at the end of this specification section.
- .2 Adjust room airflow rates to achieve the required room differential pressure as listed in Schedule A at the end of this specification section, and which is maintained for a test time period of ten (10) minutes,
 - .1 for positive pressure rooms, adjust the return/exhaust airflow rates,

- .2 for negative pressure rooms, adjust the return/exhaust airflow rates. If necessary, the supply airflow rate may be reduced by up to 5% of design supply airflow value to achieve the required negative pressure.
- .3 For rooms which have anterooms (vestibules);
 - .1 first adjust airflow rates to achieve required differential pressure between the room and the connecting corridor,
 - .2 then adjust airflow rates in the anteroom to achieve required differential pressures.
- .4 Acceptance criteria: measured differential pressure is within -0/+15% of design differential pressure.

3.5 Site Acceptance Testing

After completion of differential pressure balancing, conduct Site Acceptance Testing ("SAT") of the Specialty Rooms in the presence and to the satisfaction of the Owner's representative(s) before equipment is permanently placed into service, for up to 100% of Specialty Rooms.

- .2 SAT to include the following:
 - .1 Continuous measurement and recording of room differential pressure under static conditions, with all doors to the rooms closed for at least 5 minutes prior to the test, and measured for a period of ten (10) minutes,
 - .2 continuous measurement and recording of room differential pressure during an upset condition caused by the opening of a door to the connecting corridor for a period of 30 seconds;
 - (a) record the differential pressure vs time from the start of the door opening until time required after the door has closed for the room to return to 90% of the static differential pressure.

3.6 Commissioning Program

- .1 Comply with the project commissioning requirements in accordance with specification section 20 08 15 and Division 01 requirements.
- .2 The verification and testing requirements specified in this section may be concurrent with, or conducted separate from, the commissioning program, as coordinated with the Contractor and the commissioning authority.

3.7 Test and Installation Records

- .1 Provide the following test records to the Owner and a copy to Consultant.
 - .1 design and measured differential airflow and differential pressures for each room, to be included in the main TAB report,
 - .2 SAT results, to be included in the main TAB report.

3.8 Schedules

- .1 The following equipment schedules form part of this specification section.

- .1 Schedule A: Specialty Room Differential Pressure Values

SCHEDULE A – Specialty Room Differential Pressure Values

Notes for the following table:

[1] Open areas with no physically closed interior boundary, or enclosed rooms where doors are frequently open.

[2] Unless otherwise stated, room pressure is measured relative to adjacent corridor serving the room.

Occupancy	Room Type	Measurement Parameter (minimum)	Positive or Negative [Note 2]
Healthcare	Decontamination Room	7.5 Pa (0.03 in.w.c.)	Negative to corridor
	Decontamination Room Anteroom ("Exit Room")	2.5 Pa (0.01 in.w.c.)	Negative to corridor
		7.5 Pa (0.03 in.w.c.)	Positive to Decontamination Room
	Decontamination Room Anteroom ("Clean Room")	2.5 Pa (0.01 in.w.c.)	Negative to corridor
		7.5 Pa (0.03 in.w.c.)	Positive to Decontamination Room

End of Section

HYDRONIC PIPING – CARBON STEEL

23 21 13.23

GENERAL

1.1 Scope

- .1 Provide carbon steel pipe and fittings for HVAC liquid piping systems. Refer to section 23 05 01 for piping system applicability.
- .2 This specification applies to liquid piping systems with design pressures not exceeding 2070 kPa (300 psig) at temperatures not exceeding 121°C (250°F), except as otherwise specified.

1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
 - .1 20 05 24 Welding and Brazing
 - .2 23 05 01 HVAC Piping Systems General Requirements
 - .3 23 25 05 HVAC Pipe Cleaning

1.3 Applicable Codes and Standards

- .1 Legislation:
 - .1 Refer to section 23 05 01.
- .2 Installation standards and codes:
 - .1 Refer to section 23 05 01.
- .3 Product standards:
 - .1 ANSI A21.11 Rubber Gasket joints for Ductile-Iron Pressure Pipe and Fittings
 - .2 ANSI B1.20.1 Pipe Threads, General Purpose (inch)
 - .3 ASME B16.1 Cast Iron Pipe Flanges And Flanged Fittings
 - .4 ASME B16.3 Malleable Iron Threaded Fittings.
 - .5 ASME B16.5 Pipe Flanges and Flanged Fittings
 - .6 ASME B16.9 Factory Made Wrought Steel Buttwelding Fittings
 - .7 ASME B36.10 Welded and Seamless Wrought Steel Pipe
 - .8 ASME B16.11 Forged Steel Fittings, Socket-Welding and Threaded
 - .9 ASME B16.20 Metallic Gaskets for Pipe Flanges: Ring Joint Spiral Wound and Jacketed.
 - .10 ASME B16.21 Nonmetallic Flat Gaskets for Pipe Flanges.
 - .11 ASME B16.39 Malleable Iron Threaded Pipe Unions: Classes 150, 250 and 300.
 - .12 ASTM A47 Standard Specification for Ferritic Malleable Iron Castings.
 - .13 ASTM A53 Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
 - .14 ASTM A105 Standard Specification for Carbon Steel Forgings for Piping Applications

- | | |
|---------------|--|
| .15 ASTM A106 | Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service |
| .16 ASTM A193 | Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service |
| .17 ASTM A194 | Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both. |
| .18 ASTM A536 | Standard Specification for Ductile Iron Castings. |

2 PRODUCTS

2.1 Pipe

- .1 Carbon steel pipe:
 - .1 to ASTM A53 Grade B, seamless or electric resistance welded (type “A53”),
 - .2 to ASTM A106 Grade B (type “A106”),
- .2 Pipe wall thickness:
 - .1 Refer to Schedule A1 appended to the end of this specification section.
 - .2 Select pipe material and wall thickness/schedule (as defined in ASME B36.10), based on pipe size, design temperature and jointing method.
 - .3 Acceptable substitutions:
 - (a) where only type A53 is specified, then A106 may be used,
 - (b) where only type A106 is specified, then piping with dual certification for meeting both ASTM A53 Grade B seamless and ASTM A106 Grade B seamless may be used.

2.2 Pipe Joints and Fittings

- .1 Threaded fittings:
 - .1 End connections: NPT thread to ANSI B1.20.1.
 - .2 Fittings: Class 150 and Class 300, malleable iron to ASME B16.3..
 - .3 Unions: Class 150 and Class 300, malleable iron body with ground joint and bronze face to ASME B16.39.
 - .4 Threaded joint compound: pulverized lead paste or Teflon pipe tape sealant.

Standard of Acceptance

- Masters Pro-Dope
 - Masters Orange or White Tape.
- .2 Welding fittings:
 - .1 Butt weld fittings:
 - (a) Forged to ASME B16.9,
 - (b) wall thickness to match pipe,
 - (c) long radius elbows.
 - .2 Welding outlet fittings:
 - (a) forged to ASTM A105,

- (b) dimensions and pressure ratings to MSS SP-97, Standard Class for butt welding branch connection and Class 3000 for threaded or socket welded branch connection,
- (c) NPT ends to ASME B1.20.1.
- .3 Socket welded fittings:
 - (a) forged to ASTM A105,
 - (b) dimensions and pressure ratings to ASME B16.11, Class 3000.
- .4 Half couplings:
 - (a) forged carbon steel to ASTM A105,
 - (b) dimensions and pressure rating to ASME B16.11, Class 3000 socket weld or threaded ends,
 - (c) NPT ends to ASME B1.20.1.
- .3 Flanges:
 - .1 Flat-faced cast iron to ANSI B16.1, Class 125.
 - .2 Raised-face forged carbon steel to ASME B16.5, Class 150 and Class 300, weld neck with wall thickness to match pipe, or slip on type.
 - .3 Studs and bolts: to ASTM A193, Grade B7,
 - .4 Nuts: to ASTM A194 Grade 2H or 2HM,
 - .5 Gaskets to ANSI B16.21, ANSI B16.20 or ANSI A21.11.

Standard of Acceptance

- Chesterton - fig. 100, 195 and 450
- Beldam

3 EXECUTION

3.1 Piping Installation

- .1 Refer to section 23 05 01 for piping design criteria and general requirements for piping installation.
- .2 Slope main piping horizontal or up in direction of flow nominally at a slope of 1:500 (0.2%);
 - .1 branch piping to have greater slope,
 - .2 slope piping up in direction of terminal heating and cooling devices,
 - .3 where supply and return piping are grouped together and flow is in opposite directions, arrange piping horizontal.
- .3 Use eccentric reducers at pipe size changes arranged flat-on-top to assist venting.
- .4 Cap ends during construction to prevent entry of foreign matter.

3.2 Class Rated Fittings and Flanges Selection

- .1 Select ASME Class rated fittings and flanges in accordance with the following table for design pressure limits at coincident design temperature limits unless otherwise shown on drawings.

Class	Maximum Design Pressure	Maximum Coincident Design Temperature
125 Note [1]	900 kPa (130 psi)	≤ 65°C (150°F)

Class	Maximum Design Pressure	Maximum Coincident Design Temperature
125 Note [1]	700 kPa (100 psi)	≤ 121°C (250°F)
150	1720 (250 psi)	≤ 38°C (100°F)
150	1400 kPa (200 psi)	≤ 121°C (250°F)
300	3700 kPa (535 psi)	≤ 38°C (100°F)
300	3100 kPa (450 psi)	≤ 121°C (250°F)

Notes:

[1] For flanges only.

3.3 Pipe Joints and Fittings

- .1 Make pipe joints as follows.
 - .1 Piping NPS 2-1/2 and under:
 - (a) NPT threaded joint to ANSI B1.20.1 and made with Teflon tape or pipe dope, or
 - (b) socket weld joints.
 - .2 Piping NPS 2-1/2 and larger:
 - (a) welded,
 - (b) flanged.
 - .3 For clarity, pipe size of NPS 2-1/2 may be either type of joint specified.
- .2 For flange joints, select gasket materials in accordance with the following table so that gasket pressure and temperature both exceed the piping system design pressure and design temperature.

Gasket Temperature Limit	Gasket Pressure Limit	Gasket Material	Gasket Thickness	Chesterton Figure
80°C (180°F)	1720 kPa (250 psig)	Red rubber	1.6 mm (1/6 in)	100
200°C (390°F)	2400 kPa (350 psig)	Synthetic fiber with nitrile binder	1.6 mm (1/6 in)	450
400°C (750°F)	3700 kPa (535 psig)	Synthetic fiber with nitrile binder	1.6 mm (1/6 in)	195

3.4 Equipment connections

- .1 Make pipe connections to equipment as follows:
 - .1 NPS 2 and smaller: threaded fittings.
 - .2 NPS 2 ½ and larger:

- (a) flanged connections,
 - (b) grooved end where equipment has compatible factory-prepared grooved ends
- .2 Where connection is made to equipment with a threaded fitting, provide a union between the isolation valve and the equipment connection.

3.5 Welding

- .1 Comply with section 20 05 24 and as specified herein.

3.6 Branch Connections

- .1 Make branch connections to mains in accordance with Table 2a and 2b.
- .1 These tables are valid for design pressures up to 2070 kPa (300 psig), without adding reinforcement material where branch pipe is directly welded to the main. For welded branch connections at higher design pressures, use butt weld, socket weld, or integrally reinforced outlet fittings only.
- .2 In these tables, the following abbreviations apply.

Abbreviations:

TH	Threaded fitting to ASME B16.3
SW	Socket weld fittings to ASME B16.11
HC	Half coupling to ASME B16.11
BW	Butt weld fitting to ASME B16.9
OF	Reinforced Outlet Fittings to MSS SP-97
DP	Direct welding of Branch Pipe to Main without added reinforcement.

Table 2a – Allowable Branch to Main Connections (NPS 1 to NPS 10)										
Branch NPS	Mains Pipe, NPS									
	1	1-1/4	1-1/2	2	2-1/2	3	4	6	8	10
3/4	TH SW	TH SW	TH SW	TH SW	BW SW	BW, OF SW HC DP	BW, OF SW HC DP	BW, OF HC DP	BW, OF HC DP	BW, OF HC DP
1	TH SW	TH SW	TH SW	TH SW	BW SW	BW, OF SW DP	BW, OF SW HC DP	BW, OF HC DP	BW, OF HC DP	BW, OF HC DP
1-1/4	---	TH SW	TH SW	TH SW	BW SW	BW, OF SW DP	BW, OF SW DP	BW, OF HC DP	BW, OF HC DP	BW, OF HC DP
1-1/2	---	---	TH SW	TH SW	BW SW	BW, OF SW DP	BW, OF SW DP	BW, OF HC DP	BW, OF HC DP	BW, OF HC DP
2	---	---	---	TH SW	BW SW	BW, OF SW	BW, OF SW DP	BW, OF DP	BW, OF HC DP	BW, OF HC DP
2-1/2	---	---	---	---	BW SW	BW, OF SW	BW, OF SW	BW, OF DP	BW, OF DP	BW, OF DP
3	---	---	---	---	---	BW	BW, OF SW	BW, OF DP	BW, OF DP	BW, OF DP
4	---	---	---	---	---	---	BW	BW, OF	BW, OF DP	BW, OF DP
6	---	---	---	---	---	---	---	BW	BW, OF	BW, OF DP
8	---	---	---	---	---	---	---	---	BW	BW, OF
10	---	---	---	---	---	---	---	---	---	BW

Table 2b – Allowable Branch to Main Connections (NPS 12 to NPS 30)								
Branch NPS	Mains Pipe, NPS							
	12	14	16	18	20	22	24	30
¾ to 2	OF HC DP	OF HC DP	OF HC	OF HC	OF HC	OF HC	OF HC	OF HC
2-1/2	OF DP	OF DP	OF	OF	OF	OF	OF	OF
3	OF DP	OF DP	OF	OF	OF	OF	OF	OF
4	BW OF DP	OF DP	OF	OF	OF	OF	OF	OF
6	BW OF DP	BW OF DP	BW OF	OF	OF	OF	OF	OF
8	BW OF DP	BW OF DP	BW OF	BW OF	BW OF	OF	OF	OF
10	BW OF DP	BW OF DP	BW OF	BW OF	BW OF	BW OF	BW OF	OF
12	BW	BW OF DP	BW OF	BW OF	BW OF	BW OF	BW OF	OF
14	---	BW	BW OF	BW OF	BW OF	BW OF	BW OF	BW OF
16	---	---	BW	BW OF	BW OF	BW OF	BW OF	BW OF
18	---	---	---	BW	BW OF	BW OF	BW OF	BW OF
20	---	---	---	---	BW	BW OF	BW OF	BW OF
22	---	---	---	---	---	BW	BW OF	BW OF
24	---	---	---	---	---	---	BW	BW OF
30	---	---	---	---	---	---	---	BW

- .2 Use of Class 3000 half-couplings as a branch connector ("HC"), and direct welding of branch piping to main piping ("DP"), is permitted in accordance with the following requirements:
- .1 half-coupling or branch pipe sits on the mains pipe, and does not insert into the main pipe,
 - .2 the opening size in the main pipe to closely follow the inside diameter of the half-coupling or branch pipe,
 - .3 half-coupling or branch pipe attachment end is shaped and beveled to closely following the surface of the main pipe, suitable for a pull-penetration weld,

- .4 the half-coupling or direct branch pipe is attached with a groove weld and covered with a smooth finishing fillet weld in accordance with the requirements of the applicable piping code.
- .3 Where integrally reinforced outlet fittings, half-couplings or direct welding of branch pipe is used, hole saw or drill and ream mains pipe to maintain full inside diameter of branch line prior to welding.
- .4 Where multiple branch pipes are to connect to the main pipe in close proximity to each other, provide a minimum separation between the centerlines of adjacent branch pipes equal to or greater than the sum of the OD dimensions of the adjacent branch pipes.
- .5 If threaded fittings have been installed where the specification requires welded fittings, either cut-out and replace the fitting, or fully seal-weld the exposed threads.
- .6 Where saddle type branch welding fittings are used on mains, hole saw or drill and ream main to maintain full inside diameter of branch line prior to welding.

3.7 Pressure Testing

- .1 Conduct pressure and leak tests in accordance with section 23 05 01.

3.8 Flushing and Cleaning

- .1 After pressure testing, clean piping in accordance with Section 23 25 05.
- .2 For piping changes to existing systems, which consist of NPS 2 and smaller branch piping to terminal heating or cooling equipment, the following abbreviated cleaning and flushing procedure may be used:
 - .1 After cutting of threads and de-burring, and before installation of piping, manually clean the interior of the pipe with wire-brush on an extended rod, while washing the inside of the pipe with a solution of non-foaming, phosphate free detergent, 3% by weight, followed by a hose rinse flushed to drain until water runs clear.
 - .2 After installation of piping, check strainers are clean, and open isolation valves to use service water for pressure testing and final flush.
 - .3 After pressure testing, isolate new piping from existing piping, fully open control valves (where installed) and flush service water to drain. Use compressed air at not more than 70 kPa (10 psig) to assist in flushing the water.
 - .4 Refill system with service water and circulate for two hours. Inspect strainers, and repeat drain, fill and recirculate routine until strainers are free of debris.

3.9 Schedules

- .1 The following appended equipment schedules form part of this specification section.
 - .1 Schedule A1 Pipe Wall Thickness.

Schedule A1 – Pipe Wall Thickness				
Pipe Size NPS	Piping Design Temperature	Pipe Joint Method	Pipe Material	Pipe Wall Thickness
≤ 2-1/2	≤ 105°C (220°F)	All	A106, A53	Schedule 40
		Threaded	A106	Schedule 80
	>105°C (220°F)	Welded, flanged	A106, A53	Schedule 40
3 to 10	≤ 121°C	All	A106, A53	Schedule 40

12 to 18	≤ 121°C	All	A106, A53	Standard – 9.5 mm (0.375 in.)
20 to 36	≤ 121°C	All	A106, A53	Schedule 30

END OF SECTION

HYDRONIC PIPING - COPPER

23 21 13.33

1 GENERAL

1.1 Scope

- .1 Provide copper tube and fittings for HVAC liquid piping systems for aboveground and underground installations for the following applications:

(as an alternative to steel piping) final connections not exceeding 1 m (39 in) in length to terminal heating units which have copper tube coils, copper tube heating elements, and copper tube radiant panels,

- .2 tubing located in slabs or under slab-on-grade floors to connect to terminal heating or cooling units,
 - .3 drain and vent piping for equipment and piping systems (except cooling tower drainage piping).
 - .4 non-potable make-up water piping for HVAC services, or
 - .5 where otherwise shown.
- .2 This specification applies to liquid piping systems with design pressures not exceeding 2000 kPa (290 psig) at temperatures not exceeding 121°C (250°F, except as otherwise specified. Refer to section 23 05 01 for piping system applicability.
 - .3 The use of copper tube is limited to nominal tube sizes NPS 3 and under.

1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
 - .1 20 05 24 Welding and Brazing
 - .2 23 05 01 Heating and Cooling Piping Systems General Requirements
 - .3 23 25 05 HVAC Pipe Cleaning

1.3 Applicable codes and standards

- .1 Legislation:
 - .1 Refer to section 23 05 01.
- .2 Installation standards and codes:
 - .1 Refer to section 23 05 01.
- .3 Product standards:
 - .1 ASME B16.15 Cast Bronze Threaded Fittings, Classes 125 and 250
 - .2 ASME B16.18 Cast Copper Alloy Solder Joint Pressure Fittings
 - .3 ASME B16.21 Nonmetallic Flat Gaskets for Pipe Flanges
 - .4 ASME B16.22 Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
 - .5 ASME B16.24 Cast Copper Alloy Pipe Flanges and Flanged Fittings; Class 150, 300, 400, 600, 900, 1500, & 2500.
 - .6 ASME B16.50 Wrought Copper and Copper Alloy Braze-Joint Pressure Fittings
 - .7 ASTM A307 Standard Specification for Carbon Steel Bolts and Studs 60,000PSI Tensile Strength

.8	ASTM A563	Standard Specification for Carbon and Alloy Steel Nuts
.9	ASTM B32	Standard Specification for Solder Metal
.10	ASTM B88	Standard Specification for Seamless Copper Water Tube
.11	ASTM B813	Standards Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube
.12	ASTM B828	Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings.
.13	AWS A5.8	Specification for Filler Metals for Brazing and Braze Welding
.14	AWS A5.31	Specification for Fluxes for Brazing and Braze Welding
.15	AWS C3.4	Specification for Torch Brazing
.16	MSS SP-106	Cast Copper Alloy Flanges and Flanged Fittings, Class 125, 150 and 300

2 PRODUCTS

2.1 Tube

- .1 Aboveground:
 - .1 NPS ½ to 2: to ASTM B88, type "L" hard-drawn copper tube.
 - .2 NPS 2-1/2 to NPS 3: to ASTM B88, type "K" hard-drawn copper tube.
- .2 Underground or in-slab:
 - .1 NPS ½ to NPS 3: to ASTM B88, type "K" hard-drawn or annealed copper tube.
- .3 Copper tube to be marked on the exterior surface in accordance with ASTM B88, to indicate the tube type ("K" or "L") by type designation or by colour strip (green stripe for type "K" and blue stripe for type "L"), along with identification of the manufacturer.

2.2 Tube Joints and Fittings

- .1 Fittings:
 - .1 cast bronze fittings to ASME B16.18,
 - .2 wrought copper and bronze fittings to ASME B16.22,
 - .3 brazed joints only: Wrought copper and copper alloy to ASME B16.50,
 - .4 threaded fittings including unions to ASME B16.15, Class 250.
- .2 Flanges:
 - .1 brass or bronze flanges to ANSI B16.24,
 - .2 gaskets to ANSI B16.21.

Standard of Acceptance

- Chesterton - fig. 100, 195 and 450
 - Beldam
- .3 Solder:
 - .1 95:5 tin/antimony solder to ASTM B32.
- .4 Braze filler:
 - .1 silver brazing alloy: classification BCuP-5 to AWS A5.8.

3 EXECUTION

3.1 Tubing Installation

- .1 Refer to section 23 05 01 for piping design criteria and general requirements for piping installation.
- .2 Maximum tube size: NPS 3.
- .3 Slope main piping horizontal or up in direction of flow nominally at a slope of 1:1000 (1 in in 10 ft).
 - .1 branch piping to have greater slope,
 - .2 slope piping up in direction of terminal heating and cooling devices.
 - .3 where supply and return piping are grouped together and flow is in opposite directions, arrange piping horizontal.
- .4 Use eccentric reducers at tube size changes arranged flat on bottom to assist venting.
- .5 Where tubing is installed to run inside of concrete slabs, support tubing to maintain tube centerline at the center of the floor slab unless otherwise shown. Where tubing is supported by ferrous metals or where it might come into contact with reinforcing steel bar, provide two layers of Denso Tape around the tubing at the point of contact.
- .6 Use copper tubing for equipment drains (pressure and non-pressure)
- .7 Provide di-electric unions or flanges in accordance with section 23 05 01.

3.2 Tube Joints and Fittings

- .1 Prepare and install tube and fittings;
 - .1 in accordance with ASTM B828 for solder joints,
 - .2 in accordance with AWS C3.4 and specification section 20 05
- .2 Use of direct butt weld style soldered or brazed joints, including pulled-Tee's, are not permitted.
- .3 Before assembling solder or brazed joints, remove working parts of valves.
- .4 Make tube joint for above-ground piping as follows:
 - .1 NPS 2 and smaller: soldered or brazed joints with socket type fittings.
 - .2 NPS 2-1/2 to NPS 3: brazed joints with socket type fittings.
- .5 Make tube joints for underground and/or in-slab piping as follows:
 - .1 all sizes: brazed joints with sweat fittings,
 - .2 arrange tubing to minimize the number of joints. Use annealed tubing wherever possible, with field-bends made with tube bending dies which provide uniform support of tubing during bending operations.

3.3 Equipment Connections

- .1 Equipment connections:
 - .1 NPS 2 and smaller: unions and threaded fittings,
 - .2 NPS 2 1/2 to NPS 3: flanged connections.

3.4 Pressure and Leak Testing

- .1 Conduct pressure and leak tests in accordance with section 20 05 01.

3.5 Flushing and cleaning

- .1 After pressure testing, clean piping in accordance with Section 23 25 05.
- .2 For piping changes to existing systems, which consist of NPS 2 and smaller branch piping to terminal heating or cooling equipment, the following abbreviated cleaning and flushing procedure may be used:
 - .1 After cutting of threads and de-burring, and before installation of tubing, manually clean the interior of the tube with wire-brush on an extended rod, while washing the inside of the tube with a solution of non-foaming, phosphate free detergent, 3% by weight, followed by a hose rinse flushed to drain until water runs clear,
 - .2 After installation of piping, check strainers are clean, and open isolation valves to use service water for pressure testing and final flush.
 - .3 After pressure testing, isolate new piping from existing piping, fully open control valves (where installed) and flush service water to drain. Use compressed air at not more than 70 kPa (10 psig) to assist in flushing the water.
 - .4 Refill system with service water and circulate for two hours. Inspect strainers, and repeat drain, fill and recirculate routine until strainers are free of debris.

END OF SECTION

HYDRONIC PIPING SPECIALTIES

23 21 16

1 GENERAL

1.1 Scope

- .1 Provide water piping specialty products for hydronic heating and cooling systems.

1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
 - .1 23 05 01 HVAC Piping Systems General Requirements.
 - .2 25 30 19.16 Building Automation Pressure Independent Control Valves

1.3 Applicable Codes and Standards

- .1 Refer to section 20 05 23 and as specified herein.
- .2 Product standards:
 - .1 ASME B1.20.1 Pipe Threads, General Purpose, Inch
 - .2 ASME B16.5 Pipe Flanges and Flanged Fittings
 - .3 CSA B51. Boiler and Pressure Vessel Code.

1.4 Submittals

- .1 Submit manufacturer catalogue cut-sheets for products specified herein.
- .2 Include confirmation of CRN.

1.5 Quality Control

- .1 All products are to have Canadian Registration Numbers in accordance with CSA B51.

2 PRODUCTS

2.1 Dielectric Fittings

- .1 Dielectric unions – NPS 2 and under:
 - .1 body and union nut material selected to suit connecting various dissimilar piping materials, including all pair combinations of copper, stainless steel, carbon steel and galvanized steel.
 - .2 flat-face union design,
 - .3 tail-piece with FNPT ends with thermobaked epoxy coating, and Teflon shoulder gasket,
 - .4 head-piece with integral O-ring, with threaded or soldered pipe ends.
 - .5 union nut,
 - .6 pressure rating: Class 3000.
 - .7 dielectric coating resistance rating: minimum 500 V/mil thickness.

Standard of Acceptance

- ° Hart Industrial Unions - fig. D-3136 series

.2 Dielectric nipples – NPS 3 and smaller:

- .1 fitting body: Zinc-plated carbon steel tube to ASTM A513,
- .2 liner: polypropylene covering entire inner surface of fitting body,
- .3 fitting ends: threaded to ASME B1.20.1.
- .4 design pressure: 2000 kPa (300 psi) at design temperature,
- .5 design temperature: -40 to +110°C (-40 to +230°F)

Standard of Acceptance

- ° ASC - fig. 7090

.3 Dielectric insulating flanges – NPS 2-1/2 to NPS 4;

- .1 Ductile iron flanges, Class 125 to ANSI B16.42.
- .2 copper tailpiece for soldered joint,
- .3 FNPT thread to AMSE B1.20.1 x copper solder joint,
- .4 BUNA-N gasket,
- .5 lead free materials to NSF 61+G.
- .6 maximum design pressure: 1200 kPa (175 psi)
- .7 maximum operating temperature: 82°C (180°F)

Standard of Acceptance

- ° Watts No. LF3100

.4 Dielectric insulated flange – single face with copper tube tailpiece – NPS 2 to NPS 6;

- .1 Van Stone style carbon steel flange with copper tailpiece with flared end,
- .2 carbon steel flange, Class 150 to ANSI B16.5, with powder coated finish.
- .3 copper tailpiece with rolled flange face-end, and EPDM insulating gasket isolating the copper tube from the steel flange,
- .4 copper tailpiece end connection: rolled groove or sweat.

Standard of Acceptance

- ° CTS Flange Canada - fig. CTS Copper Flange Adaptor

.5 Dielectric flange isolating gasket kits for flanges NPS 6 and over:

- .1 for use with ASME Class 150 and 300 dimensional flanges.
- .2 suitable for connecting various dissimilar piping materials, including all pair combinations of copper, stainless steel, carbon steel and galvanized steel.
- .3 compatible with pressure and temperature service,
- .4 gasket: BUNA-N or EPDM gasket seals compatible with potable water,
- .5 flange bolt insulating sleeves: non-conductive isolating bolt sleeve and washer assemblies to prevent metal-to-metal contact between flange bolt and flange.

Standard of Acceptance

- Advance Products and Systems

2.2 Pressure Independent Balancing Valve (Automatic Balancing valve)

.1 General

- .1 Combination automatic flow limiting and commissioning pressure independent balancing valve.

Standard of Acceptance

- Bell & Gossett - Circuit Sentry Model WV Circuit Sentry

.2 Design conditions:

- .1 Design pressure: NPS 2½ to 6: minimum 1700 kPa (250 psig)
- .2 Design temperature: -20°C to 111°C (-4°F to 230°F).

.3 Flow control characteristics:

- .1 pressure independent flow control over design flow range at an operating differential pressure range of 14 to 414 kPa (2 to 60 psi) across the valve body,
- .2 minimum flow rate: 0.95 l/s (15 gpm)
- .3 maximum allowable pressure drop: ●kPa (● Ft)
- .4 accuracy: ± 5% of control flow rate for total assembly error incorporating differential pressure fluctuation, manufacturing tolerances and valve hysteresis.

.4 Valve body:

- .1 body construction NPS 2 ½ to 6:
 - (a) ductile iron body, 304 stainless steel cartridge, EPDM O-ring packing design, reinforced EPDM diaphragm and a stainless steel spring.
 - (b) wafer body style suitable for installation in ANSI Class 125, 150 or 250 flanges.

.5 Accessories:

- .1 two (2) 100 mm (4 in) long pressure/temperature ports,
- .2 identification tag indicating unit size, and balanced flow rate.

2.3 Automatic Air Vents

.1 Float operated with brass or cast iron body;

- .1 minimum component pressure rating: [1000 kPa (150 psi)][2000 kPa (300 psi)] at 115°C (240°F),

Standard of Acceptance

- Armstrong - fig. AAE-750
- Bell & Gossett – fig. 87
- Maid-O-Mist - fig. 75
- Spirax Sarco - fig. AE30
- Taco - fig. Hy-Vent
- Thrush - fig. 720

2.4 Air Separator; In-Line

- .1 Inertial centrifugal (vortex) style air and dirt separator, cast iron or fabricated steel body, with stainless steel mesh strainer,

- .1 ASME code stamped to ASME BPVC Section VIII,

- .2 Canadian Registration Number to CSA B51,
- .3 pipe-ends: NPT threaded NPS 2 and under, ASME Class 150 flanged NPS 2-1/2 and larger,
- .4 minimum component pressure rating: 1030 kPa (150 psi) at 121°C (250°F).

Standard of Acceptance

- Taco - fig. 4900
- Bell & Gossett – fig. Rolairtrol
- Amtrol - fig. Tangential Air Separator
- Armstrong - fig. Vortex VAS

2.5 Pressure Relief Valves

- .1 Bronze or cast iron body pressure relief valve;
 - .1 stamped to ASME Section IV;
 - .2 EPDM diaphragm and seat,
 - .3 minimum component pressure rating: 860 kPa (125 psi) at 121°C (250°C),
 - .4 selectable pressure setting range: 200 to 860 kPa (30 to 125 psi),
 - .5 capacity rating: not less than associated heating boiler or unfired heat exchanger heat rating,
 - .6 operating differential pressure from open to close not more than 20 kPa (3 psi).

Standard of Acceptance

- Bell & Gossett - fig. A-434E
- Watts - fig. 174A, 740

2.6 Wye-Pattern Strainers

- .1 NPS 3 and smaller:
 - .1 bronze, cast iron, or ductile iron bodies to ASME B16.1, with threaded cap,
 - .2 minimum component pressure rating:
 - (a) ASME Class 125: 1200 kPa (175 psi) at 93°C (200°F),
 - (b) ASME Class 250: 2270 kPa (330 psi) at 93°C (200°F),
 - .3 pipe end: NPT threaded or ASME flanged,
 - .4 basket: stainless steel, 0.8 mm ($1/32$ in) diameter perforations.
- .2 NPS 4 to NPS 24:
 - .1 cast steel or stainless steel bodies to ASME B16.5, with bolted flange cover,
 - (a) stainless steel body where installed in stainless steel piping system,
 - .2 minimum component pressure rating:
 - (a) ASME Class 150: 1800 kPa (260 psi) at 93°C (200°F),
 - (b) ASME Class 300: 3400 kPa (500 psi) at 93°C (200°F),
 - .3 pipe end: ASME Class raised face flanged,
 - .4 basket:
 - (a) stainless steel, 3.2 mm ($1/8$ in) diameter perforations,
 - (b) made from 0.9 mm (0.037 in) stock reinforced with 13 mm x 0.9 mm ($1/2$ in x 0.037 in) bands of same material spot welded to baskets,

- .5 blow-down fitting in strainer cap: NPS 3/4 threaded connection with plug.

Standard of Acceptance

- Nibco
- Sure Flow
- Watts (Mueller)
- Zurn Wilkins

2.7 Valve Enclosure Box

- .1 Valve enclosure box complete with access door for valve kits for terminal unit reheat coils, duct mounted reheat coils, and chilled water or dual temperature fan coils.
- .2 Access door:
 - .1 hospital white access door (by diffuser manufacturer) complete with hinged frame & keyed fastener release,
 - .2 suitable for mounting in drywall or T-bar ceiling as required,
 - .3 enclosure supported from structure above with 3/8" hanger rods.
- .3 Enclosure:
 - .1 24" wide x 24" long factory fabricated galvanized sheet metal enclosure or equivalent custom fabricated enclosure
 - .2 12" high minimum or as required to fully enclose all components
- .4 For custom fabricated enclosures, access door shall be permanently affixed to the enclosure and all seams sealed with caulking.

Standard of Acceptance

- Acudor
- Cendrex
- Karp Inc

2.8 Basket- Pattern Strainers

- .1 NPS 2 to 20, simplex basket:
 - .1 in-line, single basket arrangement,
 - .2 cast steel or stainless steel bodies to ASME B16.5,
 - (a) stainless steel body where installed in stainless steel piping system.
 - .3 cover: same material as body, with quick-opening feature, to ASME Section VIII or ASME B16.5,
 - .4 bottom blow-down fitting: NPS 3/4 threaded connection with plug,
 - .5 minimum component pressure rating:
 - (a) ASME Class 150: 1800 kPa (260 psi) at 93°C (200°F),
 - (b) ASME Class 300: 3400 kPa (500 psi) at 93°C (200°F),
 - .6 pipe ends:
 - (a) NPS 2 to 2-1/2: NPT threaded to ASME B1.20.1,
 - (b) NPS 3 to 20: ASME Class raised face flanged,
 - .7 basket screens:
 - (a) perforated T304 stainless steel plate,

- (b) NPS 2 and 3: 1.15 mm (3/64 in.) perforation, 36% open area,
- (c) NPS 4 and over: 3.2 mm (1/8 in.) perforation, 40% open area.

Standard of Acceptance

- John Brookes (HART)
- Mueller (Watts)
- Spirax Sarco
- Sure Flow

Packaged Coil Valve Kits

- .1 Packaged installation valve-kits for terminal unit reheat coils, duct mounted reheat coils, and chilled water or dual temperature fan coils.

Standard of Acceptance

- Victaulic - fig. 79V Koil-Kit Coil Pac
- Belimo

- .2 Terminal device connection size range: NPS 1/2 to NPS 2.
- .3 Required MCPR for packaged assembly: 2100 kPa (300 psi) at 110°C (230°F).
- .4 Each packaged kit assembly to consist of:
 - .1 as individual components or as multi-function components,
 - .2 supply side:
 - (a) service isolation ball valve, Y-body strainer, valved and capped drain port, test plug port, union pipe-end fitting,
 - .3 return side;
 - (a) service isolation ball valve, pressure-independent electronic automatic control valve, manual air vent/test port, union pipe-end fitting,
 - (b) pressure-independent control valves to conform to Specification section 25 30 19.16.
 - .4 flexible hose connectors:
 - (a) at installation contractors option,
 - (b) for supply and return connections between coil and valve assemblies,
 - (c) maximum length: 300 mm (12 in.)
 - (d) to Specification section 20 05 16 of all metal construction, or stainless steel braided guard with Teflon primary hose,
 - i) for clarity, where EPDM primary hose is used, the braided hose connector shall only be provided by the kit package manufacturer.
- .5 Packaging coordination services:
 - .1 shrink wrap each package coil kit, and identify package with an unique reference number and which identifies as a minimum;
 - (a) the applicable room number and floor level,
 - (b) associated equipment identification tag,
 - (c) contractor name, and project name.

3 EXECUTION

3.1 Equipment Selection Based on Pressure Rating

- .1 Unless otherwise specified herein or shown, select equipment that has a Minimum Component Pressure Rating (MCPR) which exceed the applicable piping system Design Pressure and Design Temperature specified in section 23 05 01.
- .2 Where drawings indicate either: (a) a pressure rating; or (b) a pressure rating and Class rating, by floor level then select equipment as follows:
 - .1 select equipment with a MCPR rating equal to or greater than the pressure rating indicated on the drawings for each floor level.
 - .2 for clarity, even if a valve has an ASME Class rating, do not select a valve based on its Class to match any Class rating shown on the drawings.

3.2 Dielectric Fitting Installation

Provide dielectric fittings at the connection point between the following combinations of dissimilar metals:

- .1 copper and stainless steel,
- .2 copper and carbon steel or galvanized steel,
- .3 stainless steel and carbon steel or galvanized steel.
- .2 Dielectric nipples may only be used at connections to reheat coils, radiant panels and other terminal heating equipment which uses copper tubing.
- .3 Brass or bronze valves are not to be used for the purpose of a dielectric fitting on hydronic water systems. Where a brass or bronze valve is installed at the connection point between carbon steel/galvanized steel pipe and a dissimilar piping material, provide a dielectric fitting on either side of the valve.

3.3 Pressure Independent Balancing Valve (Automatic Balancing Valve)

- .1 Manufacturer to select and provide valves to suit flow and differential pressure requirements. Include the information as a schedule in the shop drawing submittal.
- .2 Install balancing valve assembly with shut-off valve on either end of assembly.
- .3 Install balancing valve assembly in accordance with the manufacturer installation instructions. Provide companion flanges, mounting hardware and gaskets. Install in locations to provide five (5) pipe diameters of straight pipe before and two (2) pipe diameters after, which are free of fittings and valves.
- .4 Support balancing valve assembly rigidly from adjacent piping. Support piping within 300 mm (1 ft) of unit and flanges to prevent strain transmitted to assembly.
- .5 Manufacturer to supply a published commissioning procedure following the guidelines of the National Environmental Balancing Bureau (NEBB) and the Testing Adjusting Balancing Bureau (TABB).

3.4 Air Vents Installation

- .1 Provide air vents at high points in the piping system, including at the top of all pipe risers, and in sections of piping subject to air binding, in both supply and return mains. Allow for additional air vents as directed by Consultant based on site review of installed work.
- .2 Provide isolating valves installed between unit and piping.
- .3 Pipe vent outlets to discharge to drain, over janitors sinks, over floor drains in mechanical rooms and other similar visible locations.

3.5 In-Line Air Separator Installation

- .1 Provide in-line air separators in locations as shown. Provide an automatic air vent on top of the air separator, except where this connection is shown to be connected to a compression tank.
- .2 Provide a valved blow-down drain line from the air separator blow-down fitting, and extend piping to nearest floor drain. Arrange location of blow-down valve so that it is located within 500 to 1800 mm above the floor adjacent to the point of discharge to the floor drain.

3.6 Pressure Relief Valves Installation

- .1 Provide pressure relief valves on hot water boilers, heat exchangers, expansion tanks and other pressure vessels in accordance with relevant codes.
- .2 Select relief valve setpoints to be not greater than the maximum allowable working pressure of the protected equipment (for individual equipment).
- .3 For main pressure relief valves for piping systems, set the pressure relief valve setpoint to the value as shown.
- .4 Pipe relief valve outlets to drain.

3.7 Strainers Installation

- .1 Provide pipeline-size strainers in each of following locations
 - .1 on the inlet side of automatic control valves (except at reheat coils with piping connections NPS $\frac{3}{4}$ or less, radiation, or radiant panels),
- .2 Install wye-pattern strainers in horizontal or vertical-downflow orientation. Install basket strainers only in horizontal piping.
- .3 Install strainers with clearance for removal of basket.
- .4 For strainers NPS $2\frac{1}{2}$ and over, provide NPS 1 valved blowout connection, consisting of ball valve with hose end and chained cap. Pipe valved blowout connections from strainers at pumps to open drain.

Packaged Coil Valve Kits Installation

- .1 The use of packaged coil valve-kits are at the contractor's option in lieu of providing site assembly of separate valves and fittings.
- .2 Coordinate with the trade contractor under Division 25 for the supply of pressure independent control valves for inclusion in the coil valve kits.
- .3 Create and provide a schedule of valve kits required to the manufacturer/packager, which includes the following information:
 - .1 a designation indicating the location of the applicable HVAC equipment,
 - .2 design flow rates of the applicable HVAC equipment,
 - .3 manufacturer/packager to select and size the pressure-independent control valves in accordance with Specification section 25 30 19.16.
- .4 Arrange piping to HVAC equipment so that flexible connector hoses are not bent to change direction. Flexible connector hoses may be deflected laterally by an amount not exceeding the outside diameter of the connector hose. Where necessary, provide a rigid elbow at the HVAC coil-end connections.

3.9 Valve Enclosure Box Installation

- .1 Valve enclosure box shall house valve kits for terminal unit reheat coils, duct mounted reheat coils, and chilled water or dual temperature fan coils; this requirement applies both site assembly of separate valves and fittings, or for packaged coil valve kits.

- .2 Support enclosure box from structure above with 3/8" hanger rods.
- .3 Provide installation drawings showing locations of all enclosure boxes on architectural reflected ceiling plans for approval prior to installation.

END OF SECTION

HVAC PIPE CLEANING 23 25 05

1 GENERAL

Scope

- .1 Provide chemicals and instructions for the cleaning of piping systems and equipment.
- .2 This specification only applies to piping systems within Division 23.

Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
 - .1 23 25 13 HVAC Water Treatment Systems

1.3 Qualifications of Supplier

- .1 Equipment, chemicals and services to be provided by specialist firm with an established reputation in field including:
 - .1 a verifiable minimum of five (5) years experience of providing these types of services to both Government and/or private industry customers,
 - .2 the supplier is a member in good standing of the Association of Water Technologies (AWT),
 - .3 supplier's service technicians are either a Certified Water Technologist (CWT) accredited by the AWT, or is a qualified Chemical Water Treatment Services Chemist,
 - .4 certification records or similar proof-of-training for service personnel shall be made available upon request.

Standard of Acceptance

- Klenzoid
- GE Betz
- D.H. Jutzi Limited
- Nalco Chemical Company
- Ashland]

2 PRODUCTS

2.1 Pipe Cleaning Chemicals

- .1 Boiler internals:
 - .1 Alkaline boil-out compound for chemically cleaning of new boiler internals.
- .2 Piping:
 - .1 Non-foaming, non-chromate, phosphate free, neutral pH chemical cleaner detergent to remove sludge oil and debris.

2.2 Temporary Strainer Screens

- .1 Conical strainer with indicating handle, 1.6 mm (1.16 in) perforations, sized to suit NPS pipe and to be clamped between ASME pipe flanges.

Standard of Acceptance

- Suyre Flow Equipment Inc

3 EXECUTION

3.1 Temporary Services and Equipment

- .1 Provide all temporary equipment, including pumps, drain and fill connections, hoses, water meters and other miscellaneous equipment necessary to circulate cleaning compounds and to flush piping.
- .2 Where permanent system pumps are to be used for circulating cleaning fluid, provide temporary 1.6 mm (1/16 in) screens in permanent strainer bodies, or provide temporary insertion style strainers of same screen size inserted into a pipe spool section on the suction side of the pump.
- .3 Where permanent system pumps are not available, or where connections are made to an existing piping system, provide temporary circulation pumps to maintain cleaning fluid minimum velocity through piping at 1.5 m/s (5 fps).
- .4 At completion of testing, temporary equipment is to be removed from site and becomes the property of the contractor.

3.2 Temporary Work

- .1 At air handling unit coils and terminal units, do not subject the control valve to the cleaning fluid even if a strainer is installed ahead of the valve. Provide the following temporary piping arrangement:
 - .1 Method A – hard pipe coil connections:
 - (a) remove the control valve and provide a spool piece and flush through the coil,
 - .2 Method B – flexible connector coil connections:
 - (a) disconnect the flexible connectors at the coil,
 - (b) remove the control valve,
 - (c) cross-connect the supply and return connections to bypass the coil.
- .2 At major equipment such as boilers and chillers, protect the equipment from debris by one of the following methods:
 - .1 where each equipment unit is provided with a dedicated pump and strainer which are located on the inlet side to the equipment, use the in-line strainer,
 - .2 for all other installations, provide temporary strainer cones installed in a pipe flange ahead of the equipment. Remove strainer after completion of system cleaning.

Cleaning of New Piping in Existing Installations

- .1 For piping connections to existing systems, provide NPS 1 valved drains on the load side of the new supply and return piping service isolation valve. Blank-off or otherwise isolate connections to existing treated piping systems. Provide temporary bypass piping/hose and circulation pump to permit circulation of cleaning fluid.

3.4 Cleaning of HVAC Water Piping

- .1 After completion of piping pressure tests, chemically clean HVAC water piping systems followed by flushing piping with clean water.
- .2 For plate-and-frame heat exchangers, disconnect piping and make temporary cross-connections to bypass heat exchanger unless the heat exchanger is equipped with an integral strainer. Provide a temporary fine mesh strainer screen..

- .3 Fill piping with clean city water using permanent or temporary water meter to establish system volume. Add cleaning detergent to achieve required concentration as recommended by chemical cleaning manufacturer.
- .4 Circulate solution for minimum of seventy-two (72) hours at room temperature or as recommended by chemical cleaning manufacturer instructions.
- .5 Flush to drain with clean water until sample tests of flush-water indicate an iron residual of < 1 ppm.
- .6 Check for removal of cleaning compound; samples to be clear, not coloured, and free of foam after agitation.
- .7 At completion of water flushing, remove and clean strainers. If there is visible debris in the strainers, repeat drain, fill and recirculation routine until strainers are free of debris.
- .8 Refill system with clean water and add water treatment corrosion inhibitors in accordance with the requirements of Section 23 25 13.
- .9 After system is in operation for at least eight (8) hours, perform a final clean of strainers.

3.5 Records

- .1 Provide a cleaning test record and submit to the Consultant and the Owner. Test record to record for each piping system:
 - .1 water volume of system as measured,
 - .2 quantity of cleaner added to the system, by volume or weight,
 - .3 name of cleaner product used,
 - .4 manufacturer's recommended concentration,
 - .5 start and end times/dates of circulation,
 - .6 free-iron residual measured at end of cleaning, and name of person conducting test,

END OF SECTION

AIR DISTRIBUTION - GENERAL

23 31 01

1 GENERAL

1.1 Scope

- .1 Provide labour, materials and equipment for installation, testing and putting into operation ventilating and air conditioning systems as further specified in other Specification sections of Division 20 to 25.

1.2 Qualified Tradesperson

- .1 Work to be performed by qualified, licensed and recognized firm with an established reputation in this field, using tradesperson holding applicable certificates of competency.

2 PRODUCTS

2.1 Not Used

3 EXECUTION

3.1 Ductwork

- .1 Ductwork system routing is shown diagrammatically. Drawings are not to be considered as fabrication or installation drawings.
- .2 Locate mains, risers and runouts to be concealed behind furrings or above ceilings, except in mechanical equipment rooms and access spaces where ductwork is to be exposed.
- .3 Determine areas without ceilings from Architectural drawings and Room Finish Schedules, and in these areas keep ductwork as high as possible.
- .4 Anchor, guide and support vertical and horizontal runs of ductwork to resist dead load and external live loads, and to absorb pressure thrust.

3.2 Air Supply Equipment

- .1 Install and connect air handling units, air conditioning units, fans and associated equipment, and build casing and plenums.

3.3 Air Exhaust Equipment

- .1 Install and connect exhaust fans, roof and wall exhausters and dust and fume collectors.

3.4 Terminals Units

- .1 Locate and install terminal units, registers, diffusers, and grilles. Coordinate with Architectural reflected ceiling plans for position of ceiling mounted elements.

3.5 Life Safety

- .1 Install fire dampers, smoke dampers, and combination smoke and fire dampers to protect openings in fire separations.
- .2 Provide smoke stopping around unprotected ducts passing through smoke separations.

3.6 Air Balancing

- .1 Co-operate with air balancing agency; install supplementary dampers, access openings and access doors to facilitate testing and adjustment.

END OF SECTION

METAL DUCTS

23 31 13.13

GENERAL

1.1 Scope

- .1 Provide metal HVAC ductwork including casings and plenums as shown.

1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
 - .1 20 05 01 Basic Materials and Methods
 - .2 20 05 49 Seismic Restraint
 - .3 23 33 05 Duct Accessories

1.3 Definitions and Abbreviations

- .1 The following definitions apply to this section and as applicable to related sections.
 - .1 **Casing(s)** – a fabricated metal construct of some combination of walls, roofs, and/or floors for the conveyance of air at relatively low air velocities (typically below 5 m/s (1000 fpm) and which encloses equipment such, as but not limited to, fans, coils, and filters.
 - .2 **Ductwork** – a network of metallic or flexible material distributed through a building or space for the conveyance of air: (a) from an HVAC unit to one or more spaces, or (b) exhausted from those spaces.
 - .3 **Plenums** – a form of ductwork for the conveyance of air at relatively low velocities (typically below 3.5 m/s (700 fpm)).
- .2 In SMACNA 006 - *HVAC Duct Construction Standard – Metal and Flexible*, a reference to requirements for construction of “casings” in chapter 9 applies equally to construction of plenums, except/and as specified herein.

1.4 Applicable Codes and Standards

- .1 Installation codes and standards:
 - .1 NFPA 90A Standard for the Installation of Air-Conditioning and Ventilating Systems.
 - .2 ASHRAE Letter and number designations, shown as “CR3-16” etc., are taken from ASHRAE Duct Fitting Data Base.(DFDB)
 - .3 ANSI/SMACNA 006 HVAC Duct Construction Standards - Metal and Flexible (4th edition)
 - .4 ANS/SMACNA 002 Rectangular Industrial Duct Construction Standards (2nd edition)
 - .5 ANSI/SMACNA 016 HVAC Air Duct Leakage Test Manual (2nd edition)
- .2 Product standards:
 - .1 ASTM A36 Standard Specification for Carbon Structural Steel
 - .2 ASTM A90 Standard Test Method for Weight (Mass) of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings
 - .3 ASTM A240 Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications

- | | | |
|-----|----------------|--|
| .4 | ASTM A283 | Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates |
| .5 | ASTM A463 | Standard Specification for Steel Sheet, Aluminum-Coated, by the Hot-Dip Process |
| .6 | ASTM A480 | Specification for General requirements for Flat Rolled Plate, Sheet, and Strip |
| .7 | ASTM A653 | Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot Dip Process |
| .8 | ASTM A924 | Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process |
| .9 | ASTM A1011 | Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength |
| .10 | ASTM B209 | Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate |
| .11 | ANSI/MSS SP-58 | Pipe Hangers and Supports |

1.5 Qualified Tradesperson

- .1 Work to be performed by qualified, licensed and recognized firm with an established reputation in this field, using tradesperson holding applicable certificates of competency.

1.6 Design Criteria

Seismic design loading for duct supports to conform to Specification section 20 05 49.

1.7 Submittals

- .1 Submit manufacturer's catalogue literature for:
 - .1 proprietary joints.
- .2 Submit fabrication shop drawings for the following ductwork elements:
 - .1 water-resistant ductwork,

1.8 As-Built Drawings

- .1 As work progresses, mark-up field drawings as to actual location of ductwork, balancing dampers and other duct accessories and submit as part of record of "As-Built" conditions.

2 PRODUCTS**2.1 Common Material**

- .1 Galvanized steel:
 - .1 Ducts and connectors: lock forming quality to ASTM A653 or ASTM A924, type Z180 (G60) or Z275(G90) as specified in Part 3 – EXECUTION.
 - .2 Miscellaneous pipe, angles, strips and threaded rod in contact with ductwork: galvanized with a minimum thickness equal to ASTM A653 - Z180 (G60).
- .2 Stainless steel:
 - .1 to ASTM A480/ASTM A240, Type 304L and 316L.
 - .2 finish: 2B mill, except where otherwise shown.

.3 Aluminum:

.1 To ASTM B209;

(a) alloy 3003-H14 or 5052-H32 for sheet material.

(b) alloy 6061-T6 for plate material

(c) alloy 6061-T4 or T6 for shapes material.

.4 Plain mild carbon steel:

.1 To ASTM A1011, A283, A572 and A36 as applicable.

2.2 Joints

.1 Fabricated joints: to ANSI/SMACNA 006 as applicable to duct pressure class, duct size, duct-wall thickness, and reinforcing requirements.

.2 Bolted companion flange – rectangular ductwork:

.1 formed flanges, corner pieces, integral edge seals, gaskets and cleats.

.2 material to match that of ductwork being joined,

.3 Neoprene gaskets.

Standard of Acceptance

- Ductmate – fig. System 25/35/45
- Hardcase (Carlisle) – fig. Nexus

.3 Barrel-rim clamped companion flange – round ductwork:

.1 roll-formed companion flanges, field installed, mechanically fastened and sealed to ends of duct,

.2 barrel ring clamp with bolted or no-tool cam locking clamp,

.3 Neoprene gaskets.

Standard of Acceptance

- Ductmate - fig. Spiralmate
- Nordfab - fig. Quick-Fit Ducting

2.3 Sealant and Tape

.1 To Specification section 23 33 05.

2.4 Hangers and Supports

.1 Upper hanger attachments;

.1 for steel joist: galvanized joist clamps or steel plate washer.

Standard of Acceptance

- Anvil Fig. 61 or 86
- Anvil Fig. 60 for plate washer

.2 for steel beams: galvanized beam clamps.

Standard of Acceptance

- Anvil Fig. 60

- .2 Hanger straps:
 - .1 Galvanized steel strap hangers for indoor use only.

- .3 Hanger rod:
 - .1 Continuous threaded rod:
 - (a) carbon steel, USS national course thread,
 - (b) tension load ratings to MSS SP-58,

Standard of Acceptance

- Anvil - fig. 146
- Taylor – fig. 54

- .2 Welded eye rod:
 - (a) carbon steel, USS national course thread,
 - (b) tension load ratings to MSS SP-58,
 - (c) tension load rating to be the same as continuous welded rod.

Standard of Acceptance

- Anvil - fig. 278
- Taylor

- .4 Seismic supports and restraints to Specification section 20 05 49.

2.5 Duct Access Doors

- .1 To Specification section 23 33 05.

3 EXECUTION

3.1 General Fabrication and Installation Requirements

- .1 Construction details, sheet gauges, reinforcing, and bracing for ductwork, casings, and plenums to be in accordance with SMACNA 006, except/and as otherwise shown.
- .2 Material selection: refer to Schedule A at the end of this section where otherwise shown.
- .3 Rectangular ductwork seams and joints:
 - .1 longitudinal seams: Pittsburgh Lock, with specified sealant applied prior to hammering of joint,
 - .2 transverse joints: to SMACNA HVAC standards based on pressure class and reinforcement used, and for sealing requirements.
- .4 Round ductwork seams and joints, for pressure class 500 Pa (2 in wg) and higher:
 - .1 spiral flat type longitudinal seam, button punched.

3.2 Balancing Dampers

- .1 Provide splitter dampers where branch connections are taken from supply mains.
- .2 Provide single blade dampers on each branch of supply air systems downstream of terminal boxes.
- .3 Provide Opposed Blade Dampers (OBD) at branch and main connection on exhaust and return air systems.

3.3 Finishing, Fastening and Supports

- .1 Hammer edges and slips to leave smooth finished surface inside duct.
- .2 Support vertical ducts with steel angles riveted to duct and bearing on building structure;
 - .1 design and fabricate duct riser supports using supplementary structural steel supports in accordance with SMACNA 006 and Specification section 20 05 01.
 - .2 use plain carbon steel for duct riser supports located indoors,
 - .3 use galvanized carbon steel for duct riser supports located outdoors.
- .3 Duct hangers;
 - .1 for ducts with both dimensions not exceeding 500 mm (20 in):
 - (a) supported with strap hangers of same material as duct but one sheet metal thickness heavier, or on steel angles as specified below.
 - (b) extend strap hangers down duct side and turn under 50 mm (2 in) fastening securely to side and underside of duct.
 - .2 for ducts with any dimension greater than 500 mm (20 in):
 - (a) supported with trapeze hangers constructed from galvanized steel angle with steel rods in accordance with table 1;

Table 1 : Duct Hangers		
Duct size mm (in)	Angle size mm (in)	Rod size mm (in)
up to 750 (up to 30)	25x25x3 (1x1x $\frac{1}{8}$)	6 ($\frac{1}{4}$)
750 to 1050 (30 to 40)	40x40x3 (1 $\frac{1}{2}$ x1 $\frac{1}{2}$ x $\frac{1}{8}$)	6 ($\frac{1}{4}$)
1050 to 1500 (40 to 60)	40x40x3 (1 $\frac{1}{2}$ x1 $\frac{1}{2}$ x $\frac{1}{8}$)	10 ($\frac{3}{8}$)
1500 to 2400 (60 to 90)	50x50x3 (2x2x $\frac{1}{8}$)	10 ($\frac{3}{8}$)
2400 and over (90 and over)	50x50x6 (2x2x $\frac{1}{4}$)	10 ($\frac{3}{8}$)

- .3 maximum hanger spacing: 2.4 m (8 ft) on centre.

For additional requirements for seismic restraints, refer to Section 20 05 49.

Water-resistant Ducts for Showers and Decontamination Rooms

- .1 General construction requirements for water penetration-resistant ductwork:
 - .1 weld longitudinal and transverse joints,
- .2 Shower and Decontamination Room exhaust ducts:
 - .1 application:
 - .2 material: in accordance with Schedule A at the end of this section,
 - .3 ductwork limits: commencing at connection to exhaust grilles and extending a minimum of 1500 mm (5 ft) from shower exhaust grilles and sloped to drain back through exhaust grilles served.

3.5 Pressure Classification and Seal Class

- .1 Low pressure ductwork construction classification in accordance with Table 2.

Table 2: Duct Pressure Classification			
Pressure class Pa (in wg)	Operating pressure Pa (in wg)	Velocity m/s (fpm)	Leakage Test Pressure Pa (in wg)
125 (½)	up to 125 (½)	10.0 (2000)	125 (½)
250 (1)	125 to 250 (½ to 1)	12.5 (2500)	250 (1)
500 (2)	250 to 500 (1 to 2)	12.5 (2500)	500 (2)
750 (3)	500 to 750 (2 to 3)	15.0 (3000)	750 (3)
Greater than 750 (3)	High Pressure Ductwork		Not less than 1000 (4)

- .2 Assemble ductwork seams and joints with joint sealant as shown in table 3.
- .3 Sealant application:
 - .1 store duct sealant at room temperature for 24 hours before use,
 - .2 apply sealant on seams as noted in table 1, and brush or extrude sealant to cover fasteners,
 - .3 on bell and spigot style joints apply sealant on male section with caulking gun and spread sealant evenly on mating surface with brush,
 - (a) insert fitting and secure with sheet metal screws
 - (b) brush sealant onto outside of assembled joint in 50 mm (2 in) wide band covering fastener heads,
 - .4 allow 40 hours curing time before pressure testing.

Table 3: Duct System Pressure and Seal Class – Healthcare and Laboratories

No.	Ductwork System	Static pressure construction class Pa (in.wg.)	Seal class	Sealing requirements (1)(2)(3)(4)
1	Supply air ducts inside of mechanical rooms	+1000 (4)	A	Transverse joints, longitudinal seams, and duct wall penetrations
3	Supply air duct risers in vertical service space (duct shafts).	+1000 (4)	A	
4	Supply air ducts serving operating rooms and associated support spaces	+1000 (4)	A	
5	Return/exhaust air ducts between a Heat Recovery Wheel and suction side of fan.	-1000 (4)	A	
6	Supply, return and exhaust air ducts located outdoors.	All classes as otherwise specified herein	A	
7	Autopsy exhaust air ducts.	-1000 (4)	A	
8	Process exhaust air ducts between exhaust HEPA filters and suction side of fan.	-1000 (4)	A	
9	Process exhaust air ducts upstream of exhaust air filters, or upstream of exhaust fan if there are no exhaust filters	-750 (3)	A	
10	Chemical fume hood exhaust ductwork on suction side of exhaust fan	-750 (3)	A	
11	Biohazard exhaust ductwork	-750 (3)	A	
12	Perchloric Acid exhaust system on suction side of exhaust fan	-1500 (6)	A	
13	Perchloric Acid exhaust system on discharge side of exhaust fan	+500 (2)	A	
14	Supply air ductwork between vertical riser and inlet to terminal units or reheat coils (excluding any supply air system containing HEPA filters)	500 (2)	B	Transverse joints and longitudinal seams

Table 3: Duct System Pressure and Seal Class – Healthcare and Laboratories

No.	Ductwork System	Static pressure construction class Pa (in.wg.)	Seal class	Sealing requirements (1)(2)(3)(4)
15	Supply air ducts between supply fan and inlet to HEPA filters/HEPA diffusers (other than operating rooms)	750 (3)	B	
16	Supply air ductwork downstream of terminal units or reheat coil to outlet HEPA filters	+500 (2)	B	
17	Return air and general exhaust air duct risers in mechanical rooms and in vertical service spaces (duct shafts).	-750 (3)	B	
18	Exhaust ductwork on discharge side of fans for: autopsy exhaust, process exhaust, chemical fume hood exhaust, biohazard exhaust	+500 (2)	B	
19	Supply air ductwork downstream of terminal units or reheat coil (no HEPA filters)	250 (1)	C	Transverse joints
20	Return air and general exhaust air main ducts on suction side of fans <u>other than</u> in mechanical rooms and vertical service spaces.	-250 (1)	C	
21	Relief air ductwork on discharge side of return fan	+250 (1)	C	
22	Fan coil units, suction and discharge.	+250 (1)	C	
23	Washroom and general exhaust branch ducts to individual rooms	125 (1/2)	---	None

Notes for table 3:

- (1) *Transverse joints* are connections of two duct or fitting elements oriented perpendicular to flow,
- (2) *Longitudinal seams* are joints oriented in direction of flow,
- (3) *Duct wall penetrations* are openings made by screws, non-self-sealing fasteners, pipe, tubing, rod and wire,
- (4) *Other connections* such as spin-ins taps and other branch fittings inserted into cut openings in duct, access door frames, insertion type control elements and duct joints at equipment are to be treated as *transverse joints*.
- (5) *This pressure class also applies to supply ductwork downstream of a terminal unit or reheat coil which serve diffusers with integral HEPA filters.*

3.6 Fittings - Rectangular Ductwork

- .1 Refer to Schedule B at the end of this section for illustrations of referenced fitting types.
- .2 Elbows:
 - .1 Elbows are to be installed as shown, or if not shown, in descending order as listed in table 4.

- (a) for clarity, elbows types are to be selected based on the highest order number (where 1 is the highest) which will fit the available space.

Table 4: Rectangular Duct, Elbows						
Order No.	ASHRAE Fitting No.	Description	Throat Radius Ratio R/W	Duct Width Limit mm (in)	Minimum Throat Radius mm (in)	Remarks
1	CR3-1	Smooth radius Un-vaned elbow	1.5	≤ 300 (12)	---	Default
			1.0	> 300 (12)	---	
2	CR3-3	Smooth radius Vaned elbow	0.75	≤ 900 (36)	150 (6)	One full radius single thickness splitter vane
	CR3-4	Smooth radius Vaned elbow	0.75	> 900 (36) ≤ 1500 (60)	150 (6)	Two full radius single thickness splitter vane
	CR3-5	Smooth radius Vaned elbow	0.75	> 1500 (60)	150 (6)	Three full radius single thickness splitter vane
3	CR3-15	Square Mitred Vaned elbow	Square throat; Square heel.	--	---	Double thickness turning vanes; 50 (2) heel radius vane; 54 mm (2.125 in) vane spacing.

.2 First elbow on discharge side of fan:

- (a) fitting CR3-1, un-vaned elbow with throat radius 1.0 times duct width, with the required upstream effective length L_e of straight length of duct in accordance with fitting type SR7-5 or SR7-9 as applicable.

.3 Wye and tee branch fittings - Supply air systems:

- .1 Wye and tee branch fittings are to be installed as shown, or if not shown, as selected from table 5.

Table 5 : Rectangular Duct, Wye and Tee Branch Fittings - Supply Air Systems			
Ref. No.	Supply Ductwork System	Fitting Type	ASHRAE Fitting No
1	For 750 Pa (3 in.wg) pressure class and above: branch take-off from ducts in shafts, and ducts upstream of terminal boxes, filters and reheat coils	Smooth radius wye; diverging	SR5-1
		Dovetail wye	SR5-14
		Divided flow fittings	(SMACNA) 4A or 4B
		45° entry branch diverging	SR5-13
2	Supply ducts downstream of terminal boxes, fan coil units, reheat coils or heat pumps	Tee, rectangular main to round conical tap	SR5-12
		Tee, 45° entry branch diverging	SR5-13

Table 5 : Rectangular Duct, Wye and Tee Branch Fittings - Supply Air Systems			
Ref. No.	Supply Ductwork System	Fitting Type	ASHRAE Fitting No
		Smooth radius wye; diverging	SR5-1

.4 Wye and tee branches - Return/Exhaust air systems:

- .1 Wye and tee branch fittings are to be installed as shown, or if not shown, as selected from table 6.

Table 5 : Rectangular Duct, Wye and Tee Branch Fittings - Return/Exhaust Air Systems			
Ref. No.	Return/Exhaust Ductwork System	Fitting Type	ASHRAE Fitting No
1	All pressure classes including branch connections at duct shafts	Smooth radius wye; converging	ER5-1
		Dovetail wye	ER5-4
		Divided flow fittings	(SMACNA) 4A or 4B
		45° entry branch diverging, where shown on drawings	ER5-3

.5 Transitions (Rectangular and Round):

- .1 converging: maximum 20° angle between duct side and direction of flow,
.2 diverging: maximum 15° angle between duct side and direction of flow.

.6 Fabricate duct offsets using elbows selected in accordance with table 2 and as follows:

- .1 single offset in single plane, less than duct height: made up with two 45° elbows,
.2 single offset, of greater displacement, made up with 90° elbows,
.3 double offset in single plane, less than duct height, made up with four 45° elbows,
.4 double offset in single plane, of greater displacement than duct height, made up with 90° elbows.

.7 Obstructions passing through duct:

- .1 covered by round nosed streamline enclosure where free area of duct is reduced by less than 15%,
.2 fitted in round nosed streamline enclosure with duct width increase, SMACNA HVAC FIG 2-10, Detail E , with converging and diverging transition angle requirements as specified above.

3.7 Fittings - Round Ductwork

- .1 Refer to Annex A at the end of this Section for illustrations of referenced fitting types.

.2 Elbows:

- .1 Elbows are to be installed as shown, or if not shown, in order of available space as listed in table 6.

Table 6 : Round Duct, Elbows					
Ref. No.	Description	ASHRAE Fitting No.	Throat Radius Ratio R/W	Duct Width Limit mm (in)	Remarks
1	30° elbow	CD3-3*	1.5	≤ 300 (12)	Die stamped
		CD3-14*	1.5	> 300 (12)	2-Gore
2	45° elbow	CD3-3	1.5	≤ 300 (12)	Die stamped
		CD3-14	1.5	> 300 (12)	3-Gore
3	60° elbow	CD3-3*	1.5	≤ 300 (12)	Die stamped
		CD3-14*	1.5	> 300 (12)	4-Gore
4	90° elbow	CD3-1	1.5	≤ 200 (8)	Die stamped
		CD3-9	1.5	>200 (8) and ≤ 350 (14)	5-Gore
		CD3-10	1.5	>350 (14) and ≤ 900 (36)	7-Gore
			2.5	> 900 (36)	7-Gore

.3 Wye branches:

- .1 Wye and tee branch fittings are to be installed as shown, or if not shown, as selected from table 7.

Table 7 : Round Duct, Wye and Tee Branch Fittings			
Ref. No.	Supply Ductwork System	Fitting Type	ASHRAE Fitting No
1	Downstream of supply fan.	Wye branch plus 45° elbow	SD5-2
		Tee, tapering	SD5-12
2	Downstream of terminal boxes.	Wye branch plus 45° elbow	SD5-1
		Tee, tapering	SD5-10
3	Return or exhaust duct branches.	Wye branch plus 45° elbow	ED5-2
4	Return or exhaust duct branches; equal main and branch duct size.	Tee, tapering, with 45° elbow	SD5-2
5	Return or exhaust duct branches; smaller branch size.	Tee, tapering, with 45° elbow	SD5-12

3.8 Temporary Protection of Duct Openings

- .1 Cap off ends of unfinished ducts while plastering, drywall and other finishing operations are in progress,
- .2 Cover open ends or registers of active exhaust/return ducts with 25 mm (1 in) thick filter media secured with tape. Maintain media until dust producing finishing operations are completed.

3.9 Duct Access Doors

- .1 Provide for inspection and servicing of duct mounted components and cleaning of duct system;
 - .1 located such that any section of duct is not more than 15 m (50 ft) from point of access,
 - .2 in front of and behind duct mounted coils.
- .2 Door size:
 - .1 Select access door sizes based on smallest duct dimension in accordance with table 8.

Table 8 : Access Door Sizes			
Smallest Duct Dimension mm (in)	Bottom of duct height above floor m (ft)	Location	Door Size mm (in)
≤ 350 (14)	Any	Side or bottom	300 x 150 (12x6)
>350 and ≤500 (>14 and ≤20)	Any	Side or bottom	450 x 250 (18x10)
>500 (>20)	≤3.6 (12)	Side or bottom	530x350 (21x14)
	>3.6 (12)	Bottom	635x430 (25x17)

3.10 Duct Pressure Testing

- .1 Duct pressure testing must be completed to the satisfaction of Consultant before ductwork is insulated or concealed.
- .2 Pressure test air duct systems for leaks at 1.0 times the system, or portion of the system, pressure class specified and as follows;
 - .1 between supply air handling units and terminal units,
 - .2 between supply air handling units and final connection to supply outlets on supply systems without terminal units (excluding flexible ductwork)
 - .3 between inlet grilles and the exhaust/return fan inlet,
 - .4 between the return fan discharge outlet and the mixing plenum on recirculating return systems,
 - .5 between the exhaust fan discharge outlet and the point of discharge before leaving the building, but only for process exhaust systems conveying any materials other than general building exhaust air,
- .3 The following parts of system are exempt from pressure testing;
 - .1 short duct runs of 15 metres (45 feet) or less, operating at 37 Pa (1/8 in) SP or less.
 - .2 ductwork installed downstream of terminal boxes and fan coil units.
- .4 Conduct test in accordance with Associated Air Balance Council (AABC) recommended procedures.
- .5 Where audible air noise is detected during test, remove test, pressure apply sealant to leaking joints and seams, and retest after 48 hours. Continue testing and sealing until leaks are inaudible.

3.11 Duct Leakage Testing

- .1 Duct leakage testing must be completed to the satisfaction of Consultant before ductwork is insulated or concealed.
- .2 Conduct duct leakage tests in accordance with SMACNA *HVAC and Duct Leakage Test Manual* and as specified herein.
- .3 For each duct systems, calculate the maximum allowable ductwork airflow leakage rate based on duct surface area, pressure class and duct seal class in accordance with the following:

$$L = F \times D_{SA}$$

$$\text{and } F = K \times C_L \times P^{0.65}$$

where these parameters are unique to each section of duct:

- L is the maximum allowable leakage airflow rate,
- D_{SA} is the duct surface area,
- F is the leakage rate coefficient,
- C_L is the duct leakage class, and is listed in Table 10,
- P is the duct design pressure,
- K is a conversion factor depending on the units of measure and is listed in Table 9.

Table 9: Duct Leakage Measurement Units			
	Parameter	Flow Measurement Units	
		L/s	CFM
L	Allowable leakage units	L/s	CFM
D_{SA}	Duct surface area units	m ²	ft ²
F	leakage rate coefficient	L/s per m ²	CFM per 100 ft ²
C_L	Leakage Class Coefficient	Refer to table 10 below	Refer to table 10 below
P	Duct Class pressure units	Pa	in.w.c.
K	unit conversion (multiplier)	1.4 x 10 ⁻³	1

Table 10: Leakage Coefficient, C_L			
Duct Type	Pressure Class		
	500 (2)	750 (3)	≥1000 (4)
Rectangular metal	16	8	4
Round Metal	8	4	2
Unsealed rectangular metal duct	48	48	48
Unsealed round or oval metal duct	30	30	30

- .4 Conduct duct leakage tests for each duct system at an air pressure equal to the duct system pressure class. Where a duct system has multiple pressure classes for different sections, test each section of the system independently.
- .5 If leakage rate exceeds the calculated maximum allowable value, examine ductwork for excessive leakage, re-seal and then repeat the leak test until the measured leakage rate is less than the calculated maximum allowable value for the section of the system under test.
 - .1 for clarity, where a duct system consists of multiple sections of different pressure classes, the acceptance criteria is based on not exceeding the aggregate of the calculated maximum allowable leakage of all sections in the same duct system.
- .6 Maintain a set of drawings on site, coloured each day during testing to indicate extent of duct satisfying leakage criteria under test.
- .7 Submit a written report, verified by the TAB Agent, identifying each segment of duct system tested, showing calculation of maximum allowable leakage (duct surface area, pressure class, seal class, leakage class "C_L" and calculated leakage air flow rate for the section), along with the test pressure and measured leakage airflow rate, and certifying that leakage testing has been satisfactorily completed.
- .8 Submit the report for review by Consultant before duct insulation is installed and branch take-offs are made for terminal units.

3.12 Duct Cleaning

- .1 Cleaning to be performed by agent specializing in this field of work, be a member in good standing with National Air Duct Cleaners Association (NADCA), and to comply with NADCA standards.
- .2 Clean new horizontal and vertical ducts (supply, return, exhaust, transfer), as well as existing supply and return ductwork connected to new fan systems.
- .3 Clean ductwork using high powered vacuum system, hand tools and mechanical brushing systems such that metal surfaces are visibly clean.
- .4 Reset balancing dampers to original settings if moved during work. Have TAB Agent confirm damper settings.
- .5 Maintain set of drawings on site, coloured each day during cleaning to indicate extent of duct cleaning completed.
- .6 Submit a written report, verified by TAB Agent, identifying extent of duct system cleaning and certifying that NADCA standards have been met.

3.13 Schedules

- .1 The following schedules form part of this specification section.
 - .1 Schedule A – Ductwork, Casings and Plenum Materials
 - .2 Schedule B – Illustrations of Referenced Fittings.

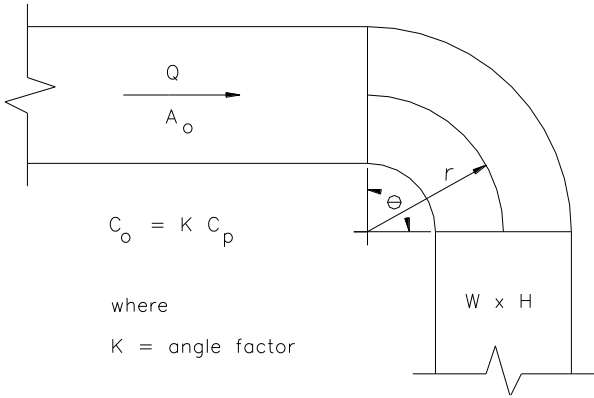
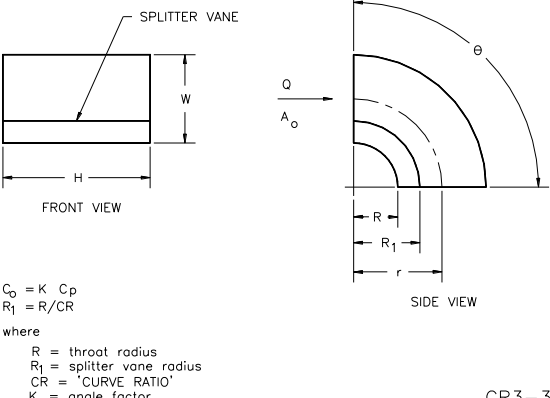
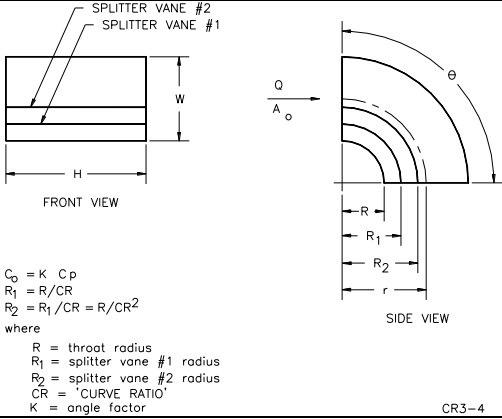
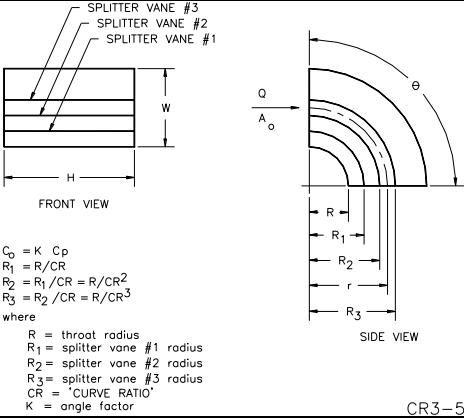
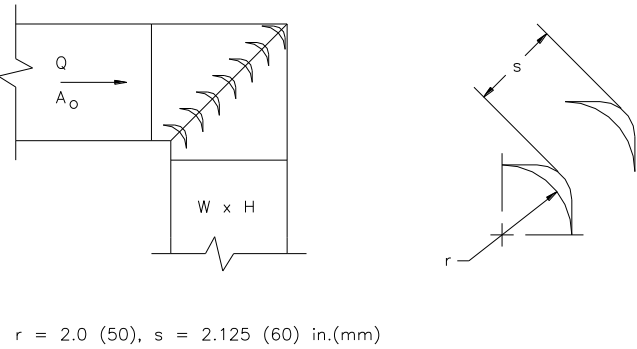
Schedule A – Materials for Ductwork, Casings and Plenums					
<u>Legend</u> "Yes" means permitted material "---" means not permitted Where more than one material is indicate as permitted for a particular application or location, than any of those permitted materials may be used.					
Application or Location	Galvanized Steel Z180 (G60)	Galvanized Steel Z275 (G90)	Stainless Steel 304L or 316L	Aluminum	Notes
Shower room supply ducts	---	---	Yes	Yes	[5]
Shower room exhaust ducts	---	---	Yes	Yes	[4] [5]
All other indoor locations	Yes	Yes	---	---	

Notes:

- [1] Not used.
- [2] Not used.
- [3] Not used.
- [4] Welded joints and seams. Flanges, including Vanstone-type flanges, may be used for duct section connections and connections at equipment
- [5] Applies to Decontamination Room.

Schedule B – Illustration of Referenced Fittings

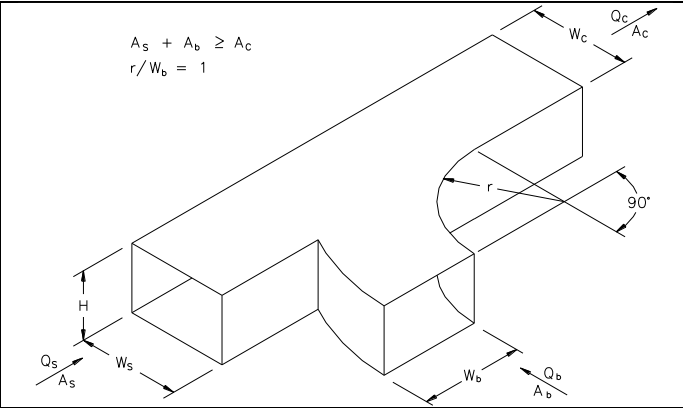
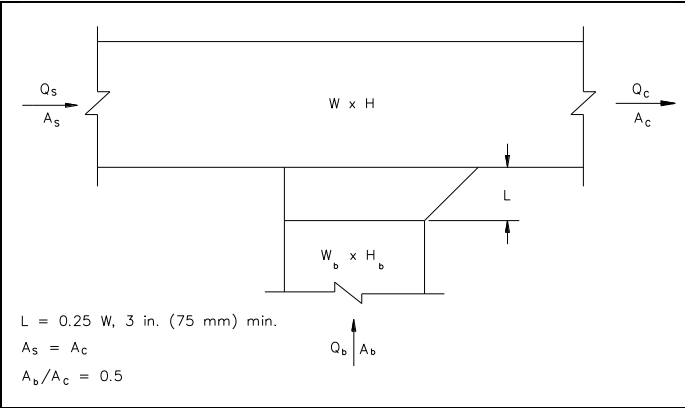
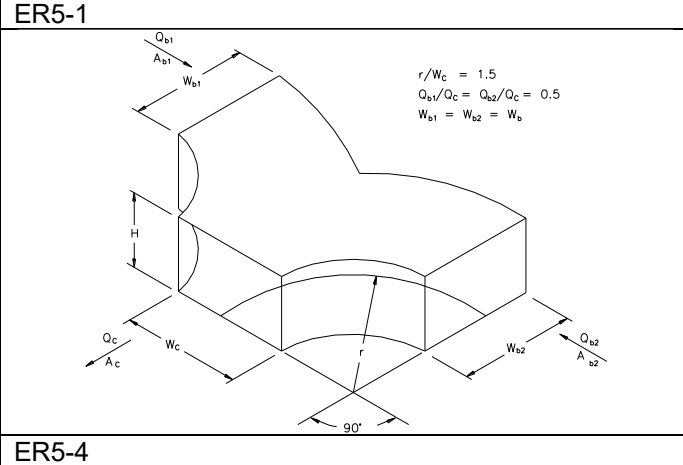
Rectangular Elbows (see Table 4 in Part 3.)

 $C_o = K C_p$ where K = angle factor $W \times H$	 SPLITTER VANE FRONT VIEW SIDE VIEW $C_o = K C_p$ $R_1 = R/CR$ where R = throat radius R_1 = splitter vane radius CR = 'CURVE RATIO' K = angle factor CR3-3
 SPLITTER VANE #2 SPLITTER VANE #1 FRONT VIEW SIDE VIEW $C_o = K C_p$ $R_1 = R/CR$ $R_2 = R_1/CR = R/CR^2$ where R = throat radius R_1 = splitter vane #1 radius R_2 = splitter vane #2 radius CR = 'CURVE RATIO' K = angle factor CR3-4	 SPLITTER VANE #3 SPLITTER VANE #2 SPLITTER VANE #1 FRONT VIEW SIDE VIEW $C_o = K C_p$ $R_1 = R/CR$ $R_2 = R_1/CR = R/CR^2$ $R_3 = R_2/CR = R/CR^3$ where R = throat radius R_1 = splitter vane #1 radius R_2 = splitter vane #2 radius R_3 = splitter vane #3 radius CR = 'CURVE RATIO' K = angle factor CR3-5
 $r = 2.0$ (50), $s = 2.125$ (60) in.(mm) CR3-15	

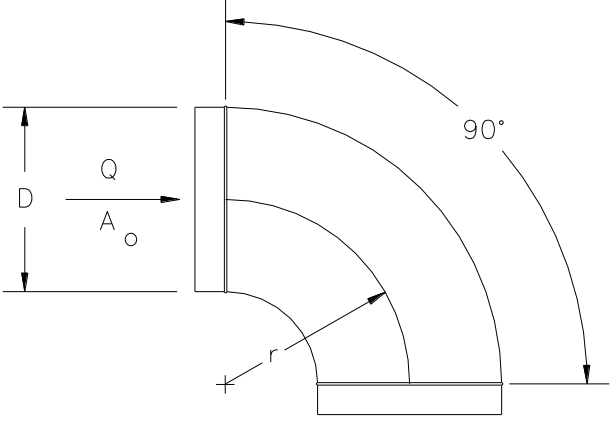
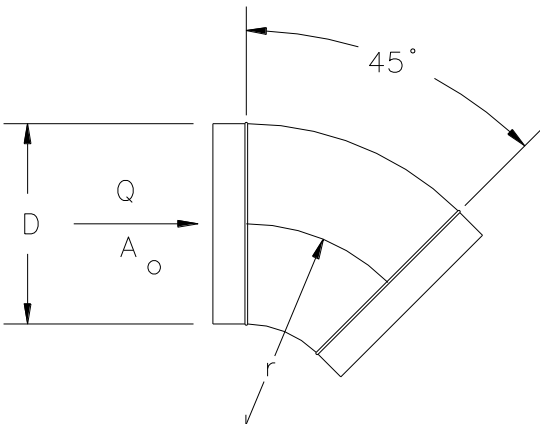
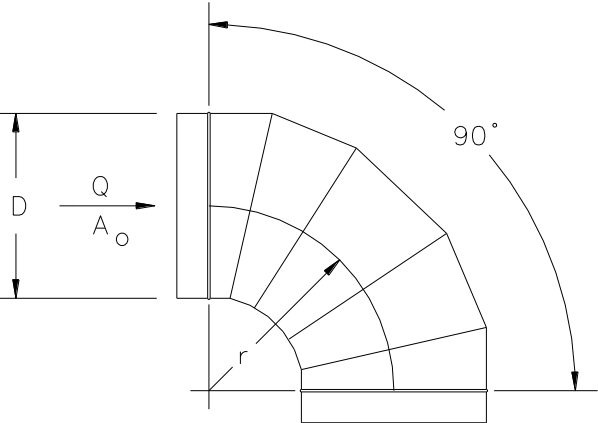
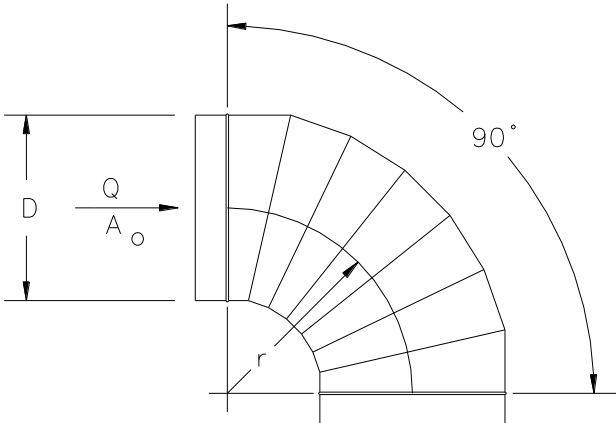
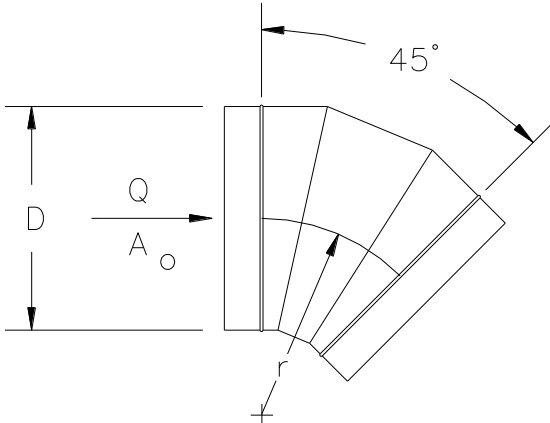
Rectangular Wyes and Tee's – Supply Ductwork (see Table 5 in Part 3)

$A_s = A_b \geq A_c$ $r/W_b = 1.0$	$L = 4\text{in.}(100\text{mm})$
SR5-1 $L = 0.25W_b, 3 \text{ in. (75mm) min.}$	SR5-12 $r/W_c = 1.5$ $Q_{b1}/Q_c = Q_{b2}/Q_c = 0.5$ $W_{b1} = W_{b2} = W_b$
SR5-13 SMACNA Fig. 4A/4B	SR5-14

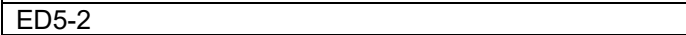
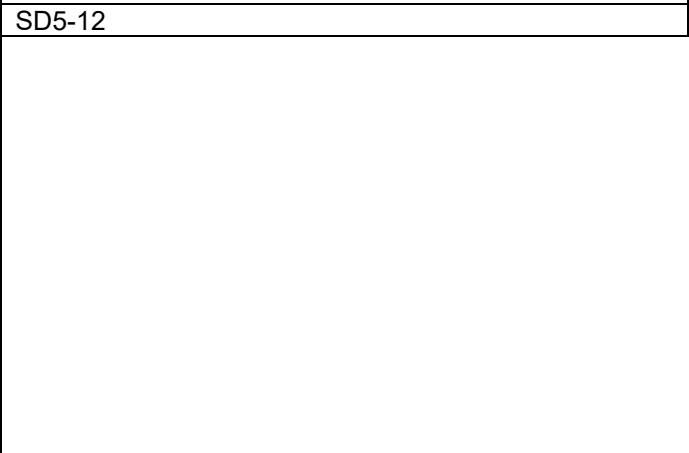
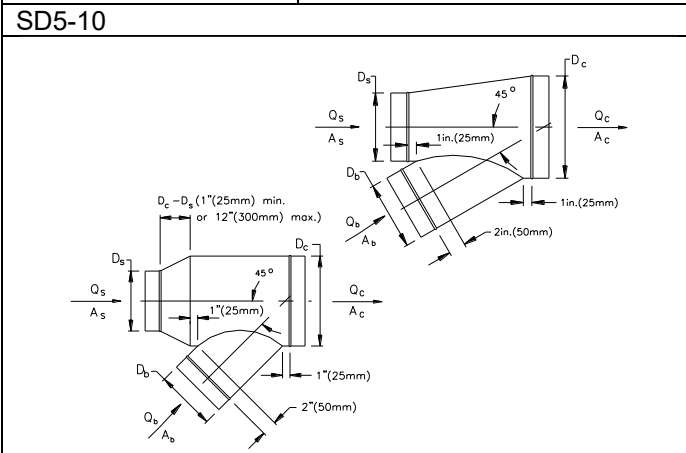
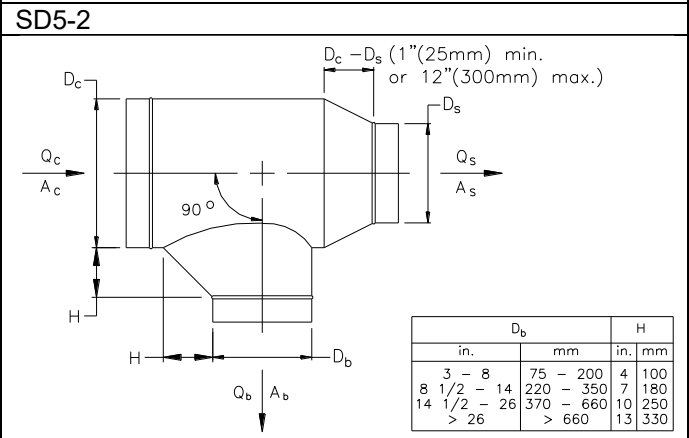
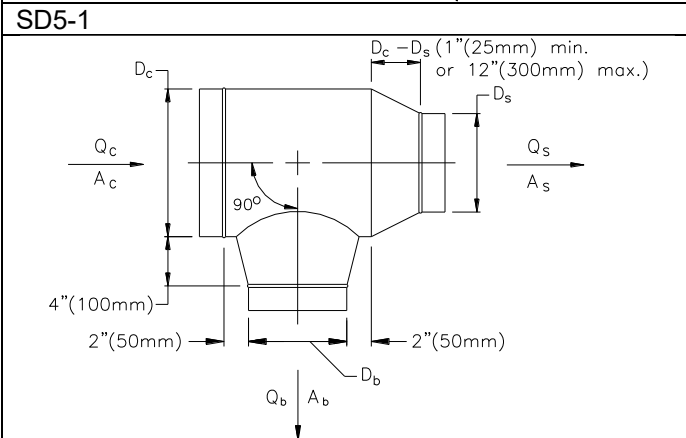
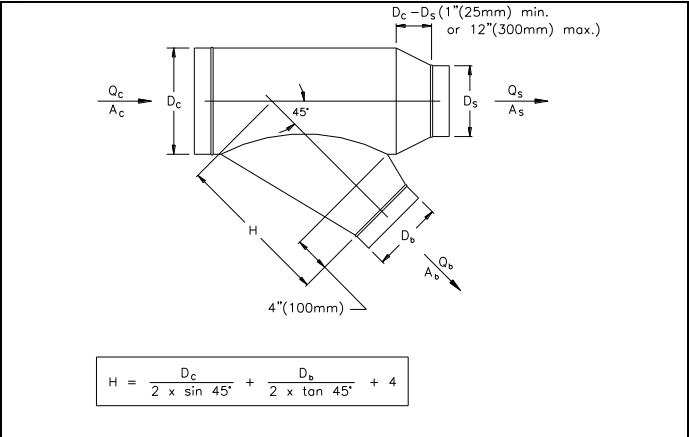
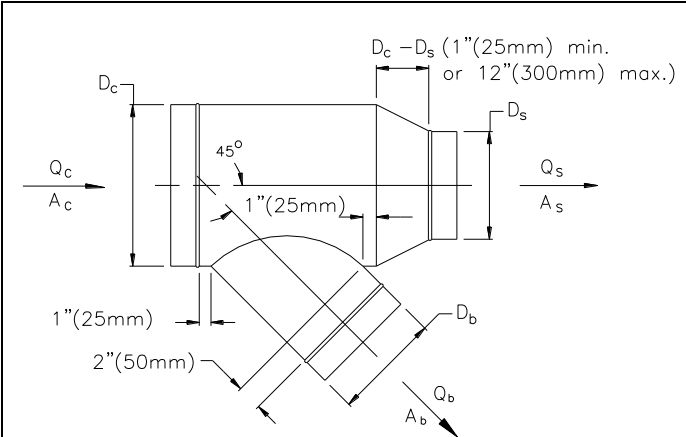
Rectangular Wyes and Tee's – Return/Exhaust Ductwork (see Table 5 in Part 3)

 $A_s + A_b \geq A_c$ $r/W_b = 1$	 $L = 0.25 W, 3 \text{ in. (75 mm) min.}$ $A_s = A_c$ $A_b/A_c = 0.5$
 $r/W_c = 1.5$ $Q_{b1}/Q_c = Q_{b2}/Q_c = 0.5$ $W_{b1} = W_{b2} = W_b$	ER5-3
ER5-1	ER5-4

Round Elbows (see Table 6 in Part 3)

	
CD3-1	CD3-3
	
CD3-9	CD3-10
	
CD3-14	

Round Wyes and Tees (see Table 7 in Part 3)



END OF SECTION

DUCT ACCESSORIES

23 33 05

1 GENERAL

1.1 Scope

- .1 Provide duct accessories as shown.
- .2 Access doors for kitchen grease ducts to conform to Specification section 23 31 13.23.

1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
 - .1 23 31 13.23 Kitchen Grease Ductwork.

1.3 Applicable Codes and Standards

- .1 Product standards:
 - .1 LEED v4 New Construction, Low-Emitting Materials credit
 - .2 UL 1978 Grease Ducts
 - .3 ULC-S110 Standard Methods of Test for Air Ducts

1.4 Submittals

- .1 Submit product data sheets for:
 - .1 flexible fan connectors,
 - .2 sealants,
 - .3 tapes,
 - .4 duct access doors and hardware,
 - .5 instrument test ports.

2 PRODUCTS

2.1 Flexible Fan Connectors

- .1 Neoprene, non-insulated:
 - .1 fabric material: fire resistant, self-extinguishing, neoprene-coated glass fabric, density 0.653 kg/m² (0.13 lb./sq. ft),
 - .2 attachment frames: galvanized 0.66 mm (24 ga.) sheet metal frame, with fabric clenched with double locked seams,
 - .3 operating temperature: -40°C to 90°C (-40°F to 194°F),
 - ° Duro-Dyne - fig. Durolon
 - ° Ventfabric - fig. Ventglas
 - ° Elgin - fig. Neoprene
- .2 Vinyl coated, insulated:
 - .1 fabric material: flame resistant, 0.56 mm (0.022 in) thick vinyl coated fabric, encapsulating minimum 25 mm (1 in.) thick, 21 kg/m³ (1.34 lb./cu ft) fiberglass insulation,

- .2 attachment frames: galvanized 0.66 mm (24 ga.) sheet metal frame, with fabric clenched with double locked seams,
- .3 operating temperature: 82°C (180°F) continuous and 93°C (200°F) intermittent,

Standard of Acceptance

- Duro-Dyne - fig. Insulflex

- .3 Silicon rubber, non-insulated:

- .1 silicon rubber-coated woven fiberglass fabric, density of 0.461 kg/m² (0.094 lb./sq. ft),
- .2 attachment frames: galvanized 0.66 mm (24 ga.) sheet metal frame, with fabric clenched with double locked seams,
- .3 operating temperature: up to 260°C (500°F).

Standard of Acceptance

- Duro-Dyne - fig. Thermafab

2.2 Duct Sealant

- .1 Water-based polymer emulsion type, flame resistant duct sealing compound.
- .2 Operating temperature range: -29°C to 93°C (-20°F to 200°F).
- .3 Operating pressure: tested to operate at 2.5 kPa (10 in.w.c.) duct static air pressure,
- .4 Meets requirements for SMACNA Class A, B and C duct sealing requirements.
- .5 Listed to ULC-S102 with flame-spread rating of 25 or less and smoke-development classification of 50 or less.
- .6 LEED requirements:
 - .1 meets requirements for LEED BD+C v4 credit for low emitting material – Paints and Coatings.
 - .2 manufacturer to supply documentation demonstrating compliance.

Standard of Acceptance

- Bakor - fig. Duck-Seal
- RCD - fig. #6 Mastic
- Childers - fig. CP-146
- McGill Air Seal - fig. United Duct Sealer (Water Based)
- Duro Dyne - fig. DWN (water based)

2.3 Tape

- .1 Polyvinyl treated open weave glass fibre tape, 50mm (2") wide.

2.4 Access Doors for Standard-Duty Ducts

- .1 Application: for general purpose HVAC ductwork.
- .2 Low-pressure access doors:
 - .1 manufactured duct access doors, of same material as associated duct,
 - .2 pressure rating: 500 Pa (2 in.w.c.) positive and negative pressure,
 - .3 door panel:
 - (a) double-wall construction encapsulating 25 mm (1 in.) thick fibreglass insulation,

- (b) minimum 0.7 mm (24 ga.) sheet thickness for both inner and outer panel,
- (c) inside face of access door does not protrude into interior space of duct,
- .4 door frame: minimum 0.7 mm (24 ga.) thick channels, with mounting tabs and neoprene door gasket,
- .5 door size: 150x150 mm (6 x 6 in.) up to 600x600 mm (24x24 in.)
- .6 door hardware:
 - (a) hinge: continuous length, galvanized steel piano hinge of same material as door,
 - (b) latch - standard: galvanized steel cam-latch,
 - (c) latch – secured: common-key operated latch,
 - (d) security chain when only provided with cam-latches.

Standard of Acceptance

- Ductmate
- Duro-Dyne

- .3 High-pressure access doors – framed style:
 - .1 similar construction as for low-pressure framed access doors, except/and as specified below,
 - .2 pressure rating: 2500 Pa (10 in.w.c.) positive and negative pressure without measurable leakage under laboratory testing,
 - .3 hardware: cam-latch only,
 - (a) one (1) latch per door edge (total of 4) for 150x150 mm (6 x 6 in.) doors,
 - (b) two (2) latches per door edge (total of 8) for larger doors.

Standard of Acceptance

- Ductmate
- Duro-Dyne

- .4 High-pressure access doors – frameless style:
 - .1 manufactured duct access doors, of same material as associated duct, for rectangular, round and flat-oval ducts,
 - .2 pressure rating: 2500 Pa (10 in.w.c.) positive and negative pressure without measurable leakage under laboratory testing,
 - .3 door panel:
 - (a) inner sandwich double-wall construction, encapsulating 25 mm (1 in.) thick fibreglass insulation, spot-welded seams, with smooth-faced finish where exposed to the airstream,
 - (b) outer pressure panel: stamped reinforced-exterior panel,
 - (c) neoprene gasket applied to inner panel face, positioned for positive or negative pressure applications,
 - (d) inside face of access door does not protrude into interior space of duct,
 - .4 door frame: none.
 - .5 door size: 200x100 mm (8 x 4 in.) up to 600x450 mm (24 x 18 in.)
 - .6 door hardware:
 - (a) two (2) spring-loaded pressure-retaining bolting system, with tool-less polypropylene knobs.

Standard of Acceptance

- Ductmate - fig. Sandwich Access Doors

2.5 Instrument Test Ports

- .1 Manufactured test ports:
 - .1 nominal size: Ø25 mm (1 in) minimum inside diameter, length to suit insulation thickness,
 - .2 extended body to accommodate 25 and 50 mm (1 and 2 in.) insulation thickness as applicable to the duct system,
 - .3 1.6 mm (16 ga.) thick steel body zinc plated after manufacture,
 - .4 chain-secured neoprene expansion plug with cam lock handle,
 - .5 Neoprene mounting gasket: flat for rectangular duct and moulded for round duct.

Standard of Acceptance

- Duro-Dyne - fig. TH1 or IP2

- .2 Sealant for test port: high temperature silicone.

Standard of Acceptance

- Duro-Dyne - fig. Red High Temperature Silicon

3 EXECUTION

3.1 Flexible Fan Connectors

- .1 Provide flexible fan connectors to isolate ductwork which is connected to the following equipment:
 - .1 fans,
 - .2 radiators on engine-drive equipment including generators and fire pumps,
 - .3 indoor suspended air handling equipment,
 - .4 indoor air handling equipment supported on spring isolators,
 - .5 outdoor air handling units supported on spring-isolated roof curbs,
 - .6 and as shown.
- .2 For clarity, flexible fan connectors are not required for connection of ductwork to the following equipment:
 - .1 indoor air handling units with fans which have vibration isolation and where the unit is floor-mounted with or without elastomeric mounting pads.
- .3 Flexible fan connector dimensions:
 - .1 minimum length: 75 mm (3 in) length of fabric measured in direction of air flow,
 - .2 minimum distance between metal parts when system is in operation: 25 mm (1 in).
- .4 Use insulated type where connected ductwork is insulated.
- .5 Use silicon-rubber type for laboratory exhaust ducting, and other process exhaust ducting conveying chemical vapours and gases.

3.2 Sealant and Tape

- .1 Apply sealant to ductwork joints and seams as detailed in other sections.

- .2 Use of tape is limited to low-pressure systems requiring Class C

3.3 Access Doors for Standard Ducts

- .1 Provide access doors in HVAC standard ducts in accordance with the following table:

Access Point	Location
Reheat coils	Both sides of coil

- .2 Weld door frames in place for high velocity ductwork having air velocities in excess of 10 m/s (2500 fpm).
- .3 Access door sizes:
 - .1 as large as possible, with 1:1.5 aspect ratio, for duct sides up to and including 360 mm (14 in),
 - .2 300 mm x 380 mm (12 in x 15 in) for duct sides 380 mm (15 in) and larger,
 - .3 1500 mm (60 in) high by 450 mm (18 in) wide in casings and plenums.

3.4 Instrument Test Ports

- .1 Install test ports for duct velocity traverse readings and for duct air temperature readings.
- .2 Locate across duct or plenum at right angles to flow, at not more than 250 mm (10 in) intervals for traverses and at not more than 500 mm (20 in) for temperature measurements.
- .3 Install test ports for velocity traverses in the following locations:
 - .1 at inlet to and outlet from other fan systems, and
 - .2 at main and branch ducts where branch serves more than one outlet. Ports in main to be upstream of branch in both diverging and converging flow.
- .4 Install test ports for temperature measurement;
 - .1 at inlet and outlet of coils, and
 - .2 downstream of intersection of converging air streams of different temperatures.

END OF SECTION

MANUAL BALANCING DAMPERS

23 33 13.11

1 GENERAL

1.1 Scope

- .1 Provide manual balancing dampers.
- .2 This section does not apply to dampers installed in kitchen grease exhaust duct systems.

2 PRODUCTS

2.1 Splitter Dampers

- .1 Shop-fabricated, single thickness construction, of same material as duct but one sheet metal gauge thickness heavier where both dimensions of damper blade are less than 300 mm (12 in).
- .2 Double thickness construction, one metal gauge thickness lighter than duct, where either dimension of damper blade is 300 mm (12 in) or larger,
- .3 Height equal to full depth of branch duct, and length 1½ times branch duct width.
- .4 Fitted with piano hinge pivot, control rod, and locking device accessible from outside fitting.

2.2 Single Blade Dampers in Rectangular Ductwork

- .1 Manufactured product.
- .2 Blades and shaft:
 - .1 constructed of same material as the duct, with longitudinal V-grooves,
 - .2 blade thickness: 1.0 mm (20 ga.) minimum,
 - .3 blade length: 915 mm (36 in) maximum.
 - .4 bronze bearings,
 - .5 shaft extension with locking quadrant with 50 mm (2 in.) stand-off bracket.
- .3 Frame:
 - .1 channel section of same material as duct, minimum 1.3 mm (18 ga.) thickness,
 - .2 angle blade stop.

Standard of Acceptance

- ° Nailor - fig. 1870
- ° Ruskin
- ° Greenheck

2.3 Multi-Blade Dampers in Rectangular Ductwork

- .1 Manufactured product.
- .2 Blades and shaft:
 - .1 constructed of same material as the duct, with longitudinal V-grooves,
 - .2 opposed blade configuration, with link assembly located out of airstream,
 - .3 blade thickness: 1.6 mm (16 ga.) minimum,
 - .4 blade height: 150 mm (6 in) maximum,

- .5 blade length: 1200 mm (48 in) maximum.
- .6 synthetic polymer or bronze bushings,
- .7 shaft extension with locking quadrant with 50 mm (2 in.) stand-off bracket.
- .3 Frame:
 - .1 channel section of same material as duct, minimum 1.6 mm (16 ga.) thickness,
 - .2 angle blade stop,

Standard of Acceptance

- Nailor - fig. 1820
- Ruskin
- Greenheck

2.4 Single Blade Dampers in Round Ductwork

- .1 Manufactured product.
- .2 Blades and shaft:
 - .1 constructed of same material as the duct,
 - .2 blade thickness: 0.86 mm (22 ga.) minimum,
 - .3 blade diameter: Ø100 to 500 mm (4 to 20 in. dia.),
 - .4 bearings: synthetic self-lubricating bushing,
 - .5 shaft extension with locking quadrant with 50 mm (2 in.) stand-off bracket.
- .3 Frame:
 - .1 round duct section of same material as duct, minimum 0.86 mm (22 ga.) thickness, with stiffening beads,
 - .2 angle blade stop,
 - .3 stand-off bracket for locking quadrant for insulated ducts.

Standard of Acceptance

- Nailor - fig. 1890
- Ruskin
- Greenheck

2.5 Single Blade Dampers in Round Ductwork with Remote Cable Adjustment

- .1 Manufactured product.
- .2 Blades and shaft:
 - .1 constructed of same material as the duct,
 - .2 blade thickness: 1.0 mm (20 ga.) minimum with V brake centreline,
 - .3 blade diameter: Ø100 to 500 mm (4 to 20 in. dia.),
 - .4 bearings: synthetic self-lubricating bushing,
 - .5 shaft extension with 50 mm (2 in.) stand-off bracket.
- .3 Frame:
 - .1 round duct section of same material as duct,

- .2 wall thickness:
 - (a) Ø100 to 250 mm (4 to 10 in. dia.): 0.7 mm (24 ga.)
 - (b) Ø300 to 500 mm (12 to 20 in. dia.): 1.0 mm (20 ga.).
- .3 angle blade stop,
- .4 stand-off bracket for insulated ducts.
- .4 Remote cable operator:
 - .1 damper blade gear operator:
 - (a) self-locking worm-gear regulator, suitable for 9.5 mm (3/8 in.) square or Ø13 mm (½ in.dia) damper shaft,
 - .2 flex-shaft cable:
 - (a) Ø6 mm (1/4 in.dia.) multi-core wound cable in flexible non-binding protective sheath,
 - (b) length: standard and custom lengths up to 15 m (50 ft),
 - (c) with brass end caps and threaded end fittings to attached to damper gear operator and adjustment operator,
 - .3 remote cable operator fixture:
 - (a) cable termination end for tool access,
 - (b) termination kit:
 - i) Ø60 mm (2-1/4 in. dia) zinc coated termination access housing, with prime coated cover plate, for self-clamping installation in drywall ceilings,
 - ii) remote cable operator kit for installation in slot diffuser plenum to allow tool access through diffuser slot.

Standard of Acceptance

- ° Young Regulators - fig. 5020CC with 270-275 cable operator

3 EXECUTION

3.1 Balancing Damper Locations and Type

- .1 Provide balancing dampers in the following locations:
 - .1 at floor branches from a duct riser, use a single or multiple blade damper in the branch duct,
 - (a) where a wye-fitting is installed directly after the duct riser take-off, provide a balancing damper in each outlet branch after the wye fitting,
 - .2 for supply branch ducts that do not directly serve outlet grilles or diffusers, use a single or multiple blade damper in the branch duct,
 - .3 for exhaust or return branch ducts that do not directly serve inlet grilles, use a single or multiple blade damper in the branch duct,
 - .4 for branch duct which directly serve three or more grilles or diffusers (supply, return or exhaust), use splitter damper in the take-off fitting, or use a single or multiple blade damper in the branch duct,
 - .5 on the inlet to a supply air terminal unit, use a damper of the style to match the inlet duct connection to the air terminal unit,
 - .6 on the outlet from a return or exhaust air terminal unit, use a single or multiple blade damper in the branch duct.
- .2 Provide other manual dampers as shown.

3.2 Access for Adjustment

- .1 Locate dampers to allow adjustment of blade position and for locking of the quadrant.

3.3 Remote Cable Adjustment Station

- .1 Use round balancing dampers with remote cable operators where:
 - .1 ceiling height is greater than 3.0 m (10 ft),
 - .2 ceiling height is less than 3.0 m (10 ft) and is not accessible, or
 - .3 elsewhere at the Contractor's discretion.
- .2 Review with Consultant approximate location for each group of remote cable operators;
 - .1 exception: Consultant's review is not required when remote cable operator is located in a slot diffuser plenum.
- .3 Group operators together within the limits of the allowable cable length.
- .4 For ceilings up to 3.0 m (10 ft) in height, remote cable operators may be located in the following locations:
 - .1 within slot diffuser plenums, or
 - .2 mounted in or immediate above ceilings, with termination kit which passes through the ceiling to allow adjustment tool access from below ceiling.
- .5 For ceilings greater than 3.0 m (10 ft) in height, group remote operators together in wall chase access in locations agreed by Consultant, positioned between 1200 and 1800 mm (4 and 6 ft) above the floor. Provide a wall mounted access cover with screwdriver door operator and prime coated finish.
- .6 Where a service room, including mechanical rooms, electrical rooms, and janitor closets are available, mount the remote cable operator in those rooms on a wall mounted bracket. A panel enclosure is not required.
- .7 Label each remote cable operator with a unique reference number, and mark-up as-built drawings to include the reference number for each applicable balancing damper.

END OF SECTION

FLEXIBLE CONNECTORS

23 33 43

GENERAL

1.1 Scope

- .1 Provide flexible connectors between rigid ductwork and air terminal devices, as shown.
- .2 Flexible connectors not to be used where the supply air temperature exceeds 121°C (250°F).

1.2 Definitions and Abbreviations

- .1 The following definitions apply to this section.
 - .1 **Core** – means the element of the flexible connector in direct contact with and containing the transported air.
 - .2 **Flexible connector** – means metallic and non-metallic round ducting that is used to connect rigid ductwork to air distribution terminal devices.
 - .3 **Relative pressure drop coefficient** – means the pressure loss of flexible connectors compared to a reference sheet metal duct pressure drop coefficient of 1.00 for same size duct and airflow rates.
 - .4 **Terminal devices** – means air grilles and diffusers.

1.3 Applicable Codes and Standards

- .1 Installation codes and standards:
 - .1 SMACNA HVAC Duct Construction Standards Metal and Flexible
- .2 Product standards:
 - .1 ULC S102 Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies
 - .2 ULC S102.2 Standard Method of Test for Surface Burning Characteristics of Flooring, Floor Coverings, and Miscellaneous Materials and Assemblies
 - .3 ULC S110 Standard Method of Test for Air Ducts
 - .4 ULC 181 Factory Made Air Ducts and Connections.

1.4 Submittals

- .1 Submit manufacturer's data sheets for each product showing;
 - .1 thermal properties,
 - .2 friction loss characteristics,
 - .3 acoustical insertion loss data,
 - .4 leakage rates,
 - .5 fire and smoke ratings,
 - .6 product listings and certifications.

2 PRODUCTS

2.1 General Requirements for Flexible Connectors

- .1 Flame spread rating not to exceed 25 and smoke developed rating not to exceed 50 when tested in accordance with ULC-S102 or S102.2.
- .2 Maximum manufactured unit length: 4 m (12 ft).
- .3 Listed to ULC-S110 and UL 181 as a Class 0 or Class 1 product.
- .4 Common requirements for metallic (aluminum) connector cores:
 - .1 material: spiral wound, corrugated flexible aluminum alloy with interlocked seams folded flat and rolled,
 - .2 design positive working pressure: 1.5 kPa (6 in. w.g) minimum,
 - .3 design negative working pressure: 0.25 kPa (1 in.w.g.) minimum,
 - .4 rated air velocity: 25 m/s (5000 fpm)
 - .5 minimum bending radius: 0.5 x duct diameter
 - .6 relative pressure drop coefficient: 2.0 maximum
 - .7 core air leakage: zero leakage.

Metallic Insulated Flexible Connectors

- .1 Core: as specified above for aluminium cores.
- .2 Insulation layer: factory-applied outer insulation layer of flexible glass-fibre thermal insulation, maximum thermal resistance value of 0.74 m²·K/W (4.2 ft²·°F·h)/BTU
- .3 Jacket: polyethylene or aluminium foil-skrim vapour barrier.

Standard of Acceptance

- TCE - fig. SIG, SIA
- Flexmaster - fig. T/L-T, T/L-M
- Peppertree - fig. TFT-M

2.3 Flexible Connector Sealing Compound

- .1 Water based duct sealer, adheres to galvanized steel, aluminum and non-metallic flexible connector fabrics.
- .2 Zero VOC content.
- .3 High-solids content, low shrinkage, permanently flexible.
- .4 Listed to ANSI/UL 181A.

Standard of Acceptance

- Durodyne - fig. EDS-RS
- Ductmate - fig. PROseal
- Transcontinental Equipment - fig. MP

3 EXECUTION

3.1 Restrictions on Use of Flexible Connectors

- .1 Do not install flexible connectors that would pass through any wall, partition or floor.

- .2 Do not use flexible connectors to connect rigid ductwork to the inlet of terminal units including variable volume or constant volume terminal units, with or without integral fans.
- .3 Do not use flexible connectors on exhaust systems which convey:
 - .1 exhaust air serving high humidity spaces including shower rooms and decontamination rooms
 - .2 exhaust air containing particulates.

Flexible connectors may be used on connections to return/exhaust grilles only where it is not possible to make a rigid duct connection.

3.2 Flexible Connector Installation

- .1 Use the type of flexible connectors in accordance with the following:
insulated metallic
 - .2 Maximum installed flexible connector lengths:
 - .1 supply air: 2 m (6 ft).
 - .2 return/exhaust air: 1 m (39 in.).
 - .3 The centre-line radius of bends in flexible connector to be at least equal to one duct diameter or larger.
 - .4 Apply sealing compound at connection points between sheet metal and flexible connector. Apply the sealing compound to the sheet metal prior to placing the flexible connector over the sheet metal, to minimize ingress of sealant into the airstream.
 - .5 Overlap flexible connectors onto rigid ductwork and diffuser/grill collars by not less than 50 mm (2 in.), and to fully overlap the sheetmetal connector on diffusers and grilles.
 - .6 For metallic flexible connectors, secure the core material to the sheet metal with #8 sheet metal screws as follows:
 - .1 for connectors sizes Ø300 mm (12 in.dia.) and smaller, with at least three screws equally spaced around the connector,
 - .2 for connector sizes larger than Ø300 mm (12 in.dia.), at least five screws equally spaced around the connector,
 - .3 the screws installed at least 12 mm (1/2 in.) from the end of the connector,
 - .7 For non-metallic flexible connectors, secure the core material to the sheet metal with a Panduit-type draw-band. Locate the draw-band behind a bead on the metal collar.
 - .8 Fit insulation and vapour barrier jackets over the core connection and secure with a Panduit-type draw band.

3.3 Rigid Duct Collar Construction

- .1 Provide a rolled external bead on rigid duct connection collars, located at least 25 mm (1 in.) from the end of the collar.

3.4 Connections to Exhaust Grills

- .1 Where a flexible connector is to be connected to an exhaust grill, order the grill with a backing plenum with applicable sized sheet metal connector.
- .2 Where an exhaust grille is not provided with a factory plenum and connector, shop fabricate a plenum that;
 - .1 has the same plan dimensions as the exhaust grille and having a depth of not less than:
 - (a) 75 mm (3 in) for a back-inlet connection,

- (b) at least 50 mm (2 in) greater than the diameter of the flexible connector for a side-entry connection,
- .2 has a sheet metal connector of a diameter to suit the flexible connector and having a depth of not less than 50 mm (2 in.).

END OF SECTION

HVAC FANS

23 34 16

1 GENERAL

1.1 Scope

- .1 Provide centrifugal and axial HVAC fans of type, size and performance as shown.

1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
- .1 20 05 01 Basic Materials and Methods
 - .2 20 05 13 Common Motor Requirements for Mechanical Equipment.
 - .3 20 05 49.23 Seismic Qualification for Mechanical Equipment

1.3 Applicable Codes and Standards

- .1 Product standards:
- .1 ABMA 9 Load Ratings and Fatigue Life for Ball Bearings
 - .2 ABMA 11 Load Ratings and Fatigue Life for Roller Bearings
 - .3 AMCA 99 Standards Handbook
 - .4 AMCA 204 Balance Quality and Vibration Levels for Fans
 - .5 AMCA 205 Energy Efficiency Classification for Fans
 - .6 AMCA 210 Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating
 - .7 AMCA 211 Certified Ratings Program – Product Rating Manual for Fan Air Performance
 - .8 AMCA 300 Reverberant Room Method for Sound Testing of Fans,
 - .9 AMCA 311 Certified Ratings Program – Product Rating Manual for Fan Sound Performance
 - .10 AMCA 320 Laboratory Methods of Sound Testing Fans Using Sound Intensity
 - .11 ASME B117 Standard Practice for Operating Salt Spray (Fog) Apparatus

1.4 Design Criteria

Fan rating conditions:

- .1 elevation: project site elevation-based.
- .2 airflow design temperature:

Application	Temperature
Conditioned space return air or exhaust air fans	21°C (70°F)

Seismic Qualification

- .1 Seismically qualify (certify) the following equipment specified herein:
- .1 Fans.

- .2 The seismic qualification of the above-listed equipment is to conform to Specification section 20 05 49.23 for the following seismic qualification level and certification method:

.1 Functional seismic qualifications (Level III): by shake table testing.

- .3 The following equipment specific seismic force parameters are to be used:

C_p	A_r	R_p	h_x/h_n
1.00	2.50	2.50	1.0

1.6 Submittals

- .1 Submit product data sheets for materials specified herein. Submittals to include:
- .1 Dimensioned standard drawings indicating dimensions, motor mounting details, inlet and outlet connection details, and equipment weight,
 - .2 motor ratings and characteristics,
 - .3 drive arrangements including drive-set details,
 - .4 AMCA certified performance curves for each fan showing airflow, static pressure, efficiency point, fan RPM, and power input as KW (brake horsepower) from shut-off to free delivery through scheduled rating point, and also show fan curves for fan RPM at 15% above and 15% below this curve.
 - .5 certified sound power data for supply, return and exhaust fans.
 - .6 specified accessories.
- .2 Operating and maintenance data:
- .1 provide operation and maintenance data for incorporation into operating and maintenance manuals,
 - .2 include factory test vibration analysis report for fans with motor power ratings greater than 15 kW (20 hp).
- .3 Submit certification test certificate for seismic qualification in accordance with Specification section 20 05 49.

1.7 Quality Control

- .1 Fan performance for airflow rate, fan pressure, fan power, air density, fan RPM and fan efficiency: certified and bear the AMCA seal to AMCA Publication 211 when tested in accordance with AMCA Standards 210.
- .2 Fan acoustic performance: certified and bear the AMCA seal to AMCA Publication 311 when tested in accordance with AMCA Standard 300 or AMCA Standards 320.
- .3 Fan energy efficiency: rated in accordance with AMCA Standard 205.
- .4 Fan vibration: factory vibration tested prior to shipment as a completed assembly, in accordance with AMCA Standard 204 and as follows:
 - .1 tested at the specified fan RPM,
 - .2 vibration signature measured at each fan bearing in the horizontal, vertical and axial directions,
 - .3 maximum allowable fan vibration level: grade G6.3 to AMCA Standard 204, at 3.8 mm/s (0.15 in/sec) peak velocity, filter-in, with the fan rigidly mounted,
 - .4 vibration test records are to be retained by the manufacturer and copies to be made available to the Owner on request.

2 PRODUCTS

2.1 General

Space allocation, motor sizes, base details, connection arrangements and performance are based on fan equipment by manufacturers as shown in schedules.

- .2 Fans to be of same manufacture for similar applications, but may be chosen from other manufacturers' product lines for other different applications, and are to be selected from manufacturer's catalogued range of standard products.

Standard of Acceptance)

- New York Blower (Northern Industrial Supply)
- Barry Blower/Pennbarry)
- Chicago Blower
- CML Northern Blower
- Trane
- Greenheck
- Loren Cook
- Twin City
- Industrial Air
- Woods
- Carnes
- Acme

2.2 Selection Criteria

- .1 Select fan size, operating RPM and rating point on stable part of head flow curve with smooth characteristics.

Except as specified elsewhere in this Section, select fans (excluding motors) so that the fan construction will permit fan operation up to 125% of the design static pressure and airflow rate, individually and concurrently, without requiring modifications to this equipment.

2.3 Construction General Requirements

- .1 Fan class to conform with AMCA 99-2408, Operating Limits for centrifugal fans.
- .2 Operating temperature range: fans to be constructed to be suitable for operation from -40°C (-40°F) up to the temperatures specified under article Design Criteria.
- .3 Fan housing and impeller:
 - .1 statically and dynamically balanced impeller,
 - .2 operating at least 20% below first critical speed when operating at maximum speed for class of construction,
 - .3 continuously welded steel housing, unless other materials are shown, with integral reinforcing bracing, and spun inlet cones,
 - .4 pre-punched flanges for ductwork connections,
 - .5 interior and exterior surfaces factory cleaned and primed with zinc-rich coating, and finished in manufacturers standard top coat,
 - (a) where shown on equipment schedules, coatings for surfaces contacting airstream: Heresite coated for carbon steel materials.
 - (b) coating performance to meet 1000 hour salt spray test in accordance with ASME B117.

- .4 Fan shaft:
 - .1 steel shaft, turned, ground and polished, and protected with a petroleum-based rust preventative coating,
 - .2 sized for first critical speed at a minimum of:
 - (a) 1.25 times maximum speed for fan Class I and II, and
 - (b) 1.40 times maximum speed for fan Class III and IV.
 - .3 key shaft to the wheel hub,
- .5 Fan bearings:
 - .1 grease lubricated self-aligning ball or roller type with oil retaining, dust excluding seals,
 - .2 cartridge type for shafts less than 37 mm (1 - 7/16 in) diameter,
 - .3 shaft adapter sleeves with horizontally split pillow blocks and mechanical flinger type grease valves for shafts 37 mm (1 - 7/16 in) diameter or larger,
 - .4 interference fit rather than adapter sleeve type on shafts 56 mm (2 - 3/16 in) and larger
 - .5 furnished with drain plugs,
 - .6 fitted with extended grease lubricating lines where access is restricted,
 - .7 packed with grease at factory,
 - .8 chosen for 125% of rotational speed at point of selection, and with an L₁₀ service life rating of 100,000 hours in accordance with ABMA 9 or ABMA 11.
- .6 Fan configuration (unless shown or noted otherwise):
 - .1 Arrangement #1 or #2 for single inlet, single width, belt driven fans up to and including 915 mm (36 in) wheel diameter.
 - .2 Arrangement #3 for belt driven single inlet fans with wheel diameter larger than 915 mm (36 in) diameter and belt driven double inlet fans.
 - .3 Arrangement #3 for plenum (plug) fans.
 - .4 Arrangement #10 for utility sets.
 - .5 Arrangement #8 for direct connected single inlet centrifugal fans.
 - .6 Arrangement #7 for direct connected double inlet fans.
- .7 Variable volume devices:
 - .1 adjustable inlet vanes,
 - .2 operated from mechanism, with locking device for manual operation, linked to each damper vane, and interconnecting vanes in each inlet of DWDI fans
- .8 Fan/motor drives and guards:
 - .1 pulleys and drive belts to conform to Section 20 05 01,
 - .2 guards for fan/motor belt-drive and couplings, to conform to Section 20 05 01,
 - .3 guards for fan inlet openings to conform to Section 20 05 01.
- .9 Fan motors:
 - .1 motors to conform to Section 20 05 13, except/and as specified herein,
 - (a) minimum motor power rating: not less than motor kW (horsepower) shown in equipment schedules, and

- (b) capable of satisfactory operation without motor overload or operation in the motor service factor, over a performance range from shut-off to run-out at 115% of rotational speed at point of selection.

- .2 motor slide rails to conform to Section 20 05 01,

2.4 Centrifugal Fans

.1 Arrangement:

- .1 rotation, discharge and motor position to be as shown,
- .2 unless otherwise shown, fan classification to be selected to permit operation at 125% of rotational speed at point of selection.

.2 Fan wheels:

- .1 backward curved or backward inclined blades for fan wheel diameters less than 686 mm (27 in), backward curved air foil blades for fan wheel diameters 686 mm (27 in) and larger.

.3 Accessories:

- .1 38 mm (1 - ½ in) casing drains where fans discharge vertically,
- .2 access doors in scroll casing,
- .3 stuffing box style shaft seals on single inlet single width fans and utility sets.

3 EXECUTION

3.1 Fan installation

- .1 Mount fans as shown, with vibration isolation, restraining snubbers, flexible electrical leads, and flexible connections to inlet and discharge ductwork.
- .2 Align shafts, belt drive and motor, and adjust belt static tension based on measured belt deflection test in accordance with drive manufacturer instructions.
- .3 Confirm and check motor rotation before start-up.

3.2 Protection

- .1 Provide temporary enclosures for open drip proof motors.
- .2 Cover fan inlet and discharge openings during construction to prevent ingress of foreign objects into the fan housing.
- .3 Rotate fans, by hand, every month between delivery and acceptance of building.

3.3 Start-Up and Testing

- .1 During system air balancing, adjust sheaves on variable pitch belt drives, adjust blade pitch of axial flow fans, and change pulleys and belts on fixed pitch belt drives, to achieve specified air quantities.

END OF SECTION

AIR TERMINAL UNITS

23 36 13

1 GENERAL

1.1 Scope

- .1 Provide air terminal units as shown.
 - .1 supply air terminal units with reheat coils,

1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
 - .1 20 05 12 Common Electrical Requirements for Mechanical Services
 - .2 23 82 16.16 Hydronic Duct Mounted Air Coils
 - .3 25 05 11 Building Automation Control Panels and Wiring

1.3 Applicable Codes and Standards

- .1 Product standards:
 - .1 AHRI 880 Standard for Performance Rating of Air Terminals
 - .2 ANSI/ASHRAE 130 Laboratory Method of Testing Air Terminal Units
 - .3 ASTM C1071 Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorption Material)
 - .4 CSA C22.2 No. 66.3 / UL 5085-3
 - .5 Low Voltage Transformers – Part 3: Class 2 and Class 3 Transformers
 - .6 CSA C22.2 No. 94.1 Enclosures for Electrical Equipment, Non-Environmental Considerations
 - .7 CAN/ULC-S102.2 Standard Method of Test for Surface Burning Characteristics of Flooring, Floor Coverings, and Miscellaneous Materials and Assemblies.

1.4 Submittals

- .1 Shop drawings:
 - .1 Submit manufacturer's data sheets with;
 - (a) equipment model numbers, performance and design data, outline dimensions, enclosure details, support and connection arrangements and electrical power requirements where applicable.
 - (b) schedules listing discharge and radiated sound power level for each of the second through seventh octave bands (125 - 4000 Hertz) at specified differential static pressures.

2 PRODUCTS

2.1 General Requirements

- .1 Factory-assembled terminal units, with performance ratings in accordance with AHRI 880, and bearing the AHRI seal for an air volume control terminal with damper assembly and flow sensor.

Standard of Acceptance

- E.H. Price
 - Titus
 - Environmental Technologies
 - Nailor Industries.
 - Carnes
 - Metalaire
- .2 Airflow performance tested and rated in accordance with ASHRAE standard 130.
- .3 Unit performance rating to be over the following inlet static pressure range:
- .1 maximum inlet air pressure: 750 Pa (3 in wg),
 - .2 minimum inlet air pressure: 75 Pa (0.3 in wg),
- .4 Except where the terminal unit size is shown on drawings and/or schedules, select terminal unit sizes so that design airflow rates as shown do not exceed 70% of manufacturers published maximum air flow rate.
- .5 Terminal unit sizes (e.g. size 6 as shown on drawings or equipment schedules) are based on E.H.Price model SDV for physical dimensions and airflow performance range.
- .6 Acoustic performance:
- .1 maximum room sound pressure level (referenced at 2×10^{-4} microbar) at 250 Pa (1 in.w.c.) inlet pressure to be less than:
 - (a) NC 40 at discharge and NC 42 radiated for units with attenuator mounted exposed (without ceiling).

2.2 Single Duct Air Terminal Units

- .1 Casing:
- .1 galvanized steel, minimum 0.76 mm (22 ga) thickness, with lock-seam longitudinal joints,
 - .2 casing leakage:
 - (a) not to exceed 1.0% of maximum rated airflow at an inlet pressure of 250 Pa (1 in.w.c.) as tested in accordance with ASHRAE 130,
 - (b) includes casing penetrations for damper rods, etc.,
 - (c) includes component connection joints for factory supplied accessories including reheat coils and duct attenuators, silencers,
 - (d) randomly selected terminal units are subject to field leakage test in accordance with Part 3 of this Specification section.
 - .3 entire casing lined on all faces with acoustic attenuation liner,
 - .4 inlet connection: circular with slip end and rolled bead duct-stop,
 - .5 discharge connection: rectangular with slip-and-drive connection,
 - .6 minimum unit length with reheat coils;
 - (a) reheat coil to be mounted at the outlet of attenuator or silencer,
 - (b) where no attenuator or silencer is required to meet acoustic performance, terminal unit length to be not less than 900 mm (36 in) between the outlet of the air valve and the inlet face of the reheat coil,
 - (c) unit extensions provided with liner through entire length.
- .2 Control damper / valve assembly:

- .1 minimum 1.2 mm (18 ga) thick galvanized steel damper blade with solid shaft rotating in bearings,
- .2 damper position indicator permanently attached or formed into damper shaft,
- .3 damper blade edge gasket for tight airflow shut-off, and two reference stop pins for the 0% and 100% open positions,
- .4 air leakage in closed position: $\leq 2\%$ of unit maximum airflow at 750 Pa (3 in.w.c.) inlet static pressure and tested in accordance with ASHRAE 130.
- .3 Control enclosure:
 - .1 factory mounted on side of terminal unit,
 - .2 painted steel electrical enclosure, Type 1 listed to CSA C22.2 No. 94.21 (NEMA 1), with
 - (a) removable cover,
 - (b) wiring knockouts,
 - (c) integral backplane for mounting of control devices, constructed so there are no exposed screw tips.
 - .3 control transformer:
 - (a) factory mounted and wired 120/24 VAC Class 2 current limited control transformer,
 - (b) listed to CSA C22.2 No. 66.3,
 - (c) of size to suit terminal unit DDC controller, and disconnect switch.
 - .4 enclosure side-mounted disconnect switch.
- .4 Airflow velocity sensor:
 - .1 airflow sensor fully removable for cleaning,
 - .2 total and static differential pressure sensor, mounted in inlet duct,
 - .3 fire-resistant plastic elements conforming to UL 94,
 - .4 not less than 12 total pressure sample ports and four (4) static pressure ports, with center averaging chamber,
 - .5 sensor accuracy after field calibration: velocity sensor measured flow to be within $\pm 5\%$ of externally measured value, over the terminal unit published flow range, and independent of inlet duct arrangement,
 - .6 sample tubing provided with protective grommets where tubing passes through metal duct and enclosure.
- .5 Sound attenuator:
 - .1 sound attenuators used on terminal unit sizes 10 and smaller,
 - .2 constructed as an extension of the terminal unit casing assembly,
 - .3 attenuator construction: same as for terminal general casing complete with liner,
 - .4 attenuator length: not less than 900 mm (3 ft),
 - .5 attenuator liner: as specified in article "Liner".
- .6 Acoustic Liner – fiberglass:
 - .1 liner acoustic/thermal media:
 - (a) flexible or semi-rigid, dual-density, fibrous glass duct liner, with air-facing side factory sealed with acrylic coating and flexible glass cloth reinforcement, and factory sealed edges, to ASTM C1071,

- (b) listed to UL 2818 for low VOC content,
 - (c) surface mat treated with EPA-registered anti-microbial agent,
 - (d) insulation resistance: RSI 0.74 (R4.2)
 - (e) thickness: 25 mm (1 in),
 - (f) maximum air velocity: 30 m/s (6000 fpm),
 - (g) service temperature: 121°C (250°F) to ASTM C411,
 - (h) listed to CAN/ULC-S102, with flame spread rating not to exceed 25 and a smoke development rating not to exceed 50,
 - (i) field applied sealer applied to cut edges and damaged surfaces, as recommended by duct lining manufacturer, so there are no exposed unprotected media surfaces.
- .2 liner media fastened to inside of unit casing with 100% adhesive coverage and mechanical pin fasteners and retention heads:
- (a) 2.0 mm (1/16 in) diameter pins,
 - (b) length selected to suit thickness of insulation,
 - (c) 32 mm (1¼ in) square Nylon retaining clips.
- .3 liner media protective coverings:
- (a) a Mylar or Tedlar film, encapsulating the air-facing surface and all cut-end edges.

2.3 Hydronic Reheat Coils

- .1 Conform to specification section 23 82 16.16.
- .2 Heat output as shown.
- .3 Factory mount reheat coil at the outlet of the attenuator, silencer, or terminal unit casing extension.]

2.4 Controllers

- .1 DDC controller – Supplied Free-Issue by BAS Contractor:
 - .1 Direct Digital Control (DDC) controller with damper actuator to be supplied by BAS contractor under Division 25, free-issue (FOB destination, freight prepaid) to terminal unit manufacturer for factory mounting by terminal unit manufacturer,
 - .2 costs associated with receiving, storage, installation and calibration to be included by Terminal Unit Manufacturer.

3 EXECUTION

3.1 Terminal Unit Installation

- .1 Support terminal units independent of connecting ductwork and piping. Support terminal units from building structure with angles, hangers and supplementary steel before installation of piping and connecting ductwork.
- .2 Provide seismic restraints for terminal units independent of restraints for joining ductwork, where seismic restraints are required for the project.
- .3 Provide access door in ductwork on the downstream side of reheat coil:
 - .1 size: minimum 150 mm x 100 mm (6 in x 4 in),
 - .2 located with 100 mm (4 in) of discharge face of reheat coil.

3.2 Ductwork Connections

- .1 Connect inlet ductwork with spiral flat seam round duct of same diameter as terminal unit inlet.
- .2 Size connecting discharge ductwork as same size as terminal unit outlet.
- .3 Support outlet ductwork independent from terminal unit.
- .4 Seal openings in box and attenuator for reheat coil and connections, control, and power wiring.

3.3 Piping Services

- .1 Provide heating piping, valves and accessories in accordance with specification section 23 82 16.16.

3.4 Electrical Services

- .1 Control power supply to terminal units to be provided in accordance with specification section 20 05 12 and 25 05 11.

3.5 Leakage Testing

- .1 Terminal units are not required to be pressure tested as part of a duct system except as follows.
- .2 When requested by the Consultant, perform a site pressure test on two terminal units selected by the Consultant and in accordance with the following procedure:
 - .1 test the sample terminal units without ductwork connected to them,
 - .2 temporarily cap the inlet and outlet duct connections and seal the caps to the greatest extent possible to minimize the effect of leakage of such temperature caps,
 - .3 pressure test the sample terminal units at 250 Pa (1 in.w.c.) to verify the specified maximum allowable leakage rate plus 15% for field testing uncertainty is not exceeded,
 - .4 where OEM supplied reheat coils and duct attenuators/silencers are supplied as parts of the terminal unit, the factory joints are to be included in the test without field modification.
- .3 Where terminal unit leakage exceeds the specified maximum allowable leakage, seal the reheat coil and duct attenuator/silencer factory joints with duct sealant and retest the terminal unit.
 - .1 If the retested terminal unit air leakage is less than the specified maximum allowable leakage, then seal all such joints on all terminal units.
 - .2 If the retested terminal unit air leakage is greater than the specified maximum allowable leakage, then engage the manufacturer service representative to review the cause of the excessive air leakage.
- .4 Where installed terminal units are included in a larger duct system pressure test, the acceptable leakage rate as determined by the field test may be used and deducted from the duct system leakage rates. Where the duct system is pressure tested at a test pressure other than 250 Pa (1 in.w.c.), the terminal unit allowable air leakage may be adjusted as follows:

$$Q_D = Q_{250} \times \sqrt{\frac{P_D}{P_{250}}}$$

Where:

- | | |
|-----------|---|
| Q_{250} | Leakage airflow measured at a test pressure of 250 Pa, in L/s |
| Q_D | Allowable leakage at duct system pressure test P_D , in L/s |
| P_{250} | Terminal unit pressure test of 250 Pa |
| P_D | Duct system pressure test, Pa |

END OF SECTION

GRILLES, REGISTERS AND DIFFUSERS

23 37 13

GENERAL

1.1 Scope

- .1 Provide grilles, registers, and diffusers as shown.

1.2 Applicable Codes and Standards

- .1 Product standards:
 - .1 ASHRAE 70 Method of Testing the Performance of Air Outlets and Air Inlets
 - .2 ASTM D610 Standard Practice for Evaluating Degree of Rusting on Painted Steel Surfaces
 - .3 ASTM D714 Test Method for Evaluating Degree of Blistering of Paints
 - .4 ASTM D1308 Standard Test Method for Effect of Household Chemicals on Clear and Pigmented Organic Finishes
 - .5 ASTM D1654 Standard Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments
 - .6 ASTM D4752 Standard Practice for Measuring MEK Resistance of Ethyl Silicate (Inorganic) Zinc-Rich Primers by Solvent Rub

1.3 Submittals

- .1 Submit manufacturer's data sheets with product data including:
 - .1 equipment model numbers, configuration, dimensions, support requirements, general assembly and materials,
 - .2 catalog performance ratings that indicate air flow, static pressure, throw distance at air velocity, and noise criteria (NC) data.

1.4 Samples

- .1 Submit examples of each type and style of register, diffuser and grille with sample finishes when requested by Consultant or the Owner.

2 PRODUCTS

2.1 General Requirements

- .1 Grilles, registers and diffusers:
 - .1 product of one manufacturer where same model or type identification is used,
 - .2 performance data determined in accordance with ASHRAE 70,
 - .3 standard catalogue products selected to meet capacity, throw, and noise level,
 - .4 frames with full perimeter gaskets, plaster stops where set into plaster or gypsum board, and concealed fasteners.
- .2 Type designations:
 - .1 floor plans indicate a diffuser, register or grille type that is referenced on equipment schedules; this unit type includes model numbers taken from listed manufacturer catalogues and which represents the basis-of- design selection.

- .2 the listed manufacturer model (basis-of-design) reference establishes the esthetic (visual) appearance of the equipment and other quality requirements not otherwise specified herein. Products from other manufacturers listed herein may be used where they meet these aesthetic requirements as determined by Consultant.
- .3 Painted finishes:
 - .1 baked-on powder coat finish, minimum build thickness of 0.05 mm (2.0 mils), with a finished hardness of 2H.
 - .2 paint finishes to demonstrate no degradation when tested in accordance with ASTM D1308 and ASTM D4752,
 - .3 paint finish to withstand a minimum salt-spray exposure of 500 hours with no measurable creep in accordance with ASTM D1654, and 1000 hours of exposure with no rusting or blistering when tested in accordance with ASTM D610 and ASTM D714.
 - .4 finish colour: as shown or as selected by Consultant.
- .4 Manufacturers:

Standard of Acceptance

- Carnes
- Hart & Cooley
- MetalAire
- Nailor
- Price Industries
- Titus

2.2 Square Plaque Diffuser (ref. "SPD")

- .1 Application: supply air.
- .2 Style: square plaque-type with single outlet opening;
 - .1 backpan: one piece die-formed construction with smooth aerodynamically designed surfaces and no corner joints, with integral inlet collar,
 - .2 plaque face panel: removable plate, protruding not more than 6 mm (1/4 in.) below the ceiling plane, with smooth edges and rounded corners,
 - .3 designed to provide a 360° radial direction horizontal airflow pattern, for VAV operation.
 - .4 beaded extended neck, minimum depth of 65 mm (2-1/2 in.),
 - .5 suitable for lay-in to T-bar with drop frame,
- .3 Frame: none.
- .4 Material: aluminium
- .5 Damper: none
- .6 Specials: all aluminium construction for magnetic resonance imaging (MRI) rooms.

2.3 Louvred Grille (type "LG")

- .1 Application: supply, return and exhaust air.
- .2 Style: rectangular louvred with frame;
 - .1 fixed single-deflection louvres,
 - .2 louvres and frame materials: aluminum unless otherwise shown.
 - .3 blade spacing: 13 mm (1/2 in.) unless otherwise shown,

- .4 deflection: 45°,
- .5 blade orientation: horizontal for vertical grilles, parallel to the long dimension for horizontal grilles,
- .6 border: nominal 32 mm (1-1/4 in.) flat face for surface mount, unless otherwise shown,
- .3 Frame: 9 mm (3/8 in.) flat border,
- .4 Fasteners: concealed mounting
- .5 Finish: painted, standard white unless show except dampers are to be painted black,
- .6 Damper: opposed blade damper with manual operator.
- .7 Specials: as shown.

2.4 Adjustable Louvred Grille (type “LG-A”)

- .1 Application: supply air only.
- .2 Style: rectangular louvred with frame;
 - .1 adjustable double-deflection louvres, horizontal in rear position, vertical in front position,
 - .2 louvres and frame materials: aluminum unless otherwise shown.
 - .3 blade spacing: 13 mm (1/2 in.) unless otherwise shown,
 - .4 blade orientation: horizontal for vertical grilles, parallel to the long dimension for horizontal grilles,
 - .5 border: nominal 32 mm (1-1/4 in.) flat face for surface mount, unless otherwise shown,
- .3 Frame: 9 mm (3/8 in.) flat border,
- .4 Fasteners: concealed mounting
- .5 Finish: painted, standard white unless show except dampers are to be painted black,
- .6 Damper: opposed blade damper with manual operator.
- .7 Specials: as shown.

2.5 Eggcrate Grilles (type “ECG”)

- .1 Application: return and exhaust air.
- .2 Style: square-grid bladed grille;
 - .1 louvres and frame materials: aluminium,
 - .2 blade spacing: 25 mm x 25 mm square by 25 mm deep (1 in. x 1 in. x 1 in.),
 - .3 deflection: 0°.
 - .4 blade orientation: not applicable,
 - .5 border:
 - (a) lay-in tile ceilings: none
 - (b) gypsum board ceilings: nominal 32 mm (1-1/4 in.) flat face, suitable for ducted connections.
- .3 Frame: none.
- .4 Fasteners: countersunk holes
- .5 Finish: painted, standard white unless otherwise shown,
- .6 Damper:
 - .1 ceiling plenum return: none
 - .2 ducted return: none

.7 Specials: as shown.

3 EXECUTION

3.1 Layout

- .1 Drawings showing position of air distribution outlets are essentially diagrammatic. Coordinate exact location of diffusers with other elements in ceiling and shown on Architect's reflected ceiling drawings and select trim to suit ceiling materials listed in the Architectural drawings room finish schedules.

3.2 Installation of Grilles and Diffusers

- .1 For duct-mounted grilles installed in ceiling or walls constructed of gypsum board, coordinate and arrange with general trades to provide channel framing around ceiling/wall opening to provide backing-blocking for attachment of the grille or diffuser.
- .2 Install grilles and diffusers with oval head cadmium plated screws in countersunk holes where fastenings are visible. Use colour-matching screws.
- .3 Install diffusers with concealed fastenings.
- .4 Provide round, square and rectangular diffusers with equalizing deflectors, mounted in the connecting duct neck, accessible from diffuser face, with blades oriented at right angles to direction from which air is flowing.
- .5 Except for last diffuser on branch, where diffusers are installed directly underneath a supply duct provide an extract volume control damper at the duct diffuser-branch connection.
- .6 Where a supply air diffuser includes an air pattern controller, provide labour and services to adjust the pattern controller in conjunction with the TAB contractor during system balancing.

3.3 Special installations

- .1 Grilles, registers and diffusers penetrating fire walls and fire partitions, to have steel sleeves secured to structure in accordance with NFPA 90A-1985.
- .2 In gymnasium provide safety chain on each diffuser face and core and bolt diffuser in place.
- .3 For grilles and diffusers exceeding 5 kg (12 lbs) weight, mechanically fasten grille/diffuser to ceiling or wall structure, independent of ductwork connection or support.

END OF SECTION

PARTICULATE AIR FILTERS

23 41 11

1 GENERAL

1.1 Scope

Provide particulate filters as shown, including:

- .1 particulate air filters,
- .2 filter holding frames,
- .3 side-access filter housing,
- .4 filter gauges.

1.2 Definitions

- .1 Abbreviations
 - .1 **MERV**: minimum efficiency reporting value in accordance with ASHRAE 52.2
 - .2 **HEPA**: High Efficiency Particulate Air
 - .3 **ULPA**: Ultra Low Particulate Air

1.3 Applicable Codes and Standards

- .1 Product standards:
 - .1 ASHRAE 52.2 Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.
 - .2 CAN/ULC-S111 Standard Method of Fire Tests for Air Filter Units.
 - .3 IEST-RC-CC001 HEPA and ULP Filters
 - .4 IEST-RC-CC021 Testing HEPA and ULPA Filter Media
 - .5 IEST-RC-CC034 HEPA and ULPA Filter Leak Tests

1.4 Submittals

- .1 Submit manufacturer's catalogue literature for filters showing:
 - .1 pressure drop vs air flow rate,
 - .2 filter efficiency rating,
 - .3 media area in each cell,
 - .4 filter dimensions,
 - .5 maximum recommended pressure drop at filter change,
 - .6 product test report including all details as prescribed in ASHRAE 52.2,
- .2 In addition, for HEPA and ULPA filters, submit test certification reports.

2 PRODUCTS

2.1 General Requirements

- .1 Filters listed as a Class 2 product to CAN/ULC-S111.
- .2 Filters to be suitable for continuous exposure to air at the following conditions as applicable:

Filter Position	Minimum Air Temperature °C (°F)	Relative Humidity %RH
Before first heating coil	-25 (-13)	90%
After cooling coil	+3°C (37°F)	100%
All other locations	+3°C to 50°C (37°F to 122°F)	10% to 95%

- .1 maximum air temperature: 50°C (122°F).
- .3 Filter sizes: as shown on equipment schedules or as specified in specification sections for air handling equipment.

Standard of Acceptance

- AAF
- Camfil
- Airgaud (Parker)

2.2 HEPA – Rigid Box

- .1 Performance:
 - .1 filter efficiency performance certified to IEST-RP-CC001, Type A, when tested in accordance with IEST-RP-CC021.
 - .2 filter style: Rigid Box, disposable
 - .3 capacity: 945 L/s at 2.5 m/s (2000 CFM at 492 fpm) @ 600 x 600 mm (24 x 24 in) filter size; prorated for other sizes.
 - .4 filter depth: 300 mm (12 inch) , nominal
 - .5 efficiency: 99.97% at particle size at $\geq 0.3 \mu\text{m}$, to IEST Type A
 - .6 initial air resistance: 350 (1.4), maximum
 - .7 final air resistance: 750 Pa (3 in.w.c.), minimum at change out
- .2 Construction:
 - .1 media; glass fibre
 - .2 frame: galvanized steel
 - .3 face gasket: one-piece seamless polyurethane
 - .4 service access: [upstream][downstream][side access] servicing.
- .3 Factory testing:
 - .1 each production filter to be factory tested in accordance with IEST-RP-CC001, and scanned in accordance with IEST-RP-CC034.
 - .2 each unit to be labeled noting testing efficiency, penetration, rated and performing airflow, pressure drop, and provided with a unique serial number.

Standard of Acceptance

- Camfil - fig. XH Absolute
- AAF - fig. Astrocel I HCX, or Megacel 1

HEPA – Rigid V-Bank

- .1 Performance:
 - .1 filter efficiency performance certified to IEST-RP-CC001, Type A, when tested in accordance with IEST-RP-CC021.
 - .2 filter style: Rigid Box, disposable
 - .3 capacity: 945 L/s at 2.5 m/s (2000 CFM at 492 fpm) @ 600 x 600 mm (24 x 24 in) filter size; prorated for other sizes.
 - .4 filter depth: 300 mm (12 inch) , nominal
 - .5 efficiency: 99.97% at particle size at $\geq 0.3 \mu\text{m}$, to IEST Type A
 - .6 initial air resistance: 200 (0.8), maximum
 - .7 final air resistance: 750 Pa (3 in.w.c.), minimum at change out
- .2 Construction:
 - .1 media; glass fibre
 - .2 frame: galvanized steel
 - .3 face gasket: one-piece seamless polyurethane
 - .4 service access: [upstream][downstream][side access] servicing.
- .3 Factory testing:
 - .1 each production filter to be factory tested in accordance with IEST-RP-CC001, and scanned in accordance with IEST-RP-CC034.
 - .2 each unit to be labeled noting testing efficiency, penetration, rated and performing airflow, pressure drop, and provided with a unique serial number.

Standard of Acceptance

- AAF - fig. Astrocel III, or Superflow 24

2.4 ULPA – Rigid Box

- .1 Performance:
 - .1 filter efficiency performance certified to IEST-RP-CC001, Type A, when tested in accordance with IEST-RP-CC021.
 - .2 filter style: Rigid Box, disposable
 - .3 capacity: 945 L/s at 2.5 m/s (2000 CFM at 492 fpm) @ 600 x 600 mm (24 x 24 in) filter size; prorated for other sizes.
 - .4 filter depth: 300 mm (12 inch) , nominal
 - .5 efficiency: 99.999% at particle size at $\geq 0.1.2 \mu\text{m}$, to IEST Type D
 - .6 initial air resistance: 350 (1.4), maximum
 - .7 final air resistance: 750 Pa (3 in.w.c.), minimum at change out
- .2 Construction:
 - .1 media; glass fibre
 - .2 frame: galvanized steel
 - .3 face gasket: one-piece seamless polyurethane

- .4 service access: [upstream][downstream][side access] servicing.
- .3 Factory testing:
 - .1 each production filter to be factory tested in accordance with IEST-RP-CC001, and scanned in accordance with IEST-RP-CC034.
 - .2 each unit to be labeled noting testing efficiency, penetration, rated and performing airflow, pressure drop, and provided with a unique serial number.

Standard of Acceptance

- Camfil - fig. XH Absolute
- AAF - fig. Megacel 1

2.5 Filter Holding Frames

- .1 Construction:
 - .1 modular framing system,
 - .2 minimum 1.27 mm (18 ga) thick galvanized steel with 20 mm (3/4 in) wide filter sealing flange, pre-drilled for frame-frame fastener attachments,
 - .3 replaceable Neoprene gasket on frame face for filters not provided with integral gaskets,
 - .4 gasketing between adjacent frames and between frames and plenum walls,
 - .5 high-tensile spring clips filter-fasteners.

Standard of Acceptance

- AAF - fig. PF-1 Pureframe, Universal Holding Frames and Latches
- Camfil - fig. FastFrame (upstream filter loading)
- Camfil - fig. Type 8 Frame (downstream filter loading)

2.6 Side Access Housings

- .1 Construction:
 - .1 1.6 mm (16 ga) galvanized steel frame with Z-channel support members, with inlet and outlet mounting flanges for connection to ductwork or plenums,
 - .2 filter tracks: aluminium, with lever locking to full face of frame,
 - .3 doors: galvanized steel door, continuous or two point hinges, locking knobs, sealed with full perimeter neoprene gaskets, and seals the filter side facing the door,
 - .4 tracks and doors fully gasketed,
 - .5 50 mm (2 in) thick, double wall, insulated construction,
 - .6 capable of holding pre-filter and final filters, or separate racks for each filter bank,
 - .7 filter depth:
 - (a) 50 mm to 100 mm (2 to 4 in) for panel filters,
 - (b) 150 mm to 915 mm (6 to 26 in) for all filters

Standard of Acceptance

- AAF - fig. SureSeal (two-stage), SurePlea (panel filters)

2.7 Air Filter Gauges

- .1 Pneumatic magnehelic gauge:
 - .1 cast aluminium housing, with acrylic cover, 100 mm (4 in) diameter dial face,
 - .2 connections: NPS 1/8 NPT,
 - .3 dual scale Pa, and inch water column,
 - .4 0-250 Pa (0-1 in wg) range for panel filters,
 - .5 0-750 Pa (0-3 in wg) range for other filter banks,
 - .6 installation kit with static pressure tips and isolation valves.

Standard of Acceptance

- ° Dwyer - fig. 2001D, 2003D

3 EXECUTION

3.1 Filter Banks

- .1 Install in plenums, ducts, and air intakes in filter racks or filter housings as shown, where not provided as an integral part of an air handling unit.
- .2 Made up using one size of cell throughout. Mixed cells are not permitted.

3.2 Filter Gauges

- .1 Provide filter gauges at the following filter banks:
 - .1 each bank of filters over 1900 l/s (4000 cfm) capacity, and
 - .2 for each bank of HEPA and ULPA filters regardless of capacity.
- .2 Provide separate gauges for each filter bank.
- .3 Install and pipe static pressure tips and isolating valves to allow calibration of pressure gauges.

3.3 Filter Protection and Replacement

- .1 Provide temporary roughing filters ahead of filter banks during initial operation of air handling systems.
- .2 When building is turned over to the Owner;
 - .1 remove temporary filters and ensure that filter banks are fitted with full sets of filters.
 - .2 install new, full sets of filters for any air filter banks used during construction and loaded to more than 125% of initial clean pressure drop.

3.4 Inspection and Testing

Immediately prior to hand-over to the Owner,

- .1 visually inspect the filters and filter frames to ensure there are no visible gaps in frame gaskets and blanking plates, that filters are set square and level in their frames, and retention clips are in place.
- .2 with the air handling system operating at normal conditions, check and record the pressure drop across each filter bank, and submit a test report with the date of the test to the Owner and include in the operations and maintenance data.

END OF SECTION

HYDRONIC DUCT-MOUNTED AIR COILS

23 82 16

GENERAL

1.1 Scope

- .1 Provide hydronic duct-mounted heat transfer coils (reheat coils) and accessories as shown.
- .2 This section applies to:
 - .1 duct-run mounted reheat coils,
 - .2 reheat coils for terminal units.

1.2 Applicable Codes and Standards

- .1 Installation codes and standards:
 - .1 CSA B51 Boiler, Pressure Vessel, and Pressure Piping Code
- .2 Product standards:
 - .1 AHRI 410 Forced-Circulation Air-Handling and Air-Conditioning Coils
 - .2 ASME B1.20.1 Pipe Threads, General Purpose, Inch
 - .3 ASTM A53 Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

1.3 Design Criteria

Coils to have a Canadian Registration Number ("CRN") in accordance with CSA B51.

1.4 Submittals

- .1 Submit manufacturers product sheets with performance data for products specified herein.
- .2 Coil shop drawing data to include:
 - .1 coil size: face area, tube length, tube face, number of rows, circuiting arrangement,
 - .2 construction: tube material and size, fin material and spacing, header material and connection sizes, casing and tube support material,
 - .3 heat transfer fluid performance: working pressure, fluid flow rate, entering and leaving fluid temperatures, entering steam pressure and leaving condensate pressure, tube fluid velocity, and fluid pressure drop,
 - .4 air side performance: air flow rate, entering air dry-bulb and wet-bulb temperatures, leaving air dry-bulb and wet-bulb temperatures, and air side pressure drop.
 - .5 AHRI certified performance.

2 PRODUCTS

2.1 Water Reheat (Booster) Coils

- .1 General:
 - .1 coil performance certified to AHRI 410 where the water supply temperature is greater than 49°C (120°F).
 - .2 coil design criteria to be in accordance with the following table except as otherwise shown on equipment schedules or drawings:

Parameter	Value SI	Value IP
Minimum design pressure	1720 kPa	(250 psig)
Airside face velocity, maximum	3.5 m/s	(700 FPM)
Airside pressure drop, maximum	50 Pa	(0.2 in.w.c)
Fluid tube velocity, maximum	2.5 m/s	(8.3 fps)
Fluid side pressure drop - water	15 kPa	(5 ft)

.2 Construction:

- .1 tubes: copper, minimum 0.5mm (0.020 in) wall thickness, serpentine circuited,
- .2 fins: aluminum,
- .3 fin density: not more than 640 fins/m (16 fins/in),
- .4 maximum tube length: 750 mm (2 ft-6in).
- .5 factory leak tested with air under water between 120 and 150% of design pressure.
- .6 coil connections:
 - (a) NPS 2 and smaller: threaded to ASME B1.20.1.
- .7 Casings and tube supports:
 - (a) 1.6 mm (16 ga) thick galvanized sheet steel with out-of-face flange for bolting to ductwork or equipment, or with slip and drive connections.

Standard of Acceptance

- Aerofin
- Cancoil
- Carrier
- Coil Company
- Daikin
- RAE Coils
- Engineered Air
- Heatcraft
- Marlo Heat Transfer Solutions
- McQuay
- RefPlus
- Trane
- USA Coil & Air
- Ventrol
- York

3 EXECUTION**3.1 Coil Installation**

- .1 Install coils in accordance with manufacturer's instructions, with specific attention given to air inlet flow direction.
- .2 Support reheat coils located in ductwork independently of the ductwork with use of threaded rod at each corner of the reheat coil;
 - .1 for factory mounted terminal unit reheat coils, coils are supported as part of the terminal unit.
 - .2 for venturi valves, support reheat coils in accordance with requirements for duct mounted coils.

3.2 Ductwork Installation

- .1 Where coils have flange duct connections, provide neoprene gasket between coil flange and duct flange.
- .2 Make connections to reheat coils with gradual transitions;
 - .1 inlet transition angel: maximum 30°,
 - .2 outlet transition angle: maximum 30°,
 - .3 where reheat coil height exceeds duct height, arrange reheat coil to maintain a constant centerline between coil and ducts;
 - (a) where clearance above duct does not permit maintaining a constant centerline, elevate the coil as high as possible to minimize centerline offset.
- .3 For terminal unit reheat coils, make duct connections to coil at full size of coil connections.
- .4 Provide access doors on both sides of reheat coil;
 - .1 size: 300 x 300 mm (12 in x 12 in),
 - .2 where duct width/height dimension is less than 350 mm (14 in), access door dimension is to be duct width/height less 50 mm (2 in).
 - .3 install access doors on bottom of duct (preferred position); access doors may be installed on side of duct where bottom access is obstructed.

3.3 Piping Installation

- .1 Make piping connections to reheat coils as follows:
 - .1 supply piping: provide manual shut-off valve, strainer, union, and flexible connector,
 - .2 return piping: provide manual shut-off valve, pressure independent control valve, union and flexible connector,
 - .3 make supply connections to lower coil connection,
 - .4 provide unions between the flexible connector and pipeline, unless flexible connector is provided with an integral union joint.
- .2 Flexible connector installation:
 - .1 locate flexible connectors between the coil connections and valves and strainers,
 - .2 arrange flexible connectors to remain in a single plane, with the maximum offset in any direction not exceeding 25 mm (1 in.).
 - .3 do not bend flexible connectors; provide an elbow fitting on coil connection.
- .3 Provide coil drain on supply side piping.
- .4 Provide screwdriver air vents on both supply and return piping between valves and flexible connectors.
- .5 Refer to Section 23 21 16 for Valve Enclosure Box requirements.

END OF SECTION

BUILDING AUTOMATION COMMON WORK RESULTS

25 05 01

1 GENERAL

1.1 Scope

- .1 Provide a building automation system ("BAS") for control and supervisory management of facility mechanical and electrical equipment systems.
- .2 The BAS is to be a direct digital control ("DDC") system with digital/electric instrumentation and electric operation.
- .3 During the tender period, the contractor must perform a site inspection of the place of work and surroundings as well as areas where access would be considered reasonable and make a thorough investigation of as-built conditions to determine the scope of work required relating to existing controls equipment and main trunk locations, prior to submitting their tender price.
- .4 Controls Contractor must use previously agreed "Open Book Pricing" for this Project. Consultant will request confirmation of this.
- .5 Extend/modify existing hospital Building Automation System (BAS) with Direct Digital Control (DDC), and Energy Management for new mechanical systems and interface with other microprocessor based building subsystems.
 - .1 Controls contractor is to include for all upgrades required to the existing system (including software/hardware/controllers/licenses/etc.) as required to interface all new points and controllers into BAS.
 - .2 Provide programming and decommissioning for demolition of existing BAS headend including graphics, trends, and schedule.
 - .3 Products (including control devices, controllers, instrumentation, thermostats, etc.), controls strategies, and labelling scheme shall match base building standards.
- .6 Power and data will be terminated by Division 26. A new control panel shall be installed in these locations only and all new controls taken to/from this location.
- .7 Sequence of operations are documented on drawings and in the specifications.
- .8 Refer to spec Section 20 05 02 for spare control points to be included in contract.

1.2 Dependent Sections

- .1 The BAS Work is further defined in the following specification sections:

25 05 02	Building Automation Alternate and Separate Prices
25 05 06	Work on Existing Building Automation
25 05 11	Building Automation Control Panels and Wiring
25 14 17	Building Automation Terminal Unit Controllers
25 30 13	Building Automation Actuators and Operators
25 30 16.13	Building Automation Instrumentation
25 30 16.16	Building Automation Room Pressure Monitoring
25 30 19.13	Building Automation Control Valves
25 30 19.16	Building Automation PICV and Energy Valves
25 90 01	Building Automation Control Sequences

1.3 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the BAS system is further described in the following the work under this section directly integrates with or refers to the following specification sections:
 - .1 20 05 12 Common Electrical Requirements for Mechanical Services
 - .2 23 36 13 Terminal Units

Equipment Supplied for Installation under Other Sections

- .1 Supply the following equipment for installation under other Sections of Division 20;
 - .1 automatic control valves and pressure independent control valves,
 - .2 instrumentation including pressure sensors to be installed in piping systems,
 - .3 temperature wells for controllers and sensors provided under this Section, for installation in piping systems,

Factory Installation of Controls for Terminal Units

- .1 Supply control equipment for terminal units (as specified in section 23 36 13) free-issue to the place of the manufacturer of the terminal unit equipment, for factory installation of the control equipment by that manufacturer, including factory wiring and tubing installation. Such control equipment includes:
 - .1 TU-ASC controller,
- .2 Provide information on sizing requirements for electrical transformer or power supply, sized for all control loads including controller, damper actuator, and for control of any associated heating valves.
- .3 Coordinate with terminal unit manufacturer for delivery of controls material to suit their production schedule.
- .4 All costs associated with such method of factory installation is to be borne by the mechanical subcontractor and controls subcontractor as determined between them; the Owner shall not be responsible for any such costs.

Equipment Provided under Other Divisions

- .1 The following equipment is provided under other Sections of Division 20;
 - .1 manual dampers and gravity dampers.

1.7 Definitions and Abbreviations

- .1 The following definitions, abbreviations, and acronyms apply to this Division of the Work:
 - .1 AI Analog Input: continuously variable value, usually a sensor, referenced to a controller
 - .2 AO Analog Output: continuously variable value, usually a control signal to an actuator device, referenced to a controller.
 - .3 ASC Application Specific Controller
 - .4 DI Digital Input: a two-state (On-Off) value, usually associated with a switch or state, referenced to a controller.
 - .5 DO Digital Output: a two-state (On-Off) value, usually associated with starting or stopping equipment or generating an alarm, referenced to a controller.
 - .6 FC Fail Close (valve or damper action on failure of the controller)
 - .7 FO Fail Open (valve or damper action on failure of the controller)

- .8 FAS Fire Alarm System
- .9 GUI Graphic User Interface: an LED, LCD or monitor display
- .10 I/O Input/Output
- .11 LAN Local Area Network
- .12 NC Normally Closed: position of device in a de-energized state.
- .13 NO Normally Open: position of device in a de-energized state.
- .14 NSC Network Supervisory Controller
- .15 OEM Original Equipment Manufacturer
- .16 OWS Operator workstation: a PC based server or computer
- .17 Tier 1 Building level network providing communication between NSCs and workstations.
- .18 Tier 2 Field level network providing communications between ASCs and NSCs
- .19 WAN Wide Area Network

1.8 Applicable Codes and Standards

- .1 Product standards:
 - .1 ANSI/ASHRAE 135 BACnet – A Data Communication Protocol for Building Automation and Control Networks
 - .2 ANSI/CEA 709.1 Control Network Protocol Specification (Lonworks)
- .2 Interfacing Standard:
 - .1 Input/output devices to use ASCII (American Standard for Communication and Information Interchange) code and standard EI (Electronic Industry Association) interfaces.
 - (a) CSA T530 Commercial Building Standard for Telecommunications Pathways and Spaces
 - (b) IEEE 802.3 Ethernet

1.9 Qualified Tradesperson

- .1 Work to be performed by Johnson Controls Inc. using tradespersons holding applicable certificates of competency.

Standard of Acceptance (no alternatives)

- Johnson Controls (Metasys NAE)

1.10 Design Services

- .1 Provide engineering services for the design of the BAS including product selection, wiring details, and all installation details to meet the prescribed and performance requirements described in the specifications sections of Division 25. Issued design documents are to be sealed by a professional engineer licensed in the province of the Work.
- .2 Prior to preparation of shop drawings for the BAS, provide a design assist to review Consultant's sequence of operation and provide feedback on any recommendation that may improve the installation or ease of operation, while remaining within the hardware scope as originally designed and specified herein.

1.11 Licences and Ownership

- .1 Ownership of, and licences for, hardware and software supplied or used for this project or for ongoing system operation, maintenance and modification to be registered, without restrictions, in Owner's name.

Issued For Tender

- .2 This is applicable to System Software, Workstation Application Editors, and Controller Software.
- .3 Licensing to permit an unlimited number of users to access system without additional fees.
- .4 At the time of substantial performance of the Work, upgrade the BAS software to the most current release version at that time, at no additional cost to the Owner.
- .5 Project-developed software and resulting documentation to be treated as part of system and subject to these same requirements for ownership and licensing. This material includes;
 - .1 project graphic images,
 - .2 CAD generated record drawings,
 - .3 project database,
 - .4 project-specific application programming code and documentation.

1.12 Submittals

- .1 Submit one (1) completely engineered and coordinated shop drawing package. Partial or incomplete submission of data and/or drawings will be returned without review.
- .2 Submit shop drawings for designed elements;
 - .1 list of materials of equipment to be used indicating manufacturer, model number, and other relevant technical data,
 - .2 BAS riser diagram showing system controllers, operator workstations, network devices, and network wiring,
 - .3 control panel internal wiring diagrams, .
 - .4 single-line schematics and system flow diagrams showing location of control devices,
 - .5 wiring diagrams identifying interface hard-wire terminations to controlled equipment OEM control panels,
 - .6 points list for each system controller, including: Point Type, System Name, Object Name, Expanded ID, Display Units, Controller Type, Address, Cable Destination, Panel, Reference Drawing, and Cable Number,
 - (a) points to be named by function, and list to include software points such as programmable set-points, range limits, time delays, and so forth,
 - .7 detailed analysis of each Sequence of Operation from Consultant's design documents, ready for development of actual programming code,
 - .8 written Sequence of Operations to cover normal operation and operation under various alarm conditions applicable to that system.
- .3 Submit shop drawing schedules for;
 - .1 control dampers: spreadsheet type, to include separate line for each damper and columns for damper attributes.
 - .2 control valve: spreadsheet type, to include separate line for each valve and separate columns for valve attributes.
- .4 Submit catalogue cut-sheets for;
 - .1 manufacturer's description and technical data, such as performance curves, product specification sheets, and installation/maintenance instructions for equipment and hardware items as follows;
 - (a) controllers (NSC's and ASC's),
 - (b) instrumentation, including
 - i) accuracy data, range and scale information,

- ii) one sheet for each device marked with applicable options. Where several devices of same type are to be used, submit one sheet for each device, individually marked.
- (c) actuators,
 - (d) valves and dampers,
 - (e) relays/switches,
 - (f) control panel enclosures,
 - (g) power supplies,
 - (h) batteries,
 - (i) GUI operator interfaces,
 - (j) wiring and wiring accessories.
- .5 Submit supporting documentation:
 - .1 representative examples of graphics for GUI to include;
 - (a) BAS network schematics,
 - (b) typical terminal unit floor plan graphic that shows conditions on occupied floor,
 - (c) typical equipment room floor plan graphic,
 - (d) typical graphics for each system and terminal unit at least one sample graphic for each type of equipment,
 - (e) one sample graphic for chilled water system,
 - (f) one sample graphic for hot water system,
 - (g) description of techniques used for dynamic display of information on graphics and method of how building operator drills down to secondary information and affects control of equipment.
 - .2 Protocol Implementation Conformance (PIC) statement for BACnet devices,
 - .3 where interfaces occur with control or wiring diagrams of other sections, obtain reproducible copies of those diagrams and revise to show terminal numbers at interface and include diagrams as part of interconnection schematic shop drawings.

1.13 Quality Control

- .1 Continuity of staff and subcontractors:
 - .1 Controls contractor's project manager is to be nominated at time of shop drawing submission and is to remain involved with the project, from shop drawing preparation through to project acceptance, unless a request for change of personnel is submitted to and approved by Owner.
 - .2 Subcontractors listed in preliminary design submission are to execute the Work defined as sublet in preliminary design document, unless request for change is submitted to and approved by Owner.
 - .3 Requests for changes in staff, subcontractors, or extent of work subcontracted are to be submitted for approval by Owner and such approval is not to be unreasonably withheld.
- .2 Identification of non-conforming materials and equipment:
 - .1 Submit documentation at time of bid, identifying nature and extent of non-conformance and variances from specifications or referenced standards.
 - .2 Failure to submit this documentation at time of bid will be interpreted as confirmation that materials, workmanship, hardware and software will be in strict accordance with specifications and standards.
- .3 All products that are connected to a piping system that is subject to registration under applicable boiler and pressure vessel legislation are to have current Canadian Registration Numbers in accordance with CSA B51.
- .4 Site Acceptance Testing

- .1 Manufacturer to provide services of manufacturer's authorized service personnel in accordance with the requirements of Part 3 of this specification.

1.14 Warranty

- .1 At completion of Work, submit written guarantee undertaking to remedy defects in work for period of two (2) years from date of acceptance, which includes:
 - .1 rectification of control system failures attributable to defects in workmanship, materials, hardware, and software,
 - .2 service technician to arrive on site within 24 hours of warranty service request, to install and debug software patches, to replace defective parts, materials or equipment, and to provide incidental supplies, and labour for remedial work,
 - .3 technician to remain in attendance until system is returned to operating condition.
- .2 Submit similar guarantee for any part of the Work accepted by Owner, before completion of whole work.

2 PRODUCTS

2.1 General

- .1 Provide equipment which functions and meets detailed performance criteria when operating in following minimum ambient condition ranges unless otherwise specified in other specification sections of Division 25:
 - .1 temperature: 0°C to 40°C (32°F to 104°F)
 - .2 relative humidity 10% to 90% non-condensing
 - .3 electrical power service of single phase, 120 VAC +/- 10%, 60 Hz nominal.
- .2 Components installed within motor control devices to be designed to operate with transient electrical fields occurring within these devices.

2.2 Equipment Standard

- .1 Products and software: manufacturer/developer/supplier's catalogued current stock.
- .2 This installation is not to be used as test site for newly developed product or software, without explicit written approval by Owner.
- .3 Equipment and systems installed to meet;
 - .1 performance specifications when subjected to VHF, UHF, FM, AM or background RFI as generated by commercial or private, portable or fixed transmitters that meet regulatory codes,
 - .2 Federal Communication Commission (FCC) Rules and Regulations, Part 15, Subpart J for computing devices.

2.3 BAS General Functional Requirements

- .1 Control mechanical and electrical equipment as specified in control sequences, shown on control schematics and described in equipment schedules.
- .2 Scalable system architecture to be modular, permitting stepped expansion of application software, system peripherals, and field hardware.
- .3 Control system:
 - .1 high-speed, peer-to-peer network of microprocessor based Direct Digital Control (DDC) controllers with web-based operator interface,

- .2 each mechanical system, building floor plan, and control device to be displayed through point-and-click graphics,
- .3 Web server with network interface card to gather data from this system and generate web pages that can be accessed through conventional web browser on any PC connected to network,
- .4 operators to access this system through web browser on connected PC's, wireless tablet PCs and smart phones to perform normal operator functions,
- .5 scalable, modular, automatic process and optimized workflows, with automatic data acquisition and energy performance analytics,
- .4 Each controller;
 - .1 operates with local closed loop programming, independent from server, able to continue functional control if peer-to-peer communication is interrupted;
 - .2 performs resident control routines;
 - (a) receiving information from field mounted sensors and switches and
 - (b) transmitting instructions to actuators to perform control sequences.
 - .3 manages local hardware and software alarms;
 - (a) to collect historical data,
 - (b) to facilitate operator input and output,
 - (c) to communicate with Central BAS web server and GUI.
- .5 Central BAS Web server;
 - .1 performs global application programs and data consolidation;
 - (a) communicating with controllers,
 - (b) obtaining data from field devices for central monitoring of building systems, and
 - (c) transmitting instructions to controllers.
 - .2 has software routines for;
 - (a) BAS Server operation,
 - (b) database creation and data storage,
 - (c) web based GUI with graphics generation and display,
 - (d) report formulation, printing, and presentation,
 - (e) alarm detection, management and reporting,
 - (f) event initiated programming.

2.4 Network Integration Functional Requirements

- .1 Open protocol:
 - .1 Provide an integrated, open protocol building automation system using BACnet to ANSI/ASHRAE Standard 135, with native integration with:
 - (a) Lonworks,
 - (b) Modbus,
 - (c) OPC (OLE for process control).
 - (d) ONVIF,
 - (e) DALI.
- .2 Integral systems integration functionality:
 - .1 provide hardware and software to allow bi-directional digital communications between BAS and facility control subsystems including:

- (a) HVAC,
 - (b) fire safety including fire alarm systems,
 - (c) security systems,
 - (d) power control and monitoring systems,
 - (e) lighting control systems,
 - (f) 3rd party integration with other facility systems.
- .3 OEM Controller integration:
- .1 provide hardware and software to allow bi-directional digital communications between BAS and 3rd party manufacturers' equipment control panels including but not limited to;
 - (a) boilers,
 - (b) chillers,
 - (c) variable frequency drives,
 - (d) packaged HVAC equipment,
 - (e) power monitoring equipment,
 - (f) medical gas equipment.
 - .2 integrate real-time data from these systems.

2.5 BMS Network Architecture

Refer to specification section 25 05 06 for work required on existing BAS networks.

2.6 Performance

- .1 General:
 - .1 information transmission and display times are based upon network connections,
 - .2 test systems using manufacturer's recommended hardware and software for operator interface.
- .2 Performance criteria:
 - .1 Graphic Display;
 - (a) display graphic with 50 dynamic points with current data within 10 seconds.
 - .2 Graphic Refresh;
 - (a) update graphic with 50 dynamic points with current data within 10 seconds and
 - (b) automatically refresh every 15 seconds.
 - .3 Configuration and Tuning Screens;
 - (a) special screens used for configuring, calibrating, or tuning points, PID loops, and similar control logic to refresh every 5 seconds.
 - .4 Object Command response;
 - (a) time between command of binary object at GUI and onset of reaction by device to be less than 5 seconds,
 - (b) time between command of analog object at GUI and start of adjustment to be less than 5 seconds.
 - .5 Alarm Response Time;
 - (a) time between when an object goes into alarm and when it is annunciated at GUI to be less than 15 seconds.
 - .6 Program Execution Frequency;

- (a) execution repeat frequency to be selected in manner consistent with process under control,
- (b) custom and standard applications to be capable of executing as often as once every 5 seconds.
- (c) programmable controllers to be able to perform PID control loop routines at selectable frequency, adjustable at GUI down to once every second.
- (d) workstations connected to network to receive alarms with not more than 5 seconds spread between first and last annunciation.

2.7 Capacity for Future Expansion

- .1 Tier 1 network;
 - .1 network backbone to have capacity for future 50 routers or building controller/routers in addition to connected devices at time of acceptance of the Work,
 - .2 each router or building controller/router on network backbone to have routing capacity for 50 controllers.

2.8 Wiring and Conduit

- .1 Wire and conduit for power wiring, control wiring, and communication wiring to conform to specification section 20 05 12.

3 EXECUTION

3.1 Examination

- .1 Inspect site and thoroughly examine documents to establish locations for control devices and equipment and report discrepancies, conflicts, or omissions for resolution before starting rough-in work.
- .2 Be responsible for correction of defects caused through neglect of inspections and examinations or failure to report and resolve discrepancies.

3.2 Protection

- .1 Protect work and material against damage during construction and be responsible for work and equipment until inspected, tested, and accepted.
- .2 Protect material not immediately installed and seal connector terminations with temporary covers or plugs during storage and construction to prevent entry of foreign objects.
- .3 Protect electronic equipment from elements during construction.

3.3 Coordination

- .1 Coordinate and schedule BAS work with other work in same area to ensure orderly progress.
- .2 Testing and balancing:
 - .1 Supply sets of tools of sufficient quantity for Testing and Balancing Technicians to interface to control system, train these technicians in use of tools, and provide qualified Control Technician to assist with testing and balancing the first 10 terminal units.
 - .2 Tools to be turned over to Owners on completion of testing and balancing.
- .3 Controls work by others:
 - .1 Integrate and coordinate this control work with controls and control devices provided or installed by others.
 - .2 Each supplier of control product to configure, program, start up, and test that product to satisfy requirements of Sequence of Operation regardless of where within contract documents product is specified or described.

- .3 Resolve compatibility issues between control products provided under this Division and those provided under other Divisions of the Work.

3.4 General Workmanship

- .1 Installation to be performed by skilled and certified technicians.
- .2 Install equipment, piping, and wiring or raceways horizontally, vertically, and parallel to building lines.
- .3 Provide sufficient slack and flexibility in connections to allow for vibration isolation between conduit, raceways, piping and equipment.
- .4 Install instrumentation and devices in locations providing adequate ambient conditions.
- .5 Protect components placed in areas of potentially high humidity.

3.5 Wiring for Power, Control and Communications

- .1 Provide wire and raceways (conduit) for power wiring, control wiring, and communications wiring for BAS controllers and associated instrumentation and actuation devices, at voltages of 120 V and under, in accordance with specification section 20 05 12 and, for greater clarity, Schedule A appended to that specification section.
- .2 Verify wiring integrity to ensure continuity and freedom from shorts and ground faults.

3.6 Cleaning

- .1 Clean up debris, remove packaging material, collect waste and place in designated location, on a daily basis.
- .2 Keep work areas free from dust, dirt, and debris.
- .3 On completion of work, check finish of equipment provided under this section for damage and repair damaged factory-finished paint, replace deformed cabinets and enclosures with new material, and repaint to match original.
- .4 Prior to hand-over to the Owner, clean the inside of control panels;
 - .1 remove debris and vacuum clean internal components,
 - .2 the use of low-pressure dry nitrogen or inert compressed gases may be used to blow dust and debris out of panels where the use of such pressurized gases will not damage equipment or loosen wiring terminations,
 - .3 after cleaning, apply a label to the exterior side of the panel to identify the date the panel was cleaned and the initial of the person who cleaned the panel.

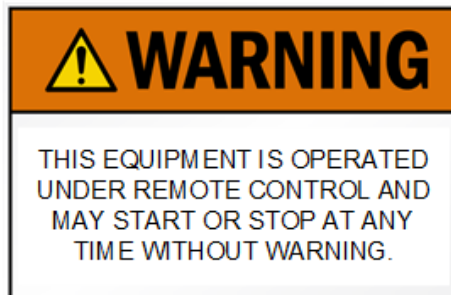
3.7 Field Quality Control

- .1 Ensure work, materials, and equipment comply with this specification and reviewed shop drawings.
- .2 Monitor field installation for applicable safety and building code compliance and workmanship quality.
- .3 Arrange and pay for inspections by local or provincial authorities having jurisdiction over the work.

3.8 Identification of Equipment

- .1 Manufacturers' nameplates and product certification labels to be visible and legible after equipment is installed.
- .2 Identify discrete items of equipment with plastic nameplates or plasticized labels, identifying equipment and function. Identification plates are in addition to manufacturers nameplates.
- .3 Identification plates:

- .1 provided for equipment identified with number designations in schedules and equipment shop drawings.
- .2 marked with equipment type, number and service following wording and numbering used in contract documents and shop drawings,
- .3 plastic laminated labels,
- .4 white face and black background field,
- .5 minimum size 75 mm x 40 mm x 3 mm (3 in x 1½ in x 1/8 in),
- .6 engraved or printed with 6.5 mm (1/4 in) high lettering.
- .7 securely attached to equipment with brass chains.
- .4 Label wiring and cabling, including that within factory-fabricated panels, with control system address or termination number at each end within 50 mm (2 in) of termination.
- .5 Label pneumatic tubing at each end within 50 mm (2 in) of termination with descriptive identifier.
- .6 Permanently label or code each point of field terminal strips to show instrument or item served.
- .7 Label each control component with permanent label. Label plug-in components so that label remains stationary during component replacement.
- .8 Label room sensors related to terminal boxes or valves with nameplates. Place labels on back of sensors.
- .9 Identify motor controllers that are remotely controlled by the BAS with self-adhesive labels, black letters on white background with a red border and electric shock warning icon, with wording as follows;



3.9 Checkout and Testing

- .1 Provide schedule for start-up and testing.
- .2 Calibrate and prepare for service equipment, instruments, controls, and accessories.
- .3 Start-up testing to verify completion of control system before system demonstrations begin;
 - .1 verify that control wiring is connected and free of shorts and ground faults. Verify that terminations are tight,
 - .2 enable control systems and verify input device calibration,
 - .3 verify that binary output devices operate and that normal positions are correct,
 - .4 verify failure positions of dampers and control valves are correct when power/compressed air is deenergized to the device,
 - .5 verify that analog output devices are functional, that start and span are correct, and that direction and normal positions are correct,
 - .6 check control valves and automatic dampers for proper action and closure and adjust valve stroke/rotation and damper blade travel,

- .7 verify that damper and control valve feedback signals are correct when device is stroked fully open and closed (two position) and at any opening position between zero and fully open (modulating devices),
 - .8 verify that system operates according to Sequences of Operation. Simulate changes in variables by overriding and varying inputs and schedules and observe and record each operational mode response.,
 - .9 tune PID loops and control routines to provide stabile operation and to minimize valve and damper hunting,
 - .10 check each alarm with an appropriate signal at value that will trip alarm,
 - .11 trip interlocks using field contacts to check logic and to ensure that actuators fail in proper direction,
 - .12 test interlock actions by simulating alarm conditions to check initiating value of variable and interlock action.
- .4 Prepare and submit test log documenting start-up testing of each input and output device and each control routine, with technician's initials certifying each device and each routine is functioning correctly and sensors have been calibrated. Include list of deficiencies and a workplan schedule setting out rectification program with time lines.

3.10 Testing of Integrated Life Safety and Fire Protection Systems

- .1 Comply with the requirements of specification section 20 08 11 for the testing of the integration of controls and communications between the BAS and life safety and fire protection systems.

3.11 Control System Demonstration

- .1 Obtain approval of start-up testing log and rectification program before scheduling demonstrations.
- .2 Provide notification to Owner and Consultant not less than 10 business days before system demonstration begins.
- .3 Demonstration to follow previously submitted and approved procedures;
 - .1 submit checklists and report forms for each system as part of demonstration,
 - .2 lists and forms to have initials of technicians conducting demonstrations,
 - .3 date of each demonstration and signatures of Owner's representatives witnessing each demonstration section.
- .4 Prior to acceptance, perform the following operating tests in the presence of the Owner or Owner's representative and Consultant to demonstrate system operation and compliance with specification after and in addition to tests specified above in article Checkout and Testing.
- .5 Demonstrate field operation of;
 - .1 each Sequence of Operation,
 - .2 Operator Interface,
 - .3 control loop response with graphical trend data output showing;
 - (a) each control loop response to set point change producing an actuator position change of at least 25% of full range.
 - (b) trend sampling rate to be from 10 seconds to 3 minutes, depending on loop speed,
 - (c) loop trend data to show set point, actuator position, and controlled variable values,
 - (d) documentation of further tuning of any loop that displays significantly under- or over-damped control
 - .4 demand limiting routine with trend data output showing demand-limiting algorithm action;

- (a) trend data to document action sampled each minute over at least 30-minute period and to show building kW, demand-limiting set point, and status of set-points and other affected equipment parameters.
- .5 control integration with life safety and fire protection systems,
- .6 trend logs for system points as selected by the Owner with;
 - (a) trend data to indicate set-points, operating points, valve positions, and other data as specified in points list provided with each Sequence of Operation,
 - (b) each log to cover three 48-hour periods and to have sample frequency not less than 10 minutes, except where a Control Sequence specifies other time intervals,
 - (c) show that trend logs are accessible through operator interface and can be retrieved for use in other software programs.
- .7 substantiate calibration and response of any input and output points requested,
- .8 provide at least two technicians equipped with two-way communication,
- .9 provide and operate test equipment to establish calibration and prove system operation.
- .6 Tests that fail to demonstrate system operation are to be repeated after repairs and/or revisions to hardware or software is completed.

3.12 Training

- .1 Materials:
 - .1 provide course outline and materials for each class at least four (4) weeks before first class,
 - .2 provide training through instructor-led sessions, with computer-based, or web-based techniques,
 - .3 instructors to be factory-trained and experienced in presenting this material,
 - .4 perform classroom training using network of working controllers representative of installed hardware.
- .2 Operating staff training:
 - .1 provide training for Owners operating staff using abovementioned training materials in self-paced mode, web-based or computer-based mode, classroom mode, or combination of these methods,allow for 3 repeat sessions for each category to cover operator shift rotation.
- .3 Training to enable students to accomplish following objectives:
 - .1 Group 1:
 - (a) proficiently operate system,
 - (b) understand control system architecture and configuration,
 - (c) understand BAS system components,
 - (d) understand system operation, including BAS system control and optimizing routines (algorithms),
 - (e) understand Sequence of Operations,
 - (f) operate workstation and peripherals,
 - (g) log on and off system,
 - (h) access graphics, point reports, and logs,
 - (i) adjust and change system set-points, time schedules, and holiday schedules,
 - (j) recognize common HVAC system malfunctions by observing system graphics, trend graphs, and other system tools,
 - (k) understand system drawings and Operation and Maintenance manual,
 - (l) understand project layout and location of control components,

- (m) access data from BAS controllers,
- (n) set-up trend logs,
- (o) operate portable operator's terminals
- .2 Group 2:
 - (a) create and change system graphics,
 - (b) create, delete, and modify alarms, including configuring alarm reactions,
 - (c) create, delete, and modify point trend logs (graphs) and multi-point trend graphs,
 - (d) configure and run reports,
 - (e) add, remove, and modify system's physical points,
 - (f) create, modify, and delete application programming,
 - (g) add and configure GUIs,
 - (h) add new controller to system,
 - (i) download firmware and advanced applications programming to controller,
 - (j) configure and calibrate I/O points.
- .3 Group 3:
 - (a) maintain software and prepare backups,
 - (b) interface with job-specific, third-party operator software,
 - (c) add new users and understand password security procedures.
- .4 Divide presentation of objectives into three sessions:
 - .1 Group 1: Day-to-day Operators,
 - .2 Group 2: Advanced Operators,
 - .3 Group 3: System Managers and Administrator,
 - .4 participants will attend one or more sessions, depending on knowledge and expertise level required,
 - .5 provide each student with one copy of training material.

3.13 Record Submittals

- .1 Submit record documents to the Owner.

Document language: English.

- .3 Submit three copies of project record documents and obtain approval during acceptance procedures.
- .4 Submit AHJ inspection certificates.
- .5 Provide as-built drawings;
 - .1 as-built interconnection wiring diagrams, or wire lists of field installed system with identified, ordering number of each system component and service,
 - .2 floor plans with accurate depiction of location of system devices, controllers, and trunk wiring. Drawings to be constructed using Architectural backgrounds provided,
 - .3 provide copies of as-built drawings on two (2) removable storage devices,
 - .4 provide five (5) full size hard copies of floor plan drawings.
- .6 Operation and Maintenance (O&M) Manuals:
 - .1 provide two (2) paper copies of material and copies on five (5) removable storage devices in portable document format.

- .2 describe operation, maintenance and servicing requirements of system and associated equipment,
- .3 provide the following information in separate sections, each with an index:
 - (a) Service and parts;
 - i) names, addresses, and telephone numbers of installing contractors and service representatives for equipment and control systems,
 - ii) list of recommended spare parts with part numbers and suppliers.
 - (b) System description;
 - i) outline of BAS system and system architecture,
 - ii) as-built versions of shop drawing product data,
 - iii) reduced size (11 in x 17 in) copies of record drawings,
 - iv) graphic files, programs, and database on magnetic or optical media,
 - v) licenses, guarantees, and warranty documents for equipment and systems.
 - (c) Technical literature for equipment, including;
 - i) catalogue sheets,
 - ii) calibration, adjustments and operation instructions,
 - iii) installation instructions,
 - iv) hardware and software manuals, with information supplied by original product developer, on application programs and on computers and controllers supplied,
 - v) Operator's manual with procedures for operating control systems; logging on and off, handling alarms, producing point reports, trending data, overriding computer control, and changing set-points and variables,
 - vi) engineering, installation, and maintenance manual or set of manuals that explains how to design and install new points, panels, and other hardware; how to perform preventive maintenance and calibration; how to debug hardware problems; and how to repair or replace hardware,
 - vii) original-issue documentation with installation and maintenance information for third-party hardware including computer equipment and sensors,
 - viii) recommended preventive maintenance procedures for system components, including schedule of tasks such as inspection, cleaning, and calibration; time between tasks; and task descriptions,
 - ix) programming manual or set of manuals with description of programming language and syntax, explanation of statements for algorithms and calculations used, procedures for point database creation and modification, documentation of techniques for program creation and modification, and instructions for use of editor,
 - x) documentation of programs created using custom programming language including set-points, tuning parameters, and object database. Electronic copies of programs to modify and create control logic, set-points, tuning parameters, and objects that can be viewed using programming tools.
- .7 Original Software:
 - .1 Furnish one original set of application and system software on original media. Disks to bear manufacturer's label. Field copies are not acceptable.
 - .2 Original-issue copies of software to include operating systems, custom programming language, application generation, graphic support, maintenance support, operator workstation or web server software, and other utilities provided in support of installed system. [
- .8 On-line record documentation:

- .1 After completion of testing and adjustment, install the following additional information on the server OWS.
 - (a) as-built record drawing files,
 - (b) detailed catalog data on all installed system components, with supplier contact information for purchasing and factory authorized repair service.[]

3.14 Acceptance

- .1 Application for substantial performance of the Work requires as a prerequisite the completion of the BAS including testing, demonstration, and submittal of required documentation, except where the Owner agrees to differ any work to a later date.
- .2 In support of an application for substantial performance, submit a signed declaration to the Owner certifying that:
 - .1 the BAS is complete and operating in accordance with the contract documents,
 - .2 control system checkout and testing is completed,
 - .3 control system demonstration is completed,
 - .4 training is completed,
 - .5 as-built documentation is completed and turned-over to the owner.
- .3 Certification document may identify tests that cannot be performed due to extenuating circumstances such as weather conditions, where previously agreed to be deferred to a later date by the Owner. Append a program for completion of deferred work to the certification document for rectification and completing these tests during warranty period.

3.15 Correction After Completion

- .1 After start-up, testing, and commissioning phase has been completed and satisfactory and reliable operation of equipment and systems has been demonstrated, acceptance of the system is to be given by Owner. Warranty period to begin on date established on certificate of acceptance.
- .2 Provide updates and patches to resolve software deficiencies in operator workstation or web server software, project-specific software, graphic software, database software, and firmware during warranty period.
- .3 Provide upgrades that improve routines and procedures of operator workstation software, web server software, project-specific software, graphic software, or database software, free of charge, during warranty period.
- .4 Provide details of proposed changes and obtain written authorization from Owner before installation of updates, patches, or upgrades.
- .5 Include preventative maintenance, with allowance for spare parts, labour, and emergency (24 hour) service for system and equipment during warranty period.
- .6 Equipment manufacturers to submit written undertakings to make circuit board repairs and provide spare parts, software support and patches, and technical assistance for at least five years after acceptance is certified.

End of Section

WORK ON EXISTING BUILDING AUTOMATION

25 05 06

GENERAL

1.1 Scope

- .1 Modifications to existing building control systems including:
 - .1 connection to of new BAS networks to the existing building BAS networks,
 - .2 connection of new control devices to existing BAS networks,
 - .3 selective demolition of existing building controls,
 - .4 modifications and upgrades of existing BAS.

1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
 - .1 20 05 26 Pipeline Hot-Tapping and Line Stopping
 - .2 25 05 01 Building Automation Common Work Results

1.3 Definitions and Abbreviations

- .1 Refer to specification section 25 05 01.

1.4 Designated Controls Contractor

- .1 BAS work shall be performed by Johnson Controls Inc. as the base building controls contractor authorized by the Owner to perform such Work.

1.5 Design Criteria

- .1 Existing BAS networks:
 - .1 Tier 1: hosted on facility IT network.
 - .2 Tier 2: BACnet MSTP

1.6 Submittals

- .1 Shop drawings:
 - .1 In addition to the requirements of section 25 05 01, submit the following information as a shop drawing:
 - (a) documentation of existing sequence of operations for applicable equipment and systems affected by the Work.

2 PRODUCTS

2.1 General

- .1 Conform to specification section 25 05 01 and other sections of Division 01 except as specified herein.

3 EXECUTION

3.1 Existing Equipment

- .1 Reuse of control components:

- .1 reuse existing equipment and components as listed below where condition and conformance with this specification permits;
 - (a) valves and operators,
 - (b) dampers and operators,
 - (c) compressed air system,
 - (d) thermocouple wells,
 - (e) freezestats,
 - (f) firestats,
 - (g) limit, end, or level switches and air or liquid flow switches,
 - (h) static pressure sensors and controllers,
 - (i) wiring and conduit for safety controls and I/O points,
 - (j) relays,
 - (k) cabinets,
 - (l) other items specifically noted as existing, to be re-used.
- .2 Remove and replace existing temperature and humidity sensors with new units, throughout the installation,
- .3 Check and re-calibrate existing indicator gauges,
 - .1 under no circumstances are existing gauges or thermometers be removed.
- .4 Re-calibrate valves and dampers as part of installation of this system.
- .5 Existing thermowells for conventional control system may be reused for new sensors,
 - .1 repack temperature wells, both new and reused, with heat conductive grease.

3.2 Existing Programming and Configuration

- .1 Document existing control device programming, configuration, and setpoint values at the start of the work, prior to any demolition or other work on existing control equipment.
- .2 For each NSC or ASC being replaced, review the existing control programming and/or configuration settings, and prepare a written sequence of operation in laymen terms that describes the operating control of each control device. Where multiple control devices of the same type exist (e.g. terminal units), review at least three (3) randomly selected controllers to verify the same control functions; a single written control sequence for each type controller is sufficient.
- .3 Provide a copy of these documentation to the Owner.
- .4 Except where otherwise specified for new sequence of operations, program and/or configure software for replacement NSC and ASC to achieve the same control functionality and sequence of operation of the pre-existing NSC and ASC controllers, and configure setpoints to match pre-existing controller values.

3.3 Existing Condition Survey

- .1 Conduct a condition survey of existing control devices:
 - .1 test, inspect and report on existing devices which are to be incorporated into the BAS, for satisfactory operation within 30 days of award of contract and prior to installation of any new devices,
 - .2 for those items found in unacceptable condition, provide with report test data, original specification sheets or written functional requirements to confirm conclusion,

- .3 Owner to arrange for repair or replacement of those existing items judged defective, but shown to be re-used in BAS and control system,
- .4 items thus repaired or replaced by Owner will be returned to site and handed over to Contractor under this Section for storage, installation, testing, and commissioning.,
- .5 warrant reused devices that have been rebuilt or repaired. Demonstrate satisfactory operating condition of reused devices at time of acceptance,
- .6 responsibility for existing control devices that have been reused is to terminate at end of warranty period.

3.4 Demolition and Removals

- .1 Unless specifically noted or shown otherwise, remove existing control components made redundant:
 - .1 room thermostats, controllers, auxiliary electronic devices, pneumatic controllers and relays, control valves, electronic sensors, and transmitters: to be removed and placed in storage as directed by Owner.
 - .2 local control panels: removed and placed in storage as directed by Owner.
- .2 Remove and dispose of existing conduits, wiring and tubing in all areas (including above accessible ceilings) as they become redundant;
 - .1 remove existing control compressed air systems and, where applicable, connect to new control air system;
 - .2 existing hardwired interlocks to remain installed in systems.
- .3 In existing areas not otherwise involved in renovations, arrange and pay for holes and marks left by decommissioning and removal of control components, wiring, conduit, and tubing to be patched and refinished to match existing.

3.5 Maintaining Existing System Operation

- .1 Mechanical systems to remain in operation and to maintain space conditions between hours of 6 a.m. and 9 p.m., Monday through Friday.
- .2 In these periods mechanical control system shut downs of up to 15 minutes may be permitted, after obtaining written agreement from Owner.
- .3 When time required for cut-over of controls will not meet these constraints, perform work outside of operating hours after making application; outlining areas affected; and likely length of interruption, and obtain written agreement from Owner. .
- .4 Maintain fan scheduling using existing or temporary time clocks or control systems throughout period of control system installation.
- .5 Modify existing motor controllers to incorporate new local operator control switches for motors to be controlled through BAS system.

3.6 Installation of New Thermowells

- .1 Existing piping services to remain in service during installation of thermowells.
- .2 Coordinate with the trade contractor under Division 23 to install thermowells for new temperature sensors mounted on steel piping by hot-tapping in accordance with specification section 20 05 26.

3.7 Interfacing Between New and Existing Control Systems

- .1 Certain building systems are to operate in event of building power failure or fire alarm. Under no circumstances should interfacing of equipment or controls modify these existing sequences of operation.
- .2 Where tying new system into existing control equipment, show on shop drawings;

- .1 signal levels,
 - .2 wire type,
 - .3 wire numbers, and
 - .4 terminal numbers.
- .3 Before attempting replacement of existing control systems, install new field panels, controllers and associated devices loose-ended ready for system changeover.
 - .4 Submit written request to Owner setting out proposed starting time for changeover, duration of system down time, and establishing extent of interruption to operation of existing control system.
 - .5 Do not proceed with work until Owner's written approval of time for, duration of, and extent of interruption is received.
 - .6 Subsequent decommissioning and removal of control components to be carried out without interfering with normal operations or creating an interruption in service of any building systems except through an approval process similar to that noted above.

End of Section

BUILDING AUTOMATION CONTROL PANELS AND WIRING

25 05 12

1 GENERAL

1.1 Scope

- .1 Provide building automation control panels for mounting and securing building automation control equipment and devices.

1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
 - .1 20 05 12 Common Electrical Requirements for Mechanical Services
 - .2 20 05 49.23 Seismic Qualification for Mechanical Equipment
 - .3 25 30 16 Building Automation Instrumentation

1.3 Definitions and Abbreviations

- .1 The following definitions apply to this section.
 - .1 **Control wiring** – has the meaning as defined in specification section 20 05 12.
 - .2 **Extra-low voltage** – any voltage not exceeding 30 V (has the same meaning as per CSA C22.1)
 - .3 **GUI** means “graphic user interface”, to display system data to the user and to allow the user to enter operating commands and data selection.
 - .4 **Power wiring** - has the meaning as defined in specification section 20 05 12.

1.4 Applicable Codes and Standards

- .1 Product standards:
 - .1 CSA C22.2 No. 0.3 Test Methods for Electrical Wires and Cables
 - .2 CSA C22.2 No. 14 Industrial Control Equipment
 - CSA C33.3 No. 18.5/UL 1565
Positioning Devices
 - .3 CSA C22.2 No. 66.2 Low Voltage Transformers – Part 2: General Purpose Transformers
 - CSA C22.2 No. 66.3 / UL 5085-3
Low Voltage Transformers – Part 3: Class 2 and Class 3 Transformers
 - .4 CSA C22.2 No. 72 Heater Elements
 - .5 CSA C22.2 No. 94.1 Enclosures for Electrical Equipment, Non-Environmental Considerations
 - .6 CSA C22.2 No. 223 Power Supplies with Extra-Low-Voltage Class 2 Outputs.

1.5 Qualified Tradesperson

- .1 Work to be performed by qualified, licensed and recognized firm with an established reputation in this field, using tradesperson holding applicable certificates of competency.

1.6 Registration and Inspection

- .1 Where control panels are not listed in accordance with CSA C22.2 No. 14, arrange and pay for field inspection by the AHJ for electrical safety.

Seismic Qualification

- .1 Seismically qualify (certify) the following equipment specified herein:
 - .1 Building automation system control panels including microprocessor control units and all other internal devices.
- .2 Exemptions:
 - .1 application specific controllers serving the following equipment types are exempt from seismic qualification:
 - (a) air terminal units under specification section 23 36 13,
 - (b) fan-coil units under specification section 23 82 19,
 - (c) terminal heating equipment under specification section 23 82 33 series and 23 82 39 series
- .3 The seismic qualification of the above-listed equipment is to conform to Specification section 20 05 49.23 for the following seismic qualification level and certification method:
 - .1 Functional seismic qualification (Level III) for electrical control equipment: by shake table testing,
- .4 The following equipment specific seismic force parameters are to be used:

C_p	A_r	R_p	h_x/h_n
1.00	1.00	1.25	1.0

1.8 Submittals

- .1 Shop drawings:
 - .1 submit product data sheets for materials specified herein.
 - .2 submit shop drawings for control panels including wiring diagrams and panel layout details.

2 PRODUCTS

2.1 General

- .1 Provide custom factory-made building automation control panels including all factory-installed devices and equipment required for operation of associated building equipment or systems including but not limited to DDC controllers, GUI, power supplies, transducers, solenoid air valves, relays and accessories.
- .2 Comply with the requirements of specification section 20 05 12 for products not otherwise specified herein.
- .3 Provide equipment which functions and meets detailed performance criteria when operating under the following conditions:
 - .1 ambient temperature:
 - (a) indoors: 4°C to 40°C (39°F to 104°F)
 - (b) outdoors: -30°C to + 40°C (-22°F to 104°F)
 - .2 ambient relative humidity: 10% to 90% non -condensing,
 - .3 electrical power service: 120 VAC +/- 10%, 1 phase, 60 Hz nominal.

2.2 Control Panels

- .1 Panel enclosure:
 - .1 indoors: type 2 with sprinkler shield, 3R or 4 to CSA C22.2 No. 94.1 (NEMA 2, 3R, or 4),
 - .2 material: galvanized steel,
 - .3 with hinged door and lock,
 - .4 integral cooling fans and vents with power supplies, wiring and circuit protection,
 - .5 mounting backplate and/or DIN rails for mounting of wiring devices, controllers, sensors, transducers, and relays,
 - .6 conduit openings and adapters in sufficient quantities and sizes to accommodate wiring terminating within enclosure,
 - .7 document holder inside panel, to include one set of as built, plasticized control Shop Drawings for equipment served by that panel permanently affixed to cabinet frame,
 - .8 enclosure finish: vendors standard colour,
- .2 GUI display:
 - .1 surface mounted on or semi-recessed in panel front door where GUI is required by other specification sections of Division 25.
 - .2 where GUI is mounted on the controller inside the panel, provide panel door cut-out with viewing glass to allow viewing only of GUI with panel door closed.
- .3 Control panel layout and construction:
 - .1 enclosures to be of sufficient size to house control components including controllers and associated transformers, control relays, wiring, conduits and other auxiliary equipment, so as to allow access for maintenance and replacement of components without requiring removal of other components.
 - .2 permanent engraved labels with black lettering on white background indicating:
 - (a) stating applicable building system name and reference number.
 - (b) function of each panel door mounted device.
 - .3 mount air pressure gauges on front of panel door to allow viewing from outside the panel,
 - .4 support wiring in cable ducts; arrange cable ducting and install wiring in a neat and workmanlike manner,
 - .5 provide numbered terminal strips for field wiring terminations; do not terminate field wiring directly on control devices or controllers. Arrange terminal strips in a common location adjacent to minimize routing and quantity of field wiring inside of panel.
 - .6 label both ends of internal wiring with label markers using name of cable function, or to identify wire number as shown on panel shop drawings,
 - .7 layout circuit fuses to facilitate location and replacement; provide labels at each fuse holder identifying fuse number and replacement fuse type and size,
- .4 Control devices mounted on panel door-front:
 - .1 Key-lock operated main panel power ON-OFF switch,
 - .2 alarm buzzer silence pushbutton (where applicable),
 - .3 alarm reset pushbutton (where applicable),
 - .4 indicating lights:
 - (a) main panel power ON (white),
 - (b) summary alarm (red),

- (c) other indicating lights as specified by control sequences.
- .5 Panel mounted alarm devices:
 - .1 alarm buzzer (where applicable).
- .6 Cable Ducts
 - .1 non-metallic cable ducting with removable cover, slotted access cable restraints,
 - .2 ambient temperature rating: -40 to +60°C (-40 to +140°F)
 - .3 listed to CSA C33.3 No. 18.5/UL 1565.
- .7 Terminal strips:
 - .1 NEMA finger-safe terminal blocks, spring-clamp or screw fastened,
 - .2 directly fastened to panel backplane or DIN rail mounted.

2.3 Power Supplies and Line Filtering

- .1 For control panels and for field installed devices.
- .2 Transformers and Power Supplies:
 - .1 industrial control transformers to be listed to CSA C22.2 No. 66-2, and temperature rated for 40°C,
 - .2 control transformers to be listed to CSA C22.2 No. 66-3,
 - .3 AC/DC power supplies to be listed to CSA C22.2 No. 223,
 - .4 provide over-current protection in primary and secondary circuits,
 - .5 limit connected loads to 80% of rated capacity.
- .3 DC power supplies:
 - .1 output to match equipment current and voltage requirements,
 - .2 units to be full-wave rectifier type with output ripple of 5.0 mV maximum peak-to-peak. Regulation to be 1.0% line and load combined, with 100-microsecond response time for 50% load changes,
 - .3 units to have built-in over-voltage and over-current protection and to be able to withstand 150% current overload for at least three seconds without trip-out or failure,
 - .4 units to operate between 0°C and 50°C (32°F and 120°F).
 - .5 EM/RF to meet FCC Class B and VDE 0871 for Class B and MILSTD 810C for shock and vibration.
- .4 Power Line Filtering:
 - .1 provide internal or external transient voltage and surge suppression for workstations and control modules,
 - .2 surge protection:
 - (a) dielectric strength of 1000 V minimum,
 - (b) response time of 10 nanoseconds or less,
 - (c) transverse mode noise attenuation of 65 dB or greater,
 - (d) common mode noise attenuation of 150 dB or greater at 40-100 Hz.

2.4 Miscellaneous Electrical Control Devices

- .1 Control Relays:
 - .1 plug-in type, UL listed, with dust cover and LED "energized" indicator.
 - .2 contact rating, configuration, and coil voltage suitable for application.

- .3 NEMA 1 enclosure for relays not installed in local control panels.
- .2 Time Delay Relays:
 - .1 solid-state plug-in type, UL listed, with adjustable time delay adjustable $\pm 100\%$ from set point shown.
 - .2 contact rating, configuration, and coil voltage suitable for application.
 - .3 NEMA 1 enclosure for relays not installed in local control panels.
- .3 Override Timers:
 - .1 spring-wound line voltage, UL Listed, with contact rating and configuration by application unless implemented in control software.
 - .2 0-6 hour calibrated dial.
 - .3 flush mounted on local control panel face.
- .4 Electronic signal isolation transducers:
 - .1 provided whenever;
 - (a) an analog output signal from BAS is connected to an external control system as an input (such as chiller control panel) or
 - (b) BAS is to receive an analog input signal from an external remote system.
 - .2 designed for ground plane isolation between systems.

2.5 Electro-Pneumatic (E/P) Transducers

- .1 To convert 4-20 mA, 0-5 Vdc, or 0-10 Vdc analog control input signal to a 20-100 kPa (3-15 psig) output signal;
 - .1 separate span and zero adjustments,
 - .2 manual output adjustments,
 - .3 output pressure gauge assembly,
 - .4 feedback loop control,
 - .5 mid-range air consumption of 0.05 NL/s (0.1 SCFM).

2.6 Pressure-Electric (P/E) Switches

- .1 To convert pressure signal to activate electric switch;
 - .1 diaphragm operated SPDT. snap acting contacts with electrical rating suitable for application,
 - .2 designed to withstand up to 170 kPa (25 psi) input pressure,
 - .3 adjustable cut-in and cut-out settings between 25 and 140 kPa (3 and 20 psi).

2.7 Wiring and Raceways

- .1 Electrical materials, equipment and installation procedures to conform to the electrical safety code applicable to the location of the Work, in accordance with the requirements of specification section 20 05 12, and as specified herein.
 - .1 conductors for digital functions: 18 AWG minimum, twisted and shielded,
 - .2 conductors for analog functions: 18 AWG minimum, twisted and shielded, 2 or 3 wire to match analog function hardware.
 - .3 conductors for transformer current wiring: 16 AWG minimum,

- .4 conductors for sensor wiring: 22 AWG minimum, twisted and shielded, 2 or 3 wire to match analog function hardware. Provide additional conductors as to support supplemental features of sensor (i.e. set-point adjustment, override, etc.).
- .2 Non-continuous cable supports:
 - .1 Sling strap:
 - (a) Galvanized steel support bracket with adjustable polyethylene support sling.

Standard of Acceptance

- ° nVent – fig. Caddy Cable 425

3 EXECUTION

3.1 Control Panel Installation

- .1 Install transmitters, transducers, controllers, solenoid air valves and relays in control panels.
- .2 Mount control panels to poured concrete or concrete block walls on mounting channels; do not fasten directly to the wall.
- .3 Where control panels are located away from concrete walls, provide a fabricated floor-mounted galvanized-steel channel support frame to mount control panels. Design support frame to withstand applicable seismic loads.
- .4 Install control panels with user interface devices on the panel door so that the centerline of the principle interface device is between 1500 and 1600 mm (60 to 64 in) above floor level.
- .5 Install other panels so that the top of the panel is located between 1800 and 1900 mm (72 to 76 in) above the floor.
- .6 Trim-back or neatly collect excess field wiring inside of control panels.

3.2 Field Wiring Installation

- .1 Provide power wiring and control wiring as needed to support operation of the building automation system. Refer to Section 20 05 12 for description of division of work and responsibility.
- .2 Installation of field wiring for power wiring and control wiring to conform to specification section 20 05 12 except/and as specified herein.
- .3 During installation follow cable manufacturer's specified cable pulling tension, and recommended minimum bend radius.
- .4 Verify entire network's integrity following cable installation using appropriate tests for each cable.
- .5 Install lightning arrester according to manufacturer's recommendations between cable and ground wherever cable enters or exits the building.
- .6 Each run of communication wiring to be continuous length without splices.
- .7 Label communication wiring to indicate origin and destination.
- .8 Ground coaxial cable according to Division 26 requirements.
- .9 Fiber optic cable installation:
 - .1 do not exceed pulling tensions specified by cable manufacturer. Post-installation residual cable tension to be in accordance with cable manufacturer's specifications,
 - .2 do not exceed minimum cable and unfaceted fiber bend radii specified by cable manufacturer.

3.3 Conduit and Raceways

- .1 Run power wiring and control wiring in conduit except where otherwise specified herein.
- .2 Extra-low voltage control wiring located in horizontal service spaces above dropped ceilings may be run exposed (without conduit) provided that wiring is;
 - .1 installed neatly and parallel to building lines,
 - .2 supported from J-hooks at intervals not exceeding 1200 mm (4 ft),
 - .3 have a FT6 rating in accordance with CSA C22.2 NO. 0.3 when installed in a supply or return air ceiling plenum
- .3 Do not run any BAS wiring in IT infrastructure cable trays.
- .4 Run conduit and raceways parallel to building lines and be secured to building structure.
- .5 Where conduit leaves heated areas and enters unheated areas, seal conduit with weather-tight sealant at the first junction box in the unheated space.

3.4 Power Conversion and Control Relays

- .1 Provide interposing and motor control relays at local item of equipment or at associated MCC as applicable.
- .2 Provide control transformers and power supplies for system components requiring power supply that do not have integral control transformers.
- .3 Where point schematics and specifications indicate auxiliary contact provision, provide instrumentation, wiring, conduit, power supplies and services as to integrate these points into BAS.
- .4 Mount transformers in enclosures adjacent to equipment served.

3.5 Cleaning

- .1 Prior to handover to the Owner, remove all debris from and vacuum clean inside of control panels. Clean exterior surfaces of panels including GUI displays.

End of Section

BUILDING AUTOMATION TERMINAL UNIT CONTROLLERS 25 14 17

1 GENERAL

1.1 Scope

- .1 Provide application specific controller for terminal units ("TU-ASC").

1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
 - .1 23 35 13 Terminal Units
 - .2 25 05 12 Building Automation Control Panels and Wiring
 - .3 25 15 16 Building Automation Software for Control and Monitoring

1.3 Applicable Codes and Standards

- .1 Product standards:
 - .1 CSA C22.2 No. 94.1 Enclosures for Electrical Equipment, Non-Environmental Considerations
 - .2 CSA C22.2 No. 205 Signal Equipment
 - .3 CAN/CSA-E60730-2-14 Automatic Electrical Controls - Part 2: Particular Requirements for Electric Actuators
 - .4 UL 864 Standard for Control Units and Accessories for Fire Alarm Systems

1.4 Network Integration Requirements

- .1 Controller Tier 2 network communications:
 - .1 BACnet MSTP native device.

1.5 Coordination with Terminal Unit Manufacturer

- .1 Terminal unit controllers and actuators to be factory-installed on terminal units by terminal unit manufacturer in accordance with specification section 20 35 13. Direct costs for factory installation of controllers and actuators on terminal units are directly born by terminal unit manufacturer.
- .2 Coordinate with the terminal unit manufacturer for delivery of products and requirements for product installation, including requirements for power supplies and overcurrent protection.
- .3 Arrange, pay, and be responsible for shipment of terminal unit controllers free-issue to the terminal unit manufacturer factory, without charge to the terminal unit manufacturer (FOB destination, freight prepaid).

1.6 Submittals

- .1 Shop drawings:
 - .1 Submit product data sheets for materials specified herein,
 - .2 Clearly mark each version type along with the applicable control sequence reference.

2 PRODUCTS

2.1 Environmental Conditions

- .1 Provide equipment which functions and meets detailed performance criteria when operating in following minimum ambient condition ranges:
 - .1 temperature: - 0°C to 32.2°C (32°F to 90°F)
 - .2 relative humidity: 10% to 90% non -condensing
 - .3 electrical service: single phase, 120 VAC +/- 10%, 60 Hz nominal,
 - .4 operating voltage: operate at 90% to 110% of nominal voltage rating and to perform an orderly shutdown below 80% nominal voltage,
 - .5 electrical noise: operation to be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 1 m (3 ft).
- .2 Components installed within motor control devices to be designed to operate with transient electrical fields occurring within these devices.

2.2 Terminal Unit Application Specific Controllers (TU-ASC)

- .1 General:
 - .1 stand-alone, multi-tasking, multi-user, real time digital processors with hardware, software, and communications interfaces, power supplies, and input/output modular devices,
 - .2 fully programmable to create custom control logic to meet requirements of the sequence of operations as shown,
 - .3 listed to CAN/CSA-E60730-2-14 or CSA C22.2. No. 205,
 - .4 listed to UL864 for smoke control and smoke venting applications,
 - .5 BTL or LonMark certified as an Application Specific Controller (as applicable to network integration requirements),
 - .6 native BACnet or Lonworks firmware (as applicable to network integration requirements),
 - .7 removable (hot swappable) without disconnection of terminals and wiring,
 - .8 have access to data within network to accomplish global control strategies,
 - .9 support firmware upgrades without need to replace hardware,
 - .10 both firmware and controller database can be loadable over the BAS network or by local service port,
 - .11 continuously perform self-diagnostics, communication diagnosis, and provide both local and remote annunciation of any detected component failures, low battery condition; and upon failure to assume predetermined failure mode.
 - .12 monitor status of overrides and inform operator if automatic control has been inhibited, and allow operator to manually override automatic or centrally executed inhibit command.
- .2 Memory:
 - .1 sufficient non-volatile memory to support its own BIOS and programming information in the event of loss of power.
- .3 GUI:
 - .1 face mounted LED type annunciation to display operational mode, and power and communication status.
- .4 Time clock:

- .1 controllers that perform scheduling operations to have on board real-time clock.
- .2 in network application, time clock synced to associated Network Supervisory Controller.
- .5 BACnet devices, Tier 2 Network;
 - .1 Conformance Class 3,
 - .2 support the BACnet functional groups for
 - (a) Change-of-Value (COV) Event Initiation,
 - (b) Change-of-Value (COV) Event Response,
 - (c) Event Initiation,
 - (d) Event Response,
 - .3 support the BACnet standard application services of;
 - (a) Read Property,
 - (b) Write Property.
 - .4 support the standard BACnet object types of;
 - (a) Device,
 - (b) Analog Input,
 - (c) Analog Output,
 - (d) Analog Value,
 - (e) Binary Input,
 - (f) Binary Output and Binary Value,
 - (g) Loop,
 - (h) Multi-State Input,
 - (i) Multi-State Output,
 - (j) Notification Class at a minimum.
 - .5 The described functionality provides reading and writing of all analog or digital inputs and outputs between BACnet devices on the network and provides for change-of-value initiation and reporting.
- .6 Communications:
 - .1 communication port (RS-232 DB-9, RJ-11 or RJ-45) for connection to laptop computer or operator interface device to allow memory downloads and other commissioning and troubleshooting operations.
 - .2 TU-ASCs reside on BAS Tier 2 network for network communications.
 - .3 communication services over BAS networks to support operator interface performance, and value passing as follows;
 - (a) connection of an operator interface device to any one controller on network to allow operator to interface with other controllers as if that interface were directly connected to those other controllers.
 - (b) data, status information, control algorithms, inputs, outputs, etc., from any controller on network is to be available for viewing and editing through operator interface device that is connected to any controller on network.
 - (c) links to execute control strategies to be programmed and tested so that an operator with appropriate password privileges is able to edit these links either by typing in standard object addresses, or by using simple point and click commands.

- (d) daily routine automatically synchronize time clocks in controllers. An operator initiated change to master time clock setting to be automatically broadcast to other controllers on network.
 - (e) minimum baud rate for peer-to-peer communication between controllers in system LAN to be at 10 Mbps and communication with low level controllers, to be at 76 Kbps.
- .7 Input/Output isolation:
- .1 I/O protected such that shorting of point to itself, shorting of point to another point, or shorting of point to ground will not damage controller.
 - .2 I/O protected such that voltage spikes of up to 24 V, of any duration, and any polarity will not damage controller.
- .8 Input/Output capacity:
- .1 I/O capacity as required to suit control sequence plus specified spare I/O.
 - .2 Analog Inputs:
 - (a) for monitoring of variable measurement properties,
 - (b) field selectable for 0-10 VDC, 4-20 mA, or resistance values for thermistors or RTD.
 - .3 Analog Outputs:
 - (a) for control of modulating control devices,
 - (b) modulating electronic signal, either 0 -10VDC or 4 -20mA.
 - .4 Digital Inputs:
 - (a) for monitoring of on/off signals from remote devices,
 - (b) provide wetting current of at least 12 ma and to be compatible with commonly available control devices.
 - .5 Digital Outputs:
 - (a) for On/Off. Open/Close control operation, or pulsed low voltage signal for pulse width modulation control,
 - (b) relays contacts: minimum 0.5 A @ 24 Volts AC or DC maximum,
 - (c) each relay to be configured as normally open or normally closed, and either dry contact or bussed.
 - .6 Universal Inputs:
 - (a) field configurable for analog or digital inputs,
 - (b) thermistor, dry contacts, or 0-5VDC with 0-10K Ohm input impedance.
 - .7 Spare I/O capacity, each TU-ASC:
 - (a) minimum of two (2) spare I/O point capacity for each point type, which may be met by two (2) only universal type,
 - (b) future use of spare capacity to involve provision of field device, field wiring, point database definition, and custom software,
 - (c) these spare points to be configurable without additional controller boards or point modules,
 - (d) wiring connections to be made to field-removable, through modular terminal strips or termination cards connected by ribbon cable.
 - .9 Airflow differential pressure sensor:
 - .1 integral, factory calibrated true differential pressure sensor, range of 0 – 250 Pa (0 – 1 in.w.c
 - .2 calibration data stored in non-volatile memory for at least 15 velocity/pressure points within terminal unit range,

- .3 two (2) silicon sample tubing (for connection to terminal unit flow sensor station),
- .4 software conversion to airflow rate based on terminal box duct size.
- .10 Airflow station:
 - .1 air flow sensor element supplied with terminal unit.
- .11 Specific control of ancillary devices:
 - .1 for specific control of ancillary equipment as required by sequence of operations,
 - .2 Input points:
 - (a) room pressurization control based on calculated volumetric offset or direct differential pressure measurement,
 - (b) room occupancy sensor and/or override switch,
 - .3 Output points:
 - (a) modulating (non-floating point) hydronic control valves for reheat coil or SCR electric reheat coil,
 - (b) modulating (non-floating point) hydronic control valves for perimeter heating units,
 - (c) slave operation of return air/exhaust air terminal boxes,
 - (d) lighting On/Off control.
- .12 Power/communications interruption:
 - .1 controller continue to provide control functions in event of network communication failures,
 - .2 incorporate sufficient non-volatile memory to store critical configuration data in event of loss of normal power, and sufficient battery backup to support real time clock and volatile memory for minimum of 72 hours,
 - .3 after loss of power and then subsequent return of mains power, controller to;
 - (a) automatically reboot and return to service,
 - (b) zero output values prior to reinitiating controls sequence,
 - (c) restart control sequence at "Normal Operation" unless a supervisory controller provides a command to operate in a different mode of operation.

2.3 TU-ASC Damper Actuator

- .1 Damper actuator to conform to specification section 25 30 13 and as follows.
- .2 Damper actuator is field replaceable without requiring replacement of the TU-ASC controller or integral to TU-ASC controller.

2.4 Application Specific Controller Software

- .1 Software for TU-ASC to conform to specification section 25 15 16 except/and as specified herein.

3 EXECUTION

3.1 Installation

- .1 Provide TU-ASC's of type and I/O capacity to suit control and instrumentation strategies as detailed in sequence of operation, and as shown.
- .2 Install equipment in accordance with manufacturer's recommendations.
- .3 Mount controllers inside terminal unit control enclosures which meet a Type 1 enclosure to CSA C22.2 No. 94.1.

3.2 Power and Wiring

- .1 Provide control power transformer and overcurrent protection to suit controller requirements.
- .2 Provide power wiring from electrical circuits or junction boxes provided by Division 26 and extend to each TU-ASC; refer to specification section 20 05 12 and to mechanical and/or electrical drawings for locations of circuits or dedicated junction boxes.
- .3 Provide control wiring in accordance with specification section 25 05 11 for field installed instrumentation and control devices.
- .4 Where controlled room is served by terminal units on both supply and return, either:
 - .1 use a single TU-ASC to control dampers on both supply and return terminal units, or
 - .2 use separate TU-ASCs for both supply and return terminal units.

3.3 Tier 2 LAN Device Density

- .1 Total number of devices on each Tier 2 LAN not to exceed 80% of maximum device limitations (with the use of repeater devices).

3.4 Programming

- .1 Provide custom programming to meet the control strategies as called for in the sequence of operation sections.
- .2 Calculate the room air change rate per hour ("ACH") based on each room volume and supply air terminal unit measured flow rate;
 - .1 calculate ACH and update current value on a one (1) minute sample rate,
 - .2 where more than one (1) terminal unit serves the same room, aggregate the airflow rates of all terminal units to represent to the total ACH of the room,

3.5 TU-ASC Database

- .1 Provide a terminal unit configuration database for each TU-ASC. Data to include as a minimum:
 - .1 room type,
 - .2 room number,
 - .3 number of terminal units serving the room,
 - .4 device number,
 - .5 terminal unit type (VAV, CAC, Dual Duct, etc.),
 - .6 terminal unit size,
 - .7 minimum and maximum air flows,
 - .8 room design air change rate,
 - .9 room design differential airflow rate (where terminal units are provided on both supply and return terminal units),
 - .10 reheat air flow: minimum turndown air flow prior to use of reheat,
 - .11 calibration factor for field calibration determined by air balancing,
 - .12 occupied temperature setpoint, cooling,
 - .13 occupied temperature setpoint, heating,
 - .14 occupant selectable maximum room temperature setpoint,
 - .15 occupant selectable minimum room temperature setpoint,

- .16 unoccupied cooling temperature setpoint,
- .17 unoccupied heating temperature setpoint,
- .18 afterhours maximum Timer: maximum time occupant may override unoccupied cycle,
- .19 internal cooling Signal: used to reset supply air temperature if more cooling is required,
- .20 internal Heating Signal: used to reset supply air temperature is less cooling is required.
- .2 Configuration database updates:
 - .1 allow updating of control configuration by individual room number.
 - .2 allow updating of control configuration by grouped "Room Type"; create room type groups as follows:
 - (a) private offices,
 - (b) open plan offices,
 - (c) corridors,
 - (d) common elements (washrooms, janitor closets),
 - (e) lobbies,
 - (f) kitchens, cafeterias and dining spaces,
 - (g) maintenance, workshops. storage rooms,
 - (h) service rooms,
 - (i) decontamination rooms
- .3 Database to also include current measured values:
 - .1 current measured room temperature,
 - .2 current measured airflow per TU-ASC,
 - .3 current measured total room airflow rate where multiple TU-ASC serves the same room,
 - .4 current calculated supply/exhaust differential airflow rate (where terminal units are provided on both supply and return terminal units),
 - .5 current measured room pressure (if differential pressure sensors are provided),
 - .6 current actual calculated air change rate.

END OF SECTION

BUILDING AUTOMATION ACTUATORS AND OPERATORS 25 30 13

1 GENERAL

1.1 Scope

- .1 Provide actuators and operators for building systems automation.
- .2 Provide actuators for operating control dampers provided as part of factory built air handling units.

1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
 - .1 23 35 13 Terminal Units
 - .2 25 05 01 Building Automation Common Work Results
 - .3 25 30 23 Building Automation PICV and Energy Valves
 - .4 25 30 26 Building Automation Control Valves

1.3 Definitions

- .1 The following definitions apply to this section.
 - .1 **Emergency equipment** means engine-driven electrical generators and diesel-engine driven fire pumps.
 - .2 **Terminal units** has the meaning in accordance with specification section 23 35 13.
 - .3 **Valves** means a water, glycol, or steam control valve in accordance with specification sections 25 30 23 or 25 30 26.

1.4 Applicable Codes and Standards

- .1 Product standards:
 - .1 CSA C22.2 No. 24 Temperature-Indicating and -Regulating Equipment
 - .2 CSA C22.2 No. 94.1 Enclosures for Electrical Equipment, Non-Environmental Considerations
 - .3 CAN/CSA-E60730-1 Automatic Electrical Controls for Household and Similar Use – Part 1: General Requirements

2 PRODUCTS

2.1 General

- .1 Provide equipment which functions and meets detailed performance criteria when operating in the following minimum ambient condition ranges except where otherwise specified:
 - .1 ambient temperature:

Actuator Location	Service Temperature Range	Notes
Indoor	4°C to 40°C (39°F to 104°F)	(a)

Notes:

- (a) *Unheated spaces to be treated as outdoor spaces.*
- (b) *Temperature ratings may be met by use of heated actuator enclosure.*

- .2 Ambient relative humidity 10% to 90% non -condensing
- .2 Components installed within motor controllers to be designed to operate with transient electrical fields occurring within these devices.

2.2 Valve Actuators - General Purpose Electric/Electronic

- .1 General purpose valve actuators for liquid and steam control valves for ball valves and globe valves.
- .2 Listed to CAN/CSA-E60730-2-14 or CSA C22.2 No. 24.
- .3 Control action:
 - .1 electric/electronic operation for two position (OPEN-CLOSE) and proportional-modulating operation as shown,
 - (a) floating-point modulation not acceptable,
 - .2 rotary or linear acting to suit valve action.
- .4 Enclosure:
 - .1 Type 2 to CSA C22.2 No. 94.1, or NEMA 2, for indoor applications,
 - .2 Type 4 or 12 to CSA C22.2 No. 94.1 or NEMA 4 or 12, for outdoor use and where dampers are exposed to the airstream inside an air intake plenum.
- .5 Construction:
 - .1 high alloy gear type mechanism with spring-return to failed position, or electronically fail-safe,
 - .2 adjustable motor rotation direction,
 - .3 mechanical position indicator,
 - .4 directly mounted to valve shaft, or with linear linkage drive assembly,
 - .5 compatible for installation on ISO 5211 mounting pad,
 - .6 electronic overload or digital rotation sensing circuitry to protect actuator through entire range of rotation,
 - .7 running time: < 160 seconds, independent of load,
 - .8 input control signals:
 - (a) proportional-modulation service: 0 - 10V, 2-10 V, or 0 - 20mA,
 - (b) two position service: power On-Off
 - .9 feedback signals:
 - (a) proportional-modulating service: 2 - 10 V position feedback signal.
 - (b) two position service: two (2) x SPDT auxiliary switches for end stop position indication (open and closed), 3 A resistive @ 250 VAC
 - .10 power supply:
 - (a) modulating service: 24 VAC/VDC, 50/60 Hz.
 - (b) two position service: 120 VAC or 24 VAC.
- .6 Selection:
 - .1 sized and selected in accordance with valve manufacturer's instructions,
 - .2 minimum torque ratings for valves: sufficient to suit valve opening or closing requirements against a fluid differential pressure on:
 - (a) closed loop piping system of not less than 280 kPa (40 psig), plus 15%.
 - (b) open loop piping systems of not less than 700 kPa (100 psig), plus 15%.

- .3 actuators may be supplied as multiple units to achieve required torque.

3 EXECUTION

3.1 Application

- .1 Use electric/electronic actuators for damper and actuators everywhere.

3.2 Installation

- .1 General:
 - .1 Mount actuators and provide adapters according to manufacturer's recommendations.
- .2 Electric and Electronic Actuators:
 - .1 Mount valve actuator directly on shaft or with linkages according to manufacturer's recommendations.
 - .2 For low-leakage dampers with seals, mount actuator with minimum 5° travel available for damper seal tightening.
 - .3 To compress seals when spring-return actuators are used on normally closed dampers, power actuator to approximately 5° open position, manually close damper, then tighten linkage.
 - .4 Provide mounting hardware and linkages for actuator installation.

3.3 Power and Control Wiring

- .1 Provide power and control wiring to each electric/electronic operator in accordance with the manufacturer requirements and in accordance with specification section 25 05 13.
- .2 Where required by actuator manufacturer instructions for parallel actuator installation, provide power isolation relays to isolate forward and reverse motor windings.

3.4 Testing

- .1 Test each actuator by applying appropriate control signal and inspect for smooth operation while operating under normal load conditions.
- .2 Alternatively, where there are more than ten (10) actuators serving the same application, a timed cycle test may be used for all valves in each application:
 - .1 randomly select ten samples for each application, and measure open and closed timing of the sample valve set, and then estimate the average time of the set.
 - .2 Using the BAS, cycle open and then closed and record the time duration for each half cycle for each actuator. Test acceptance criteria is where each damper opens and closes within 90% of the tested average time.

End of Section

BUILDING AUTOMATION INSTRUMENTATION

25 30 16.13

1 GENERAL

1.1 Scope

- .1 Provide measurement switches, sensors, and transmitter instrumentation for building automation.

1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
 - .1 20 01 13 Definitions and Abbreviations – Mechanical
 - 20 05 26 Pipeline Hot-Tapping and Line Stopping
 - .3 23 11 33 Facility Fuel-oil Controls
 - .4 25 05 01 Building Automation Common Work Results

1.3 Definitions

- .1 The following definitions apply to this section.
 - .1 **Finished rooms/spaces** means a room or space that is not a service room.
 - .2 **Instrumentation** means products covered by this specification section.
 - .3 **Service rooms** has the meaning as defined in specification section 20 01 13.

1.4 Applicable Codes and Standards

- .1 Installation codes and standards:
 - .1 CSA B51 Boilers, Pressure Vessels, and Pressure Piping Code
- .2 Product standards:
 - .1 CSA C22.2 No. 94.1 Enclosures for Electrical Equipment, Non-Environmental Considerations.

1.5 Design Criteria

- .1 Pressure rating of instrumentation connected to pressure piping to be equal to or greater than the design pressure at the design temperature of the associated piping system.

1.6 Submittals

- .1 Submit manufacturer product data sheets in accordance with the requirements of Division 01.
- .2 Include Canadian Registration Numbers for applicable products.

1.7 Quality Control

- .1 Products that are in contact with the process fluid of a piping system that is subject to registration under applicable boiler and pressure vessel legislation are to have Canadian Registration Numbers in accordance with CSA B51.

2 PRODUCTS

2.1 General

- .1 Provide equipment which functions and meets detailed performance criteria when operating in the following minimum ambient condition ranges except where otherwise specified:

- .1 ambient temperature:

Instrument Location	Service Temperature Range	Notes
Indoor	4°C to 40°C (39°F to 104°F)	(a)

Notes:

- (a) *Unheated spaces to be treated as outdoor spaces.*
(b) *Temperature ratings may be met by use of heated actuator enclosure.*

- .2 Ambient relative humidity 10% to 90% non -condensing
- .2 Components installed within motor controllers to be designed to operate with transient electrical fields occurring within these devices.

2.2 Temperature Switches

- .1 Low temperature limit temperature switch:
- .1 6m (20 ft) of sensing capillary sensitive to freezing air over any 400mm (15 in) section,
 - .2 automatic reset with fixed differential temperature,
 - .3 installed in multiples with one unit serving not more than 5 m² (40 sq. ft) of duct area.
 - .4 single pole double throw (SPDT) contacts,
 - .5 operating temperature range: 1.7°C to 7.2°C (35°F to 45°F),
 - .6 adjustable set point within specified range,
 - .7 protective enclosure.
- .2 Temperature switches:
- .1 sensing element of liquid, vapour or bimetallic type,
 - .2 adjustable set-point and differential of at least 0.22°C to 1.7°C (0.4°F to 3.0°F),
 - .3 snap action type rated at 120 volts, 15 amps or 24 volts DC,
 - .4 automatic in-operation and automatically reset when condition returns to normal,
 - .5 type:
 - (a) suitable for wall mounting on standard electrical box with protective guard, or suitable for insertion into air ducts with insertion length of 450 mm (18 in), or
 - (b) thermowell type with compression fitting for 20 mm (0.8 in) NPT well, mounting length of 100 mm (4 in), and immersion wells of type 316 stainless steel, or
- .3 Strap-on-type temperature switch with helical screw stainless steel clamps:
- .1 operating temperature range: 23°C to 57°C (75°F to 138°F) [38°C to 71°C (100°F to 160°F)],
 - .2 adjustable set point within specified range,
 - .3 single pole double throw (SPDT) contacts,
 - .4 protective enclosure.

2.3 Temperature Sensors – General Requirements

- .1 Sensor element types:
- .1 Resistance temperature device (RTD) of precision thin film platinum element type;
 - (a) linear characteristics over sensor range,
 - (b) reference resistance: 1000 ohm, [±20 ohms (2%)] [±2 ohms (0.2%)] at 0°C (32°F),

- (c) temperature resistance coefficient: $0.0385 \text{ ohms/ohm/}^{\circ}\text{C}$ ($0.0212 \text{ ohms/ohm/}^{\circ}\text{F}$),
- (d) accuracy: $\pm 0.36^{\circ}\text{C}$ at 21°C ($\pm 0.65^{\circ}\text{F}$ at 70°F) accuracy [[to Din IEC 751]
- .2 Resistance temperature device (RTD) of precision thin film nickel element type;
 - (a) linear characteristics over sensor range,
 - (b) reference resistance: 1000 ohm , [$\pm 20 \text{ ohms}$ (2%)] [$\pm 2 \text{ ohms}$ (0.2%)] at 21°C (70°F),
 - (c) temperature resistance coefficient: $5.4 \text{ ohm/}^{\circ}\text{C}$ ($3.0 \text{ ohm/}^{\circ}\text{F}$)
 - (d) accuracy: $\pm 0.18^{\circ}\text{C}$ at 21°C ($\pm 0.34^{\circ}\text{F}$ at 70°F)
- .3 Thermistor;
 - (a) non-linear negative temperature coefficient of resistance,
 - (b) reference resistance: $10,000 \text{ ohms}$ at 25°C (77°F),
 - (c) accuracy: curve matched to $\pm 0.2^{\circ}\text{C}$ ($\pm 0.36^{\circ}\text{F}$) over 0°C to 70°C (32°F to 158°F),
 - (d) long term stability: 0.025°C (0.045°F) drift per year
- .2 Sensor construction general requirements:
 - .1 2 integral anchored lead wires,
 - .2 waterproof sensor to sheath seal,
 - .3 strain minimizing construction,
 - .4 standard conduit box termination with cover,
 - .5 pig-tail wire leads with wire nuts or screwed terminal connector block,
 - .6 factory calibrated and capable of end to end (sensing element to BAS) accuracy of $\pm 0.25^{\circ}\text{C}$ ($\pm 0.5^{\circ}\text{F}$) over full range of measured variable,
 - .7 transducing circuit to convert output to signal compatible with equipment controller.

2.4 Temperature Sensors – for Ducts and Piping

- .1 For installation in duct and piping systems.
- .2 Averaging element type temperature sensors:
 - .1 averaging style element sensors, with minimum of four (4) encapsulated platinum 1 kohm RTD sensors per length,
 - .2 bendable aluminium or copper tubing construction,
 - .3 sensor operating temperature range from -40°C to 121°C (-40°F to 250°F).
 - .4 ambient relative humidity: 5 to 95% RH non-condensing,
 - .5 minimum immersion length: 1800 mm (6 feet).
 - .6 probe field-formable to minimum radius of 100 mm (4 in) at any point along probe length, other than with 200 mm (8 in) of connector box, without degradation of specified performance,
 - .7 galvanized steel or polycarbonate junction box,
 - .8 provided as multiple RTD sensors where single averaging element cannot be located to provide proper duct or plenum temperature sampling.
- .3 Duct mount probe type temperature sensors:
 - .1 provided for ducts of cross section less than 0.4 m^2 (4 sq. ft),
 - .2 sensor operating temperature range from -40°C to 121°C (-40°F to 250°F),
 - .3 copper or brass or stainless steel sheathed construction,
 - .4 ambient relative humidity: 5 to 95% RH non-condensing,

- .5 metal mounting plate,
- .6 probe length such that sensing element is between 35 and 70% of duct width or diameter,
- .7 provided as multiple sensors where single element cannot be located to provide proper duct or plenum temperature sampling.
- .4 Pipe thermowell-mounted temperature sensors:
 - .1 for measurement of fluid temperatures in piping,
 - .2 insertion elements for measurement of fluid temperatures with stainless steel sheath,
 - .3 sensor operating temperature range: -40°C to 121°C (-40°F to 250°F),
 - .4 spring loaded construction with compression fitting for 20mm (NPS $\frac{3}{4}$) well mounting,
 - .5 length suitable for application,
 - .6 stainless steel or chrome plated brass thermowells of size and material to suit relevant sensor, pipe and service.
- .5 Outside air temperature sensors:
 - .1 insertion type for through-the-wall installation with stainless steel sheath,
 - .2 sensor operating temperature range: -25°C to 60°C (-13°F to 140°F),
 - .3 waterproof seal at wall,
 - .4 ambient relative humidity: 5 to 95% RH non-condensing,
 - .5 total active probe length: 100 mm to 150 mm (4 in to 6 in),
 - .6 non-corroding outdoor shield to minimize solar heating effect,
 - .7 inert section passing through wall to allow precise measurement of outdoor temperature.

2.5 Temperature Sensors – General Purpose Space Sensors

For general use space/room temperature measurement.

- .2 General purpose space temperature sensors – no display (type TS):
 - .1 hard-wired sensor only, no display,
 - .2 sensor operating temperature range: 4°C to 60°C (40°F to 140°F),
 - .3 enclosure: surface mounted, blank (no interface) plastic mono-chromatic guard with surface mounting plate and wall anchors,
 - .4 guard secured to mounting plate by screws or snaps.
- .3 Space temperature sensors with display (type TSD):
 - .1 BAS network sensor with user interface display,
 - .2 user interface:
 - (a) LCD display, for measured values and setpoint values,
 - (b) temperature display resolution: 0.1°C (0.2°F)
 - (c) physical or virtual buttons for user adjustment of setpoints and selection of measured values.
 - .3 Programmable user input selection (buttons):
 - (a) physical or touchscreen buttons,
 - (b) sensor reading selection,
 - (c) sensor setpoint adjustment (temperature only),
 - .4 ambient relative humidity: 5 to 95% RH non condensing,

- .5 temperature sensor: 10 kOhm,
- .6 temperature sensor accuracy: $\pm 0.2^{\circ}\text{C}$ ($\pm 0.36^{\circ}\text{F}$)
- .7 adjustable setpoint range (programmed default is 20°C to 25°C (68°F to 78°F)),
- .8 BAS field-bus connector to allow local access to sensor and BAS controller and network,
- .9 temperature setpoint remotely resettable from BAS,
- .10 minimum/maximum limit set point values adjustable locally and remote from BAS,
- .11 surface mounted plastic mono-chromatic guard with surface mounting plate and wall anchors,
- .12 network connection: BACnet MSTP.
- .13 guard secured to mounting plate by screws or snaps.
- .4 Special purpose space temperature sensors - Secure Areas (type TSS):
 - .1 hard-wired sensor only, no display,
 - .2 sensor operating temperature range: 4°C to 60°C (40°F to 140°F),
 - .3 enclosure:
 - (a) stainless steel flat plate surface type with sensor epoxy-bonded to back of cover plate,
 - (b) secured to standard electrical junction box with Torx head fasteners with center-pin.

2.6 Pressure Switches

- .1 General:
 - .1 device pressure ratings – water, compressed gases and vapours: not less than the design pressure of the applicable piping system specification.
 - .2 device pressure rating – ventilation ducts: minimum 14 kPa (2 psi).
- .2 Differential pressure switches:
 - .1 spring loaded diaphragm type,
 - .2 suitable for use with air, inert gas, water, glycol, steam,
 - .3 adjustable set-point and differential,
 - .4 snap acting SPDT contacts rated at 120 volts, 15 amps AC or 24 volts DC,
 - .5 switch mounted with diaphragm in vertical plane,
 - .6 automatic in operation and automatically reset when condition returns to normal,
 - .7 operating temperature range: 0°C to 60°C (35°F to 140°F),
 - .8 operating humidity: 10 to 90% RH non-condensing,
 - .9 high and low pressure ports, brass hose barbed pressure fittings suitable for $\varnothing 8$ mm ($\frac{1}{4}$ in) tubing,
 - .10 mounting bracket suitable for duct mounting,
 - .11 dust proof enclosure,
 - .12 screw terminal block.
- .3 Pressure switches:
 - .1 bourdon tube, bellows or diaphragm type,
 - .2 suitable for use with air, inert gas, water, glycol, steam, ammonia or non-corrosive refrigerants,
 - .3 selected with span of not greater than twice maximum set pressure,
 - .4 adjustable set-point,
 - .5 snap acting SPDT contacts rated at 120 volts, 15 amps AC or 24 volts DC,

- .6 automatic in operation and automatically reset when condition returns to normal,
- .7 dust proof enclosure,
- .8 screw terminal block.

2.7 Pressure Sensors/Transmitters

- .1 General:
 - .1 device pressure ratings – water, compressed gases and vapours: not less than the design pressure of the applicable piping system specification.
 - .2 device pressure rating – ventilation ducts: minimum 14 kPa (2 psi).
- .2 Duct static pressure sensors:
 - .1 for static and differential static pressure measurement of duct airflow,
 - .2 type: diaphragm driven, capacitance change type, 0-100% linear proportional output signal indicating static pressure or differential pressure at station,
 - .3 selected with span of not greater than twice the maximum static pressure and not less than twice differential pressure at shut-off.
 - .4 output: 4-20 mA, 0-5 Vdc or 0-10 VDC,
 - .5 power supply: 24 VAC/VDC,
 - .6 stainless steel duct probe, with length equal to between 35% and 70% of duct width or diameter,
- .3 Piping static pressure and differential pressure sensors:
 - .1 for static and differential static pressure measurement for liquids, gases and vapours,
 - .2 type: diaphragm driven, capacitance change type, 0-100% linear proportional output signal indicating static pressure or differential pressure at station,
 - .3 stainless steel wetted parts,
 - .4 output: 4-20 mA, 0-5 Vdc or 0-10 VDC,
 - .5 power supply: 24 VAC/VDC,
- .4 Piping static pressure and differential pressure transmitters:
 - .1 for static and differential static pressure measurement for liquids, gases and vapours,
 - .2 type:
 - (a) type 316L stainless steel diaphragm driven, capacitance change type,
 - (b) signal conditioning electronics for 0-100% linear proportional output signal,
 - .3 operator interface: LCD display of measured process value, with selectable units.
 - .4 wetted parts: type 316L stainless steel,
 - .5 process connections:
 - (a) type 316L stainless steel threaded fitting,
 - (b) NPT to ASME B1.20.1,
 - .6 output: 4-20 mA
 - .7 field adjustable zero and span,
 - .8 selected with span of not greater than twice maximum static pressure and not less than twice differential pressure at shut-off.
 - .9 accuracy, including non-linearity, hysteresis and non-repeatability: $\pm 0.05\%$ full scale,
 - .10 operating temperature range: -40°C to 80°C (-40°F to 185°F),

- .11 operating humidity range; 0 to 100% relative humidity,
- .12 mounting bracket, suitable for pipe mounting,
- .13 enclosure;
 - (a) cast aluminium,
 - (b) Type 4X to CSA C22.2 No. 94.1 or NEMA,
 - (c) polyurethane finish paint,
 - (d) screw terminal connector block.
- .5 Differential pressure transmitters for terminal units:
 - .1 suitable for use in air with pressure independent terminal units (constant volume, variable volume or fan powered),
 - .2 capacitive sensor technology,
 - .3 pressure range: 0 to 373 Pa (0 to 15 in.w.g.),
 - .4 linear output proportional to velocity pressure of unit inlet air stream, and suitable as analog input to terminal unit controller,
 - .5 accuracy including non-linearity, hysteresis, and non-repeatability: $\pm 1\%$ full scale
 - .6 operating temperature range: 0°C to 50°C (32°F to 122°F)
 - .7 operating humidity range: 10 to 90% non-condensing
 - .8 high and low pressure ports, barbed pressure fittings suitable for Ø8 mm (¼ in) tubing for connection to air flow pick up device provided with terminal box,
 - .9 mounting kit, suitable for installation within terminal unit controller enclosure,
 - .10 coded screw terminals .

2.8 Liquid Flow Switches

- .1 For indication of fluid flow in piping systems.
- .2 Suitable for use with water, ethylene or propylene glycol, chlorinated or treated water
 - .1 snap-action SPDT switch, 10 A @ 120 VAC,
 - .2 operating ambient temperature range; 0°C to 82°C (32°F to 180°F)
 - .3 operating liquid temperature range: 0°C to 121°C (32°F to 250°F)
 - .4 general purpose dust proof enclosure for use indoors with fluids at temperature greater than 0°C (32°F)
 - .5 NEMA 3R vapour tight enclosure for use indoors or outdoors with fluids at temperatures below 0°C (32°F).

2.9 Electric Power Instrumentation

- .1 Current sensing relays:
 - .1 metering transformer ranged to match load being metered,
 - .2 plug in base and shorting shunt to protect current transformer when relay is removed from socket,
 - .3 current transformer for single or three phase metering connected into single relay,
 - .4 adjustable latch level, adjustable delay on latch and minimum differential of 10% of latch setting between latch level and release level,
 - .5 discrimination between phases in three phase applications to allow worst case selection,
 - .6 mounted in motor starter enclosure and fed from starter control transformer,

- .7 relay contacts capable of handling 10 amps at 240 volts.
- .2 Current switches:
 - .1 self-powered, solid-state type with adjustable trip current,
 - .2 integral current transformers and relays to indicate motor status,
 - .3 SPDT output relay suitable for use as digital input to the BAS,
 - .4 field adjustable output relay trip setting, over 0-100% of range. Deadband adjustment to maximum of 10% of range,
 - .5 integral zero-leakage LED's indicating sensor power and switch status,
 - .6 long term setting drift of current transformer and relay combination not more than 5% full range over 6 months,
 - .7 over current and over voltage protection for current transformer and relay,
 - .8 operating temperature range; -10°C to 50°C (14°F to 122°F),
 - .9 operating humidity range; 5% to 90% RH non condensing.
- .3 Current transducer:
 - .1 output signal proportional to measured line current,
 - .2 output signal in one of following ranges; 4-20 mA, 0-5 Vdc or 0-10 Vdc
- .4 AC Current Transmitters:
 - .1 self-powered, combination split-core current transformer type with built-in rectifier and high-gain servo amplifier with 4-20 mA two-wire output,
 - .2 full-scale unit ranges of 10 A, 20 A, 50 A, 100 A, 150 A, and 200 A, with internal zero and span adjustment,
 - .3 accuracy: $\pm 1\%$ full-scale at 500 ohm maximum burden.
 - .4 UL/CSA listed and meet or exceed ANSI/ISSA 50.1 requirements.
- .5 AC Voltage Transmitters:
 - .1 self-powered single-loop (two-wire) type, 4-20 mA output with zero and span adjustment.
 - .2 adjustable full-scale unit ranges; 100-130 Vac, 200-250 Vac, 250-330 Vac, and 400-600 Vac.
 - .3 Accuracy: $\pm 1\%$ full-scale at 500 ohm maximum burden.
 - .4 UL/CSA listed, 600 Vac rated and conforming to ANSI/ISSA 50.1.
- .6 Power Monitors:
 - .1 three-phase type with three-phase disconnect and shorting switch assembly,
 - .2 UL listed voltage transformers, and
 - .3 UL listed split-core current transformers.
 - .4 selectable output either rate pulse for kWh reading or 4-20 mA for kW reading.
 - .5 maximum error of $\pm 2\%$ at 1.0 power factor or $\pm 2.5\%$ at 0.5 power factor.

3 EXECUTION

3.1 Instrumentation Installation – General Requirements

- .1 Mount instrumentation;
 - .1 in clean areas wherever possible,

- .2 to be accessible to allow for replacement and servicing without interfering with access for adjacent equipment and personnel traffic in surrounding space,
- .2 Provide access doors where instrumentation is concealed behind solid surfaces.
- .3 In finished spaces and rooms, install room instrumentation on concealed junction boxes;
 - .1 fully recessed in gypsum board, wood, or similar construction,
 - .2 fully recessed in new concrete block construction, with conduit run block void spaces,
 - .3 fully recessed in new poured concrete construction, with conduit and outlet box roughed-in before concrete pour.
 - .4 surface mounted with exposed conduit on existing concrete block walls and existing poured concrete walls.
- .4 In service rooms, loading docks, and parking garages, install room instrumentation on surface mounted junction boxes with exposed surface-mounted conduit.
- .5 Rigidly support field mounted instrumentation on pipe stands or channel brackets.
- .6 Rigidly support duct mounted instrumentation to side of duct, in a location that will allow full removal of the instrumentation including duct probes.
- .7 Orient instrumentation sensing elements to correctly sense measured variable and to be isolated from vibrations and environmental conditions that could affect measurement or calibration.
- .8 Identify each cable and wire at every termination point.
- .9 Air seal wires attached to sensors at entry into junction box.

3.2 Power and Control Wiring

- .1 Provide power and control wiring to each instrument in accordance with the manufacturer requirements and in accordance with specification section 25 05 13.

3.3 Temperature and Humidity Instrumentation

- .1 Pipe mounted temperature sensors:
 - .1 Thermowells to be installed by the trade contractor under the applicable Division of the Work for each piping system. Supply the thermowells to the trade contractor and coordinate with them as to installation location and orientation.
 - .2 For existing steel piping systems, coordinate with the piping trade contractor to install the thermowells by hot-tapping in accordance with specification section 20 05 26 except where the Owner permits draining of the piping system.
 - .3 Install pipe-mounted liquid temperature sensors in thermowells with heat-conducting material.
 - .4 Orientate thermowells and transmitters to be located from the side of the pipe or top of pipe for horizontal piping.
 - .5 Cut and recover piping insulation to 300 mm (12 in) either side for installation of strap-on temperature sensors. Provide removable insulation box over sensor and patch insulation to match existing.
- .2 Space temperature and humidity sensors:
 - .1 Mount space temperature or combination temperature/humidity sensors / transmitters at 1200 mm (4 ft) above finished floor.

3.4 Space Temperature Sensor Selection

- .1 Select general purpose space temperature sensor types in accordance with the following table unless otherwise shown on drawings or in control sequences:

Space Types	Temperature Sensor Type
Medication Room, Security Office	TSD
Decontamination Room	TSS
All other spaces not identified above	TS

3.5 Fluid Pressure Switch

- .1 Mount pressure switch tees adjacent to fluid pressure gauge taps. Install shut-off valves before tee for water gauges.
- .2 Install pressure snubbers on pressure switches at;
 - .1 suction and discharge sides of oil pumps, and positive displacement pumps,
 - .2 for compressed air at compressors, dryers and receivers.
- .3 Install coil syphons on steam and condensate pressure switches.

3.6 Fluid Pressure Sensors and Transmitters

- .1 Provide isolation valve and snubber between pressure sensor/transmitter and pressure source.
- .2 Install coil syphons on steam and condensate pressure sensors/transmitters.
- .3 Provide two pressure transducers with software calculation at controller for differential pressure measurements in fluid piping systems.

3.7 Flow Switch Installation

- .1 Fit correct length paddle for diameter of pipe.
- .2 Adjust switch for specified flow condition in accordance with manufacturer's instructions

3.8 Safety Controls

- .1 Unless otherwise shown, safety devices including smoke detectors, freezestats, low- and high-pressure cut-offs, and other safety switches and controls, are to be hard-wired to de-energize equipment as described in Sequence of Operation.
- .2 Provide contacts that allow BAS software to monitor safety control status.

End of Section

BUILDING AUTOMATION ROOM PRESSURE MONITORING

25 30 16.16

GENERAL

1.1 Scope

- .1 Provide room differential pressure measurement and GUI monitoring devices, and remote GUI monitoring device.

1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
 - .1 25 05 12 Building Automation Control Panels and Wiring

1.3 Definitions and Abbreviations

- .1 The following definitions apply to this section.
 - .1 **power supply** means a 120 V/24 VAC transformer or 120 V to 24 VDC power rectifier supply unit.

1.4 Applicable Codes and Standards

- .1 Product standards:
 - .1 CSA C22.2 No. 61010-1 Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use
 - .2 IEC 60529 Degrees of Protection Provided by Enclosures (IP Code)

1.5 Submittals

- .1 Shop drawings:
 - .1 Submit product data sheets for materials specified herein.

2 PRODUCTS

Multiroom Differential Pressure Monitor ("MRM")

- .1 General:
 - .1 listed to CSA C22.2 No. 61010-1,
 - .2 microprocessor based, differential pressure monitor with GUI display,
 - .3 measure room differential pressure for three (3) rooms simultaneously,
 - .4 visual alarm: change in background colour for condition status,
 - .5 audible alarm: buzzer,
 - .6 flush-mounted, for installation in multi-gang electrical junction boxes,
 - .7 BACnet device: BACnet MS/TP Application Specific Controller,
 - .8 device configuration can be cloned to other similar MRMs,
 - .9 device can be configured remotely over BACnet,
 - .10 power input: 24 VAC.
- .2 GUI display:

- .1 minimum 110 mm (4.3 in.) projected capacitive touchscreen colour LCD, minimum 800x480 resolution, suitable for user input while wearing medical gloves,
- .2 enclosure rating: IP65 to IEC 60529,
- .3 exposed surfaces chemically resistant to common chemical cleaning products and vapourized hydrogen peroxide, formaldehyde, chlorine dioxide, perchloric acid, sodium hypochlorite 3-6% (bleach),
- .4 simultaneous graphic/text display of all room measured parameters,
- .5 language display: selectable English or French,
- .6 two line display for user definable space description (e.g. room name, room number),
- .7 user defined brightness (dimnable), with configuration for blacked-out operation until the screen is touched,
- .8 continuously display room pressure measured value,
- .9 display other room parameters simultaneously:
 - (a) minimum of six parameters: differential pressure, temperature, humidity, room air change rate, plus two (2) user defined parameters.
 - (b) parameter data provided by direct connected analog inputs or over BACnet from other devices.
- .10 four background colour banner for high visibility condition status:
 - (a) green: normal – rooms is within alarm deadband limits,
 - (b) yellow: warning - door is open, space remains within alarm deadband limits,
 - (c) red: alarm – room is outside of alarm deadband limits and door time delay has expired,
 - (d) blue or grey: standby - room not in use, alarms are suspended.
- .3 I/O:
 - .1 Inputs:
 - (a) three (3) universal inputs for -0-5 VDV, 0-10 VDC or 4-20 mA, configurable for analog or digital input signals.
 - (b) one (1) analog input for primary room differential pressure sensor,
 - .2 Outputs:
 - (a) one (1) alarm relay: 24 VDC, SPDT, 2.0 A @ 30 VDC.
 - (b) one (1) analogue: selectable 0-5 VDC, 0-10 VDC, or 4-20 mA, assignable to any room parameter (default primary room differential pressure).
 - .3 BAS integration:
 - (a) BACnet MSTP over RS485.
- .4 Differential pressure sensor:
 - .1 industrial grade bi-directional differential pressure transducer;
 - (a) dead-ended – no airflow passing through the sensor,
 - (b) stainless steel diaphragm capacitance-type differential pressure sensor,
 - (c) NIST-traceable calibration certificate for the sensing element,
 - (d) sensors manufactured for remote installation,
 - (e) sensor total combined accuracy (root-sum-square): $\pm 0.25\%$ of full range.
 - (f) overpressure rating: minimum ± 3500 Pa (± 15 in.w.c.).

- .2 selectable operating range at time of ordering; refer to Part 3 for sensor range selection by room type:
 - (a) ± 12.5 Pa
 - (b) ± 25 Pa
 - (c) ± 50 Pa
 - (d) ± 100 Pa
 - (e) ± 250 Pa.
- .5 Software/programming:
 - .1 user input for room operating mode:
 - (a) for healthcare facilities: only In-Use, Unoccupied, and Cleaning
 - (b) for all other applications: In-Use, Unoccupied, Cleaning, Neutral
 - .2 alarm management:
 - (a) In-Use: general alarm delay 30 seconds; alarm suspended while door is open,
 - (b) Unoccupied: all alarms suspended,
 - (c) Cleaning: all alarms suspended,
 - (d) Neutral: all alarms suspended.
 - .3 user input to set differential pressure alarm set point for each room operating mode,
 - .4 user definable time delay to suppress alarms based on door contact status,
 - .5 one-touch user input to acknowledge alarms,
 - .6 maximum two-touch user input to change room mode,
 - .7 room mode can be modified over BACnet,
 - .8 two levels of password security.

Standard of Acceptance

- Setra - fig. FLEX
- Antec Controls - fig. PMT
- Phoenix Controls - fig, Vista

Dual-Room Differential Pressure Monitor (RM2)

- .1 General:
 - .1 listed to CSA C22.2 No. 61010-1,
 - .2 microprocessor based, differential pressure monitor with GUI display,
 - .3 measure room differential pressure for two (2) rooms simultaneously,
 - .4 visual alarm: change in background colour for condition status,
 - .5 audible alarm: buzzer,
 - .6 flush-mounted, for installation in multi-gang electrical junction boxes,
 - .7 BACnet device: BACnet MS/TP Application Specific Controller,
 - .8 device can be configured remotely over BACnet,
 - .9 power input: 24 VAC.
- .2 GUI display:
 - .1 nominal 110 mm (4.3 in.) LCD TFT resistive colour touchscreen, minimum 480x272 resolution, suitable for user input while wearing medical gloves,

- .2 enclosure rating: IP54 to IEC 60529,
- .3 exposed surfaces chemically resistant to common chemical cleaning products and vapourized hydrogen peroxide, formaldehyde, chlorine dioxide, perchloric acid, sodium hypochlorite 3-6% (bleach),
- .4 simultaneous graphic/text display of all room measured parameters,
- .5 language display: selectable English or French,
- .6 graphical and text display,
- .7 user definable space description (e.g. room name, room number),
- .8 user defined brightness (dimmable),
- .9 continuously display room pressure measured value,
- .10 display other room parameters simultaneously:
 - (a) minimum of three parameters: differential pressure, temperature, humidity,
 - (b) parameter data provided by direct connected analog inputs or over BACnet from other devices.
- .11 four background colour banner for high visibility condition status:
 - (a) green: normal – rooms is within alarm deadband limits,
 - (b) yellow: warning - door is open, space remains within alarm deadband limits,
 - (c) red: alarm – room is outside of alarm deadband limits and door time delay has expired,
 - (d) blue or grey: standby - room not in use, alarms are suspended.
- .3 I/O:
 - .1 Inputs:
 - (a) one (1) digital: door contact closure,
 - (b) two (2) analog: selectable 0-5 VDV, 0-10 VDC or 4-20 mA (in addition to onboard DP sensor).
 - .2 Outputs:
 - (a) one (1) alarm relay: 24 VDC, SPDT, 2.0 A @ 30 VDC.
 - (b) one (1) analog: selectable 0-5 VDC, 0-10 VDC, or 4-20 mA, assignable to any room parameter (default primary room differential pressure).
 - .3 BAS integration:
 - (a) BACnet MSTP over RS485.
- .4 Differential pressure sensor:
 - .1 industrial grade bi-directional differential pressure transducer;
 - (a) dead-ended – no airflow passing through the sensor,
 - (b) stainless steel diaphragm capacitance-type differential pressure sensor,
 - (c) NIST-traceable calibration certificate for the sensing element,
 - (d) sensors manufactured for remote installation,
 - (e) sensor total combined accuracy (root-sum-square): $\pm 0.25\%$ of full range.
 - (f) overpressure rating: minimum ± 3500 Pa (± 15 in.w.c.).
 - .2 selectable operating range at time of ordering; refer to Part 3 for sensor range selection by room type:
 - (a) ± 12.5 Pa
 - (b) ± 25 Pa

- (c) ± 50 Pa
- (d) ± 100 Pa
- (e) ± 250 Pa.

.5 Software/programming:

- .1 user input for room operating mode:
 - (a) for healthcare facilities: only In-Use, Unoccupied, and Cleaning
 - (b) for all other applications: In-Use, Unoccupied, Cleaning, Neutral
- .2 alarm management:
 - (a) In-Use: general alarm delay 30 seconds; alarm suspended while door is open,
 - (b) Unoccupied: all alarms suspended,
 - (c) Cleaning: all alarms suspended,
 - (d) Neutral: all alarms suspended.
- .3 user input to set differential pressure alarm set point for each room operating mode,
- .4 user definable time delay to suppress alarms based on door contact status,
- .5 one-touch user input to acknowledge alarms,
- .6 maximum two-touch user input to change room mode,
- .7 room mode can be modified over BACnet,
- .8 two levels of password security.

Standard of Acceptance

- Setra - fig. SRCM
- Antec Controls - fig. PMT
- Phoenix Controls – fig. APM2

2.3 Space Differential Pressure Sensor

- .1 Industrial grade bi-directional differential pressure transducer;
 - .1 dead-ended – no airflow passing through the sensor,
 - .2 stainless steel diaphragm capacitance-type differential pressure sensor,
 - .3 NIST-traceable calibration certificate for the sensing element,
 - .4 sensors manufactured for remote installation,
 - .5 sensor total combined accuracy (root-sum-square): $\pm 0.25\%$ of full range.
 - .6 overpressure rating: minimum ± 3500 Pa (± 15 in.w.c.).
 - .7 enclosure rating: IP20 to IEC 60529 (NEMA 1),
- .2 Selectable operating range at time of ordering; refer to Part 3 for sensor range selection by room type:
 - .1 ± 12.5 Pa
 - .2 ± 25 Pa
 - .3 ± 50 Pa
 - .4 ± 100 Pa
 - .5 ± 250 Pa.

Standard of Acceptance

- Sentra - fig. 264

2.4 Accessories

- .1 Pressure sample snubber wall plate:
 - .1 Stainless steel wall plate with pressure taps suitable for mounting on standard electrical outlet box.

Standard of Acceptance

- Setra - fig. RPS
- Air Monitor – fig. SAP/B

- .2 Pressure sensing tubing:
 - .1 for all spaces (except biohazard CL 3 rooms) where concealed in walls:
 - (a) platinum-cured silicon tubing, of ID/OD as specified by DPRM installation instructions.
 - .2 for biohazard CL3 rooms, and for all spaces where sensing tubing is exposed:
 - (a) ASTM A269, T304 stainless steel tubing, 1/4" OD,
 - (b) double ferrule compression fittings.

Standard of Acceptance

- Swagelock
- Bi-Lok

- .3 Door contact switch:
 - .1 magnetic reed door switch, SPDT contacts,
 - .2 ABS enclosure, grey in colour,
 - .3 recessed mount for new door construction, surface mounted for modification to existing doors,
 - .4 12 mm air gap.

3 EXECUTION

3.1 General

- .1 Installation of laboratory room monitoring systems to section 25 05 12 and related sections.

3.2 Monitor Type and Pressure Range Selection

- .1 Select monitor types for each served space in accordance with Schedule 1 at the end of this specification section.
- .2 Order differential pressure sensors with a bi-directional range for each room type in accordance with Schedule 2 at the end of this specification section.

3.3 Monitor Installation

- .1 Install room pressure differential monitors (MRM, RM2, RM1) in accordance with manufacturer's instructions.
 - .1 install monitors on single or multi-gang galvanized steel electrical junction boxes.
 - .2 install monitors in the room or in the reference space as shown in Schedule 1 at the end of this specification section, unless otherwise shown.
 - .3 install monitors level, with the top of monitor approximately 1675-1700 mm above the floor, unless shown otherwise on architectural drawings. All monitors to be installed at the same height unless otherwise shown.

- .2 Install room pressure snubber/probes which are separate from the monitor:
 - .1 above the door to the room, centered horizontally on the door and vertically between door frame and ceiling,
 - .2 mount the pressure snubber/probes in an electrical galvanized steel junction box.
- .3 Install pressure sensors that are separate from the monitor in the ceiling space;
 - .1 immediately above one of the associated pressure snubber/probes,
 - .2 so as to minimize the run of sensing tubing, and
 - .3 to be accessible from the adjacent corridor or anteroom for service.

3.4 Wiring and Power Supplies

- .1 Provide power supplies for room differential pressure monitors, in accordance with specification section 25 05 13.
- .2 Provide a separate power supply for each monitored space. The power supply for room monitors may be fed from the same power supply used for the associated room terminal units if of the same voltage characteristics.
- .3 Where a dedicated power supply is provided for a room (but which does not supply power for a terminal unit), install the power supply in a dedicated electrical NEMA 1 metal enclosure, installed above the corridor ceiling in close proximity to the entry door or room monitor.
- .4 Provide control and power wiring between the room monitor and associated pressure sensors and door contact switches.
- .5 For BACnet ASC devices, connect the room monitor via BACnet MSTP to the building automation system network.
- .6 For monitoring devices that do not have BACnet connectivity, wire the analog output from the monitor for each monitored pressure, to the associated room terminal unit as an accessory AI to the terminal unit controller.

3.5 Door Switches

- .1 Provide door switches on each door serving the monitored room. Install the door switches on the frame head.
- .2 Where a monitored room has an anteroom, provide a door switch on both doors (corridor-anteroom door, and anteroom door to monitored space).
- .3 Where shown that two or more doors are to be monitored for any one monitor, wire the door contacts in series so that opening any door will create the door open notification condition.

3.6 Sample Tubing

- .1 Connect room pressure snubbers to room monitoring unit;
 - .1 use stainless steel tubing:
 - (a) for biohazard Class 3 or 4 rooms, or
 - (b) where tubing is exposed,
 - .2 use stainless steel tubing or silicon tubing in all other locations.
- .2 For stainless steel tubing, make joints with double ferrule fittings. Tubing may be bent for change of directions following manufacturer's minimum turning radius.
- .3 Make final connection to pressure taps on the room monitoring unit with silicone tubing.

3.7 Programming and Configuration

- .1 Configure each monitor for required differential pressure alarms, door open alarm suppression, general alarm time delay of 15 seconds, and room name and number.
- .2 Configure MRM monitors to include display differential pressures for connected pressure sensors. Configure device to display other room parameter data provided by the BAS network over BACnet:
 - .1 measured space temperature,
 - .2 measured space relative humidity (if applicable), and
 - .3 calculated room air change rate based on terminal unit air flow station and room volume parameters.
- .3 Configure RM2 monitors to include display differential pressures for connected pressure sensors. Configure device to display other room parameter data provided by the BAS network over BACnet:
 - .1 measured space temperature, and
 - .2 measured space relative humidity (if applicable).
- .4 Configure RM1 monitors to include display differential pressures for connected pressure sensor.

3.8 Cleaning

- .1 Clean surfaces of each monitor prior to hand-over of the Work, to remove all dirt, oil, and surface films.

3.9 Start-Up and Testing

- .1 Place the monitors into service in accordance with manufacturer instructions.
- .2 All configuration and testing of monitoring devices to be performed after completion of air balancing.
- .3 Conduct testing of alarm delays.
 - .1 Test 1: With the system in the Occupied mode,
 - (a) using the BAS, adjust the airflow rate to cause a change in the room differential pressure to result in a room pressure that is outside of the alarm deadband. Confirm alarms are initiated.
 - (b) conduct five entrance walks into and out of the monitored room at random walking paces. Check that alarms are suppressed during all events.
 - (c) open the door to the monitored room for a duration longer than the door open alarm suppression period and general alarm delay period. Confirm that monitor goes into alarm.
 - (d) repeat for all other monitored doors.
 - .2 Test 2: With the system in the Unoccupied mode:
 - (a) using the BAS, adjust the airflow rate to cause a change in the room differential pressure to result in a room pressure that is outside of the alarm deadband. Confirm alarms are suppressed.
 - (b) Open the doors for a time period sufficient to active the alarm. Check that alarms are suppressed while door is open.
 - (c) using the BAS, adjust the airflow rate to cause a change in the room differential pressure to result in a room pressure that is outside of the alarm deadband. Confirm alarms are suppressed.
 - .3 Repeat Test 2 for Cleaning mode.
- .4 For each monitored space, verify the measured room differential pressure under steady-state operating conditions. Compare reported values against a portable field testing device of the same differential pressure range and accuracy.

3.10 Commissioning Program

- .1 Provide field service personnel to participate in the system integration commissioning of the equipment and/or system including:
 - .1 review of equipment and system commissioning procedures provided by [Owner] in addition to the manufacturers own testing procedures.
 - .2 to have control of and operation of equipment during testing;
 - .3 adjusting of equipment controls as required to simulate load and/or fault conditions; and
 - .4 assist with record keeping of test results.

3.11 Demonstration and Training

- .1 Demonstrate the operation of, and providing training on, the system in accordance with section 20 05 01.
- .2 Provide training to Owner's staff on use and maintenance of monitoring equipment. Provide training to two groups: users, and facility operators.

3.12 Test Records

- .1 Prepare a test report of test results and include in the operations and maintenance manuals. Test record to include for each monitored room:
 - .1 steady-states pressure measurement: monitor measured, and separate field measured values,
 - .2 alarm delay durations: setpoint and actual,
 - .3 door open suppression: suppression confirmation,
 - .4 alarm acknowledge/reset functioning,
 - .5 room mode selection functioning.

3.13 Schedules

- .1 The following schedules form part of this section.
- .2 Schedule 1: Differential Pressure Monitors by Space Type:
 - .1 refer to drawings to applicable rooms and locations of monitors,
 - .2 for monitor types specified in Schedule 1
 - (a) if RM1 is required, an RM2 or MRM can also be used.
 - (b) If RM2 is required, an MRM can also be used.
 - (c) If MRM is required, only provide an MRM.
- .3 Schedule 2: Differential Pressure Sensor Selection and Setting by Space Type.

Schedule 1: Differential Pressure Monitor Type by Space Type					
Space Type	Monitor Type	1 st DP sensor: Space/ (reference)	2 nd DP sensor: Space/ (reference)	3 rd DP sensor: Space/ (reference)	Monitor Location
Healthcare: Decontamination Room	MRM	Decontamination Room Room/ (corridor)	Anterooms/ (corridor)	---	Corridor

End of Schedule 1

Schedule 2: Differential Pressure Sensor Selection and Setting by Space Type					
Space Type	Monitored Space	Differential Pressures Sensor Range	Minimum Operating Differential Pressure	Default Alarm Setpoint	Reference Room
Healthcare: Decontamination Room	Room	± 25 Pa	-10 Pa	-2.5 Pa	Corridor
	Anterooms	± 25 Pa	-5.0 Pa	0.0 Pa	Corridor

End of Schedule 2

End of Section

BUILDING AUTOMATION CONTROL VALVES

25 30 19.13

1 GENERAL

1.1 Scope

Provide automatic control valves[.]], other than those valves specified in section 25 30 19.16.]

- .2 Provide valve actuators in accordance with specification section 25 30 13.

1.2 Related Sections

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

- .1 25 30 13 Building Automation Actuators and Operators

25 30 19.16 Building Automation Pressure Independent Control Valves

1.3 Applicable Codes and Standards

- .1 Installation codes and standards:

- .1 CSA B51 Boilers, Pressure Vessels, and Pressure Piping Code.

- .2 Product standards:

- .1 ASME B1.20.1 Pipe Threads, General Purpose, Inch
 - .2 ASME B16.5 Pipe Flanges and Flanged Fittings

1.4 Design Criteria

- .1 Refer to applicable piping specification sections for piping system design pressure and design temperature.

1.5 Quality Control

- .1 Valves to have current Canadian Registration Numbers in accordance with CSA B51.

1.6 Submittals

- .1 Shop drawings:

- .1 submit product data sheets for materials specified herein,
 - .2 submit a schedule of control valves, identifying at a minimum the control valve tag, flow rate, pressure drop, Kv (Cv) values, valve body type, valve body pressure rating at design temperature, and CRN number.

2 PRODUCTS

2.1 Control Valves General Requirements

- .1 Body and trim materials selected in accordance with specification for globe valves, ball valves, or high performance butterfly valves in applicable piping system valve specifications, and in accordance with manufacturer's recommendations for design conditions and service.
- .2 Control valve type selections are shown on drawings, schematics and schedules.
- .3 Pipe end connections:
 - .1 NPS ½ to NPS 2: NPT to ASME B1.20.1.

- .2 NPS 2-1/2 and larger: flanged to ASME B16.5, or grooved to CSA.

2.2 Water Solenoid Valves

- .1 Refer to piping specification sections for specific-duty solenoid valves.
- .2 General duty solenoid valves, NPS 1 and smaller:
 - .1 Two-port, two position operation,
 - .2 body: bronze, brass or stainless steel valve with EPDM seals and disc,
 - .3 for normally closed or normally open operation as shown,
 - .4 pilot operated electric solenoid with general purpose enclosure and conduit hub,
 - .5 minimum allowable working pressure: 1035 kPa (150 psig),
 - .6 minimum operating differential pressure: 820 kPa (120 psi)
 - .7 minimum design temperature: 93°C (200°F)
 - .8 manual override operator for normally-closed valves,
 - .9 pipe ends: ASME B1.20.1 NPT threaded ends,
 - .10 listed to CSA C22.2 No. 139,
 - .11 power supply: 24 VAC, 24 VDC or 120 VAC
- .3 Valve size: pipeline size.

2.3 Water and Glycol Valves – Two Position, Two- and Three-Way

- .1 Valves for two-position service
 - .1 ON-OFF for two-way valve,
 - .2 Open port A - Open port B for three-way valve (non-isolation of ports simultaneously).
- .2 Valve pattern:
 - .1 two-way: straight through type, single seated, with replaceable ball, seats and/or disc.
 - .2 three-way: dual seated for globe valves, three way flow pattern for ball valves,
- .3 Valve size: pipeline size.
- .4 Valve type selection:
 - .1 full port ball valves, sizes NPS 2 and smaller,
 - .2 butterfly valves, sizes NPS 2 and larger.
- .5 Valve flow characteristic:
 - .1 quick opening or linear flow characteristics.

2.4 Water and Glycol Valves – Modulating Two-Way

- .1 Valves for two-way modulating service.
- .2 Valve pattern: straight through two port type, single seated, with replaceable disc or ball.
- .3 Valve type:
 - .1 globe valves for all flow rates.
 - .2 characterized ball valves for flow coefficient $K_v = 35$ ($C_v = 40$) and smaller,
 - .3 butterfly valves for flow coefficient greater than $K_v = 35$ ($C_v = 40$), based on flow coefficient rating at 70° rotation

- .4 Valve size:
 - .1 size valves based on design flow rates at a pressure drop not greater than the design pressure drop as shown, and not less than 90% of that design pressure drop.
 - .2 where valve pressure drops are not shown, size valve pressure drop (at design flow) to be the greatest of;
 - (a) 200% of pressure drop through heat exchanger,
 - (b) 100% of pressure drop through coil, or
 - (c) 35 kPa (5 psi).
 - .3 for terminal box units and duct mounted reheat coils, size valves on a pressure drop of between 20 to 35 kPa (3 to 5 psi).
- .5 Valve flow characteristic:
 - .1 equal percentage flow characteristics for heat transfer coils and heat exchangers,
 - .2 linear flow characteristic for tank filling operation (water flow discharges to atmosphere).

2.5 Water and Glycol Valves – Modulating Three-Way

- .1 Valves for three-way modulating mixing/diverting service:
- .2 Valve pattern: three-way type with dual seated for globe valves, three way flow pattern for ball valves,
- .3 Valve type:
 - .1 globe valves for all flow rates,
 - .2 characterized ball valves for flow coefficient $K_v = 35$ ($C_v = 40$) and smaller,
- .4 Valve size:
 - .1 unless otherwise shown, size valve pressure drop (at design flow) to be the smaller of;
 - (a) twice the pressure drop through coil or heat exchanger, or
 - (b) 35 kPa (5 psi).
- .5 Valve flow characteristic:
 - .1 linear flow characteristic for each port to give constant total flow, or,
 - .2 equal percentage flow characteristics with 25% valve authority (valve pressure drop equal to 33% pressure drop through load at full flow).

2.6 Water and Glycol Valve Actuators

- .1 Conform to section 25 30 01 and as specified herein.
- .2 Actuator and valve trim selected for close-off pressure ratings:
 - .1 two-way modulating or two position service: 150% of pump shut off head.
 - .2 three-way modulating service; 300% of pressure differential between ports A and B at design flow or 100% of pump shut off head.
 - .3 shut off head to be based on maximum pump RPM when pump is controlled with a VFD.
- .3 Valve failed position on isolation from control signal:
 - .1 spring-return or electronically fail safe,
 - .2 heating terminal/zone valves: normally open,
 - .3 heating coil valves in AHU; normally open,
 - .4 heating differential pressure by-pass control valves; normally closed,
 - .5 chilled water terminal, zone and AHU coil valves; normally closed,

- .6 chilled water valves serving process loads: normally open,
- .7 chilled water differential pressure by-pass control valves: normally open,

3 EXECUTION

3.1 General

- .1 Select control valves for the applicable flow rates and pressure drops.

3.2 Installation

- .1 Supply control valves to the applicable trades contractor for installation. Provide instruction to the trades contractor as to:
 - .1 any required straight pipe lengths upstream and downstream of the valve,
 - .2 correct installation orientation including requirements for valve actuator,
 - .3 for steam systems, location of steam trap drips ahead of the valve on horizontal piping.

3.3 Cleaning

- .1 Coordinate with the applicable installation trades contractor to provide protection of the control valve during pipeline cleaning. Ensure control valves are 100% open during pipeline cleaning.
- .2 After completion of pipeline cleaning, clean strainers located ahead of control valves.

3.4 Start-Up and Testing

- .1 Confirm control valves stroke fully open and fully closed under applied control signal.
- .2 Conduct tests at part load < 30% to check for control loop instability; adjust control parameters to eliminate valve hunting under steady part load conditions.

End of Section

BUILDING AUTOMATION PRESSURE INDEPENDENT CONTROL VALVES 25 30 19.16

1 GENERAL

1.1 Scope

- .1 Provide pressure independent control valves ("PICV") for modulating control of water or glycol for the following equipment:
 - .1 VAV/CAV terminal units with reheat coils, and duct mounted reheat coils.
- .2 Refer to specification section 20 05 19 for all other control valves.

1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
 - .1 25 30 13 Building Automation Actuators and Operators
 - .2 25 30 19 Building Automation Control Valves

1.3 Definitions and Abbreviations

- .1 The following definitions apply to this section.
 - .1 **Energy valves** means a PICV that includes two temperature sensors and has control functionality to manage the energy (power) output of the control valve.
 - .2 **PICV valve** means a control valve that will maintain stable flow rates under varying inlet water pressure.

1.4 Applicable Codes and Standards

- .1 Installation codes and standards:
 - .1 CSA B51 Boilers, Pressure Vessels, and Pressure Piping Code.
- .2 Product standards:
 - .1 ASME B1.20.1 Pipe Threads, General Purpose, Inch
 - .2 ASME B16.5 Pipe Flanges and Flanged Fittings

1.5 Design Criteria

- .1 Refer to applicable piping specification sections for piping system design pressure and design temperature.

Quality Control

- .1 Valves to have current Canadian Registration Numbers in accordance with CSA B51.

1.7 Submittals

- .1 Shop drawings:
 - .1 submit product data sheets for materials specified herein,

submit a schedule of control valves, identifying at a minimum the control valve tag, flow rate, pressure drop, Kv (Cv) values, valve body type, valve body pressure rating at design temperature, and CRN number (where applicable).

2 PRODUCTS

2.1 Pressure Independent Control Valve

General

- .1 two-way, pressure independent control valve assembly including valves, actuator, and means of differential pressure regulation, manufactured as a single package.
- .2 pressure test ports on inlet and outlet of valve,
- .3 100% valve authority across full operating range,
- .4 minimum differential-pressure control range for pressure-independence: 35 to 350 kPa (5 to 50 psi)
- .5 selected for valve operating differential pressure of 35 kPa (5 psi) at design flow rate, unless otherwise shown,
- .6 minimum close-off differential pressure: 700 kPa (100 psig),
- .7 combination of control valve and controller to provide valve control characteristic of:
 - (a) equal percentage flow regulation for valves serving hydronic coils, heat exchangers, and source equipment,
 - (b) linear flow regulation for hydronic system bypass valves.
- .8 user adjustable maximum flow within valve control range,

- | | |
|-----------------------|-------------------|
| ◦ Belimo - | fig. PIQCV, ePIV |
| ◦ Bell & Gosset - | fig. Ultra Setter |
| ◦ Danfoss - | fig. AB-QM |
| ◦ Griswold Controls - | fig. PIC-V, MVP, |
| ◦ Honeywell - | fig. VRW |
| ◦ Johnson Controls - | fig. VP140 |
| ◦ Siemens - | fig. PICV |
| ◦ Victaulic - | fig. TA 7MP |

- .2 Differential pressure regulation:
 - .1 maintain flow accuracy of +/-5% or better regardless of system pressure fluctuations using either:
 - (a) a wet calibrated ultrasonic or electromagnetic flow meter providing dynamic feedback to adjust valve position, or
 - (b) integral mechanical differential pressure regulator maintaining constant pressure drop across valve seat to decouple valve flow from system pressure changes.
- .3 Control valve:
 - .1 valve type:
 - (a) characterized ball, or
 - (b) globe-style with characterized guide cage.
 - .2 body material:
 - (a) NPS ½ to NPS 2: DZR brass, bronze, or cast iron.
 - (b) NPS 2-1/2 to NPS 6: cast iron or ductile iron.
 - .3 pressure rating at 121°C (250°F):
 - (a) NPS ½ to NPS 2: minimum 1580 kPa (230 psi),

- (b) NPS 2-1/2 to NPS 6:
 - i) ANSI Class 125 for piping system design pressures up to 1100 kPa (160 psig),
 - ii) ANSI Class 250 for piping system design pressures up to 2400 kPa (350 psig).
- .4 end connections:
 - (a) NPS ½ to NPS 2: NPT to ASME B1.20.1.
 - (b) NPS 2-1/2 to NPS 6: flanged to ASME B16.5
- .5 valve internals: nickel-plated brass or stainless steel,
- .6 stem: nickel-plated brass or stainless steel,
- .7 seat seals: EPDM or PTFE,
- .8 O-Rings: EPDM.
- .4 Actuator:
 - .1 to specification section 25 30 13 and/except as specified herein,
 - .2 modulating proportional control with 4-20 mA or 0-10 VDC modulating input signal,
 - .3 power supply: 24 VDC or 24 VAC.
 - .4 manually override function,
 - .5 spring-return or electronically fail-safe:
 - (a) fail closed for cooling applications (coil, heat exchanger and chiller),
 - (b) fail open for heating applications (coil, heat exchanger and boilers).
 - .6 fail in last command position for system bypass control valves,
 - .7 stroke range: 100% of valve stroke range.

3 EXECUTION

3.1 General

- .1 Select control valves for the applicable flow rates at a valve differential pressure of 35 kPa (5 psig) unless otherwise shown.
- .2 Supply control valves to the applicable trades contractor for installation. Provide instruction to the trades contractor as to:
 - .1 any required straight pipe lengths upstream and downstream of the valve,
 - .2 correct installation orientation including requirements for valve actuator.

3.2 Installation

- .1 Install PICV in accordance with manufacturer instructions.
- .2 Provide straight length of pipe upstream of valve of at least five (5) pipeline diameters, unless manufacturer instructions required longer straight lengths.
- .3 Install an isolation valve and strainer on the upstream side of the PICV.
- .4 As applicable and unless otherwise factory set,
 - .1 set the control valve mechanical limiting device to the required design flow rate, or
 - .2 program the actuator controller to the required design flow rate.
- .5 Program the valve controller to provide control characteristics of:
 - .1 equal percentage flow regulation for valves serving hydronic coils and heat exchangers,

- .2 linear flow regulation for hydronic system bypass valves, and source equipment.

3.3 Power and Control Wiring

- .1 Provide power and control wiring to each PICV in accordance with the manufacturer requirements and in accordance with specification section 25 05 13.

3.4 Cleaning

- .1 Coordinate with the applicable installation trades contractor to provide protection of the control valve during pipeline cleaning. Ensure control valves are 100% open during pipeline cleaning.
- .2 After completion of pipeline cleaning, clean strainers located ahead of PICV and Energy valves.

3.5 Start-Up and Testing – PICV

- .1 Confirm control valves stroke fully open and fully closed under applied control signal and maximum system dead-head differential pressure.

Conduct PICV valve controllability performance test for representative valves:

- .1 one reheat coil.
- .3 Test 1: Establish varying system supply pressures to demonstrate pressure independence at 100% design flow over an inlet pressure range of +30% to -10% of nominal inlet pressure at system full load condition.
- .4 Test 2: While operating within the allowable differential pressure control range, test coil power output vs valve position, at equipment part load conditions between 10% and 100% design load, at 10% load increments.
- .5 Provide a test report for each applicable coil, including a graph depicting valve position vs coil power output over the entire operating range of the coil.

3.6 Follow-Up Testing and Configuration

- .1 After start-up and testing, conduct additional testing and tuning of the valves after the valves have been in service for at least four (4) weeks.

3.7 Training

- .1 Provide training to Owners operations staff on control functions of PICV and Energy valves. Include instruction on how to analyze flow and energy performance data and to refine flow rate settings based on actual in-service flow and energy demand.

End of Section

BUILDING AUTOMATION CONTROL SEQUENCES

25 90 01

1 GENERAL

1.1 Scope

- .1 This section describes the control sequences and monitoring requirements for building services and other facility equipment or services.

1.2 Applicable Codes and Standards

- .1 Installation codes and standards:
 - .1 ASHRAE 36 High Performance Sequences of Operation for HVAC Systems

1.3 Definitions

- .1 The following definitions apply to this section:
 - .1 **Auto (alarm reset):** an alarm that automatically resets once the exit hysteresis conditions have been met.
 - .2 **Exit hysteresis:** the conditions which must be met before an alarm can be reset or cleared.
 - .3 **Latch (alarm reset):** an alarm that must be manually reset by the Operator through the BAS, even if the exit hysteresis conditions have been met.
 - .4 **Post-exit suppression:** the time duration after an alarm has been reset/cleared before the same alarm (in the same system) can be annunciated by the BAS.
- .2 The following group headings are used in the control sequences:
 - .1 **Reference:** the drawing which includes the control schematic.
 - .2 **Applicable System:** the systems for which the control sequence applies; may include multiple instances of the equipment or system.
 - .3 **General:** (if included) general background information concerning the system.
 - .4 **OEM Control:** (if included) a general description of control functions included in equipment OEM control panel – provided to clarify control functionality that is not directly controlled by the BAS.
 - .5 **System Start:** actions required at system start-up under schedule control or on re-start after power failure.
 - .6 **Normal Operation:** normal control sequence after initial start-up requirements are satisfied.
 - .7 **System Overrides:** control functions that automatically, or by user input, disable or change the control sequence for a defined period of time.
 - .8 **Unoccupied Mode Override:** a user input command to enable a control system during times when the system is disabled by an operating schedule.
 - .9 **Demand Limiting:** special operation parameters during normal utility power outages (emergency generator operation)
 - .10 **System Stop:** shut-down of system under schedule control and fail-safe position of system in event of loss of normal power.
 - .11 **Integrated FPLS Function:** control functions which are integrated with other fire protection and/or life safety systems.
 - (a) **Fire Alarm:** action required in the event of a signal from the fire alarm system (FA).
 - (b) **Smoke Control:** action required where the system functions as part of a smoke control or smoke venting system.

- .12 **Network Integration:** control points (hardware or software) which are communicated over a serial network.
- .13 **Monitoring:** control point data which is collected and included in graphical displays but are not used as part of a control loop.
- .14 **Schedule:** scheduled operation of system.
- .15 **Alarm:** alarm points required.
 - (a) **Level 1:** alarms which affect life safety,
 - (b) **Level 2:** alarms which affect critical equipment,
 - (c) **Level 3:** alarms which require urgent notification to the operator, and which affect non-critical equipment,
 - (d) **Level 4:** alarms which are non-urgent, affect non-critical components, and generally relate to pending maintenance.
- .16 **Control Power Type:** control system elements to be fed from the designated source of power.

2 PRODUCTS

- .1 Not applicable.

3 EXECUTION

3.1 Sequence of Operation and Control Drawings

- .1 Control sequences for HVAC systems are to conform to ASHRAE 36. Requirements prescribed herein may summarize selected elements of ASHRAE 36 for convenience, but such requirements do not limit or restrict the application of that standard except as otherwise specified herein.
- .2 Control sequences that follow describe and detail method of control of systems.
- .3 Control drawings listed for each control sequence illustrate required inputs and outputs for the control and monitoring of systems.
- .4 Review sequence of operation described for each system and allow for additional input and output points to achieve method of control described. Review documents to determine quantity of each piece of equipment or system.

3.2 Rebooting of BAS Controllers on Resumption of Power

- .1 Except where a BAS controller is supported on UPS power, upon resumption of power to a BAS controller after a power interruption program each controller so that;
 - .1 once the controller has rebooted, wait 30 seconds before attempting to automatically restart the associated equipment except as follows:
 - (a) cooling towers not equipped with VFDs: 60 second time delay,
 - (b) centrifugal chillers: 120 second time delay,
 - (c) heating and steam boilers: 120 second time delay.
 - .2 the controlled equipment restarts from a System Start condition.

3.3 Restart of Major Equipment on Return to Utility Power Supply

- .1 Where a BAS controller and associated controlled equipment are supported on site-generated power, use a "pre-transfer to utility" signal from the site-generated power control system to cause the following equipment to shut-down (but associated pumps may continue to operate) before transfer to utility power is implemented:
 - .1 refrigeration equipment,

- .2 heating boilers,
- .3 steam boilers.

3.4 VFD Minimum Speed Setpoints

- .1 The BAS is to maintain a software setpoint for each VFD based on the requirements for each sequence of operation. Every 60 minutes, the BAS is to read the VFD's internal minimum speed setpoint. If a mismatch exists between the VFD internal minimum speed setpoint and the BAS software setpoint, the BAS is to overwrite the VFD internal setpoint via network integration.

3.5 VFD Power Failure Configuration

- .1 Unless otherwise specified in a control sequence, program VFD's for flying restart after restoration of power following a power failure event.
- .2 Where a VFD includes a kinetic recovery function, program the VFD for kinetic recovery to keep the VFD controller DC voltage bus energized by using momentum of driven equipment during a short term power interruption of the mains AC bus.

3.6 VFD Trip Resets

- .1 Unless otherwise specified in a control sequence, the BAS is automatically attempt not more than three reset attempts. If the VFD trips after the 3rd restart attempt, the VFD is to be disabled and an alarm notification sent to the operator of the original trip event(s) and restart attempts.
 - .1 Exception: does not apply to overcurrent or overload trips (if uniquely alarmed).
- .2 Where the same VFD trip condition occurs more than two times in any sliding 60 minute window, an alarm notification is to be sent to the operator of the recurring trip event.

3.7 Operator Adjustable Setpoints

- .1 Where setpoint values are indicated in square brackets [] this means the setpoint is adjustable by the facility operator with appropriate security access rights.

3.8 Power Supply to Controls

- .1 Provide the type of power supply to the applicable controller as shown in the control sequence.

3.9 Alarm Management

- .1 Unless otherwise shown in a control sequence,
 - .1 Level 1 and Level 2 alarms are Latch reset,
 - .2 Level 3 and Level 4 alarms are Auto reset.
- .2 Alarm exit hysteresis conditions are as shown for each alarm:
 - .1 for analog inputs alarms, the conditions are listed in the format "X% / Y time";
 - (a) X%: the percent change of alarm setpoint value in the direction of the normal condition value,
 - (b) Y time: the time duration in seconds or minutes in which the percent change value must exist before the reset can occur.
 - .2 for discrete input alarms for measurement instruments, the conditions are listed in the format " Δ X / Y time";
 - (a) Δ X: the absolute change in SP units of the alarm setpoint value in the direction of normal condition values,
 - (b) Y time: the time duration in seconds or minutes in which the percent change value must exist before the reset can occur.

- .3 for discrete input alarms for equipment status, the conditions are listed in the format "COS/ Y time":
 - (a) COS: change of state
 - (b) Y time: the time duration in seconds or minutes in which the percent change value must exist before the reset can occur.
- .3 Post-exit suppression times:
 - .1 Unless otherwise shown, suppress the recurrence of the same alarm after exiting from the previous alarm state:
 - (a) Level 1 – Life Safety: 0 minutes,
 - (b) Level 2 – Critical Equipment: 5 minutes,
 - (c) Level 3 – Urgent Message: 1 hour,
 - (d) Level 4 – Normal Message: 1 day.
- .4 Suppression of contingent alarms:
 - .1 Program an automatic hierarchical suppression scheme, to suppress alarm notifications of a fault alarm condition at a load component, which is contingent (caused by) the impact of a related fault alarm condition at a source component that serves the load
 - .2 Exceptions: alarms at load components are not suppressed where:
 - (a) a fault alarm at a source component in a redundant component arrangement does not affect the ability of the source system from supplying resources to the load component.
 - .3 Alarm suppression applies to audible and visual alarm notifications to Operator interfaces, including email notifications. Load alarms are still to be registered in the alarm database.
- .5 Suppression of time-based alarms:
 - .1 Program an automatic suppression of alarms using time delays following a change in setpoint as follows:
 - (a) for thermal zone temperature alarms: 18 minutes per 1°C change, but not to exceed 120 minutes.
 - (b) for thermal zone temperature cooling requests: 9 minutes per 1°C change, but not to exceed 30 minutes.
 - (c) for thermal zone temperature heating requests: 9 minutes per 1°C change, but not to exceed 30 minutes.
- .6 Suppression of alarms due to change in operating modes:
 - .1 Suppress alarms for 15 minutes as a result of change of setpoint.
 - .2 Unless otherwise shown, suppress alarms when a system is in Unoccupied mode, Warmup mode, or Cooldown mode.

3.10 Schedules

- .1 The following schedules form part of this specification.
 - .1 Schedule A: List of Control Sequences of Operation

Schedule A: Control Sequences of Operation		
Control Sequence Number	Title	Revision Date
CS-171	Terminal Units with Reheat (Healthcare)	
CS-313	Decontamination Waste Holding Tank	
CS-314	Decontamination Waste Diverter Valve	

END OF SECTION

CS171 – Terminal Units with Reheat

Reference: Refer to drawings.

Applicable
System: Terminal units with reheat coils.

System
Start: Terminal boxes are enabled when associated AHU system is commanded to start.

For warm-up mode or cool-down mode from unoccupied mode (refer to associated AHU sequence of operation), open terminal unit dampers to maximum airflow rate until space temperature is within 10% of space setpoint temperature, then revert to normal operation.

General: Terminal units are setup as constant volume.

Normal
Operation:

Airflow Control

Supply terminal unit airflow sensor (F) modulates terminal unit damper (D) in response to changes in inlet system static pressure (pressure independent control), to maintain airflow rate Q, and to supply the required airflow rate in cooling mode.

Space Temperature Control

Space temperature sensor (T1) modulates reheat valve (V) to maintain space temperature setpoint.

Space Temperature Setpoint and User Adjustment

Setpoint shall be 21C (adjustable).

Setpoint shall be adjustable +/- 3C (adjustable) by users in the following spaces.

- Medication Room

In all other spaces, setpoint shall not be adjustable by users.

System
Stop: On shut-down of associated AHU for any reason other than occupancy schedule or life-safety requirements, terminal unit damper (D) goes to fully closed, reheat valve V1 goes to fully closed, and perimeter heating valve V2 operates to maintain setback temperature.

Integrated
FPLS
Function:

Fire Alarm Response

Not applicable.

Schedule: 24/7

Monitoring: Monitor the following inputs and include in the graphics display:

- AI-F Terminal unit airflow
- AI-T2 Duct supply temperature.

Issued For Tender

Alarms:

Point	Alarm Description	Initiating Condition	Exit Hysteresis	Alarm Level
AI-T1	Space Temperature Low	2°C < SP for 10 min	10% / 5 min	L4
AI-T1	Space Temperature Low-Low	3°C < SP for 10 min	10% / 5 min	L3
AI-F	Airflow Low during occupied mode	<85% Qmin for 10 min	10% / 5 min	L3

Controller Power
Type:

☒ Normal
☐ Vital

☐ Life-Safety
☐ Delayed-Vital

☐ Standby
☐ UPS

Notes:

[1] Where the terminal unit minimum airflow rate is the same as the maximum airflow rate, the terminal unit is constant volume under all loads.

End of Control Sequence

CS312 – Decontamination Waste System Holding Tank

Reference: Refer to drawings.

Applicable
System: Applies to:

- Existing Decontamination waste system holding tank ME-5

System
Start: Not applicable – continuous operation.

Normal
Operation:

Continuous monitoring:

Continuously monitor tank level at all times, both at the BAS and display locally at the Decontamination Waste System Holding Tank Control Panel (hereafter referred to as the “Tank Control Panel”).

Indicate percentage (%) full at monitoring panel, with a visual graphic* to indicate tank fullness corresponding to the following (% adjustable):

- Green = 0% to 50%
- Yellow = 50% to 75%
- Red = 75% to full*

*Graphic shall increase vertically to mimic a tank being filled. The level at which the graphic shows the tank is full shall be scaled to 0% (adjustable) lower than the water level in the tank at which the high level switch is activated.

The Tank Control Panel shall be located adjacent to the Diverter Valve Control Panel (refer to Control Sequence CS313). Provide hardwired connection to continuously transmit current tank level to the Diverter Valve Control Panel.

High Level Alarm

Monitor tank high level switch (LHA).

Upon LHA, alarm at BAS (see below) and generate audible alarm at the Tank Control Panel. User shall be capable of manually dismissing audible alarm locally at the Tank Control Panel. If not dismissed manually, audible alarm shall stop after 10 minutes (adjustable).

System
Stop: Not applicable – continuous operation.

Integrated
FPLS
Function: Not applicable.

Schedule: Continuous 24/7/365.

Alarms:

Issued For Tender

Point	Alarm Description	Initiating Condition	Exit Condition	Alarm Level
DI-LHA	Decontamination waste system holding tank high level alarm	COS for 30 sec	COS / 5 min	L2

Controller Power
Type:

☐ Normal
☐ Vital

☒ Life-Safety
☐ Delayed-Vital

☐ Standby
☐ UPS

Notes:

[1] BAS contractor to provide independent alarm separate from any level control devices and alarms provided with the sump pump OEM control panel. BAS level switch and associated controller to be on separate power supply from that feeding the pump OEM controller.

[2] New controls are being added to existing tank.

End of Control Sequence

CS313 – Decontamination Diverter Valve

Reference: Refer to drawings.

Applicable System: Applies to:

- Existing Decontamination waste holding tank ME-5
- New diverter valve

System Start: Not applicable – continuous operation.

Normal Operation:

Regular Sanitary Drainage Mode:

Regular Sanitary Drainage Mode shall be initiated by BAS, by BAS operator, or manually by the user at the Diverter Valve Control Panel.

Upon switching to Regular Sanitary Drainage Mode, diverter valve shall be open to the sanitary drainage system and prevent flow to Decontamination Tank ME-5.

Decontamination Mode:

Decontamination Mode shall be initiated manually by the user at the Diverter Valve Control Panel via a large red button that reads “INITIATE DECON MODE”. Upon start of Decontamination Mode, turn on indicator light in the adjacent corridor.

Upon switching to Decontamination Mode, confirm if Tank ME-5 is full; refer to Sequence CS312.

If Tank ME-5 is full, diverter valve shall remain open to the building sanitary drainage system and prevent flow to Tank ME-5.

If Tank ME-5 is not full, diverter valve shall open to Tank ME-5 and stop flow to the building sanitary drainage system.

If at any time during Decontamination Mode Tank ME-5 becomes full, diverter valve shall open to the building sanitary drainage system and prevent flow to Tank ME-5.

At any time while Decontamination Mode is in effect, the user may manually end Decontamination Mode via a large red button that reads “END DECON MODE”.

After 5 hours (adjustable), generate note at the Diverter Valve Control Panel as follows: “*DECONTAMINATION MODE SHALL BE STOPPED IN ONE HOUR. CLICK HERE TO EXTEND BY 6 HOURS.*” (text editable at BAS)

The length by which the button shall extend the Decontamination Mode shall be adjustable; setting shall be reflected in the note.

After 6 hours (adjustable), automatically switch to Regular Sanitary Drainage Mode.

Throughout the period in which the system is in Decontamination Mode, BAS shall log the position of the diverter valve.

When Decontamination Mode is complete, turn off indicator light in the adjacent corridor.

System

Issued For Tender

Stop: Not applicable – continuous operation.

Integrated

FPLS

Function: Not applicable.

Schedule: Continuous 24/7/365.

Alarms: N/A.

Controller Power

Type:

☐ Normal

☒ Life-Safety

☐ Standby

☐ Vital

☐ Delayed-Vital

☐ UPS

Notes:

[1] Not used.

End of Control Sequence

**Electrical
Specifications**
FOR
EMERGENCY DEPARTMENT RENOVATIONS
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2075 Bayview Avenue
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LIST OF SECTIONS
26 00 01

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APPENDED

SUNNYBROOK ICN CABLING STANDARDS
SUNNYBROOK HUB ROOM ACCESS POLICY

SUNNYBROOK CODE BLUE AND CODE WHITE SOP

END OF SECTION

ELECTRICAL GENERAL REQUIREMENTS

26 05 01

PART - 1 GENERAL REQUIREMENTS

1.1 SCOPE

- .1 This Section covers items common to Sections of Division 26. This section supplements requirements of Division 1.
- .2 Comply with General Conditions of Contract, Supplementary Conditions and Division 01 - General Requirements.
- .3 Where conflict occurs between Codes, Specification and Drawings, plan and riser, the maximum condition to govern, and the Tender to be based on whichever indicates the greater cost.

1.2 WORK INCLUDED

- .1 Work to be done under this section to include furnishing of labour, materials and equipment required for installation, testing and putting into proper operation complete Electrical systems as shown, as specified, as intended, and as otherwise required. Complete systems to be left ready for continuous and efficient satisfactory operation.

1.3 DOCUMENT ORGANIZATION

- .1 Applicable Divisions for Electrical Work:
 - .1 Division 26 - Electrical
 - .2 Division 27 - Communications
 - .3 Division 28 - Electronic Safety and Security
- .2 For clarity, any reference in the Contract Documents to Division 26 includes Division 27 and 28.
- .3 The Specifications for these Divisions are arranged in Sections for convenience. It is not intended to recognize, set or define limits to any subcontract or to restrict Contractor in letting subcontracts.
- .4 Contractor is responsible for completion of work whether or not portions are sublet.

1.4 DIVISION 26, AS IT APPLIES TO DIVISION 27 AND 28

- .1 Articles that are of a general nature, applicable to each Section of these Divisions.
- .2 Articles specifying materials, equipment, installation techniques and workmanship that are applicable to more than one Section of these Divisions.
- .3 Articles that are to be read in context with and form part of relevant Sections of these Divisions.

1.5 DEFINITIONS

- .1 The words "indicated", "shown", "noted", "listed" or similar words or phrases used in this Specification, mean that material or item referred to is "indicated", "shown", "listed" or "noted" on Drawings.
- .2 The words "approved", "satisfactory", "as directed", "submit", "permitted", "inspected", or similar words or phrases used in this Specification, mean that material or item referred to is to be "approved by", "satisfactory to", "as directed by", "submitted to", "permitted by", "inspected by", Consultant.
- .3 Instructions using any form of word "provide" involves Contractor in furnishing labour, materials and services to supply and install referenced item.

1.6 **LANGUAGE**

- .1 Specification is written as series of instructions addressed to Contractor, and by implication to subcontractors and to suppliers. For clarity and brevity, use is made of numbered lists and bulleted lists. Where list follows semi-colon (;) punctuation is for clarity, where list follows colon (:) punctuation is to be read as short-hand form of verb "to be" or "to have" as context requires.
- .2 It is not intended to debate with Contractor reasons for these instructions, and words associated with justification for an instruction or restatement of anticipated performance have been omitted to avoid possible ambiguities.

1.7 **EXAMINATION**

- .1 Examine any existing buildings and services, local conditions, building site, Specifications, and Drawings and report any condition, defect or interference that would prevent execution of work.
- .2 Examine work of other Divisions before commencing this work, and report any defect or interference.
- .3 No allowance will be made for any expense incurred through failure to make these examinations of site and documents prior to Tender or on account of any conditions on site or any growth or item existing there which was visible or known to exist at time of Tender.

1.8 **DESIGN SERVICES**

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

1.9 **STANDARD OF MATERIAL AND EQUIPMENT**

- .1 Provide materials and equipment in accordance with Section 01 61 00 - Material and Equipment.
- .2 Materials and equipment:
 - .1 new and of uniform pattern throughout work,
 - .2 of Canadian manufacture where obtainable,
 - .3 labelled or listed as by Code and/or Inspection Authorities CSA certified and CMB listed. Where there is no alternative to supplying equipment which is not CSA certified, obtain special approval from Electrical Safety Authority.,
 - .4 standard products of approved manufacture.
 - .5 in compliance with Standards and Regulations with respect to;
 - (a) chemical and physical properties of materials,
 - (b) design,
 - (c) performance characteristics, and
 - (d) methods of construction and installation.
 - .6 identical units of equipment to be of same manufacture.
 - .7 In any unit of equipment, identical component parts to be of same manufacture, but various component parts comprising unit need not be from one manufacturer.
- .3 Materials and equipment are described to establish standards of construction and workmanship.
 - .1 Where manufacturers or manufacturers products are identified in lists with phrase "Standard of Acceptance", these are manufacturers and/or products which meet standards with regard to performance, quality of material and workmanship.
 - .2 Manufacturers and or products used are to be chosen from these lists.
- .4 Include items of material and equipment not specifically noted on Drawings or mentioned in Specifications but which are required to make an operating system.
- .5 Confirm capacity or ratings of equipment being provided, when based on ratings of equipment being provided under other trade Sections, before such items are purchased.

- .6 Factory fabricate control panels and component assemblies.
- .7 Select materials and equipment in accordance with manufacturer's recommendations and install in accordance with manufacturer's instructions.
- .8 Materials and equipment not satisfying these selection criteria will be condemned.
 - .1 Remove condemned materials from job site and provide properly selected and approved materials.

1.10 SUBSTITUTIONS

- .1 The use of a substitute article or material which the Contractor represents to be of at least equal quality and of the required characteristics for the purpose intended may be permitted, subject to the following provisions:
 - .1 a substitution will not be considered for reasons of meeting the construction schedule unless the Contractor can demonstrate to the satisfaction of the Consultant they made all reasonable efforts to procure the specified product or material in a timely fashion,
 - .2 the Contractor must advise the Consultant of this intention to use an alternative article or material before doing so,
 - .3 the burden of proof as to the quality and suitability of alternatives to be upon the Contractor and they shall supply all information necessary as required by the Consultant at no additional costs to the Contract,
 - .4 the Consultant to be the sole judge as to the quality and suitability of alternative materials and their decision to be final,
 - .5 where use of an alternative material involves redesign or changes to other parts of the work, the costs and the time required to effect such redesign or changes will be considered in evaluating the suitability of the alternative materials,
 - .6 no test or action relating to the approval of substitute materials to be made until the request for substitution has been made in writing by the Contractor and has been accompanied by complete data as to the quality of the materials proposed. Such request to be made in ample time to permit appropriate review without delaying the work, taking into consideration that such a substitution request may be rejected and require providing the product or material as originally specified,
 - .7 Whenever classification, listing, or other certification by a recognized standards body is a part of the specifications for any material, proposals for use of substitute materials to be accompanied by reports from the equivalent body indicating compliance with the requirements of the specifications,
 - .8 The costs of all testing required to prove equality of the material proposed to be borne by the Contractor.

PART - 2 SUBMITTALS

2.1 SHOP DRAWINGS AND PRODUCT DATA

- .1 Submit shop drawings, manufacturers and product data and samples in accordance with Section 01 33 05;
 - .1 Submit for each item of equipment such as Panelboards, Luminaire cuts and Special Systems.
 - .2 Submit shop drawings in the same unit of measure as are used on the drawings. Both metric and imperial measures may be included.
 - .3 Submit shop drawings by email to: shopdrawings@hhangus.com
- .2 Include a H.H. Angus shop drawing cover sheet form prepared for this project, for each shop drawing (sample included at the end of this section), or, include the same information on the contractors submittal cover sheet:
 - .1 Information required on each submission:
 - (a) Client/Architect name
 - (b) Project Name

- (c) H.H. Angus project number
 - (d) Date
 - (e) Contractor name
 - (f) Contractor reference No.
 - (g) Manufacturer name
 - (h) Product type
 - (i) Specification section number
 - (j) Contractor trade: mechanical, electrical, elevators, or general trades
 - (k) If a re-submission, the previous submission H.H. Angus reference number.
- .3 Submit shop drawings in PDF format;
- .1 If submitted in hardcopy format, submit in 11 x 17, black and white originals of graphic quality suitable for photocopying. Allow one additional week for processing of shop drawings submitted in hardcopy format.
- .4 Manufacturers printed product data sheets for standard items are acceptable in place of shop drawings providing physical characteristics are identified and are related to specification references.
- .5 Submit manufacturers data sheets with typed schedules listing manufacturers and suppliers name and catalogue model number for such items as fire alarm system components, etc.
- .6 For luminaires, submit luminaire cuts with manufacturer's names and catalogue numbers for all luminaires to be used on the job. Identify and arrange the luminaire cuts and catalogue numbers in the same sequence as the Specification Luminaire list.
- .7 Shop drawings and product data to show:
- .1 CSA or equivalent approval.
- .2 Dimensioned outlines of equipment.
- .3 Dimensioned details showing service connection points.
- .8 Indicate details of construction, dimensions, capacities, weights and electrical performance characteristics of equipment or material.
- .9 Where applicable, include wiring, single line and schematic diagrams.
- .10 Include wiring drawings or diagrams showing interconnection with work of other Sections.
- .11 Each shop drawing to be checked and stamped as being correct, by trade purchasing item, before drawing is submitted. If above requirements are not complied with, shop drawings will be rejected and returned forthwith.
- .12 Before manufacture or assembly of the equipment, submit only the shop drawings showing dimensioned outlines of equipment and elevations illustrating locations of visible equipment such as breakers and their trip settings, windows, meters, and description of operation as well as single line diagrams. Submit drawings showing construction details, component assemblies or interior wiring diagrams which may be necessary for the correct functioning of the equipment.
- .13 For manufacturer's data and lighting fixtures, submit for approval, bound sets showing the fixture cuts, manufacturer's name and catalogue numbers. Each folder or binder to be complete with all fixtures used on the job. Arrange the fixture cuts and catalogue numbers and identify in the same sequence as the specified fixture list.
- 2.2 **FIELD, FABRICATION, OR INSTALLATION DRAWINGS**
- .1 Contractor field, fabrication, installation, and/or sleeving drawings will not be reviewed as shop drawings. If submitted as a shop drawing, a transmittal only will be returned identifying the submitted drawings have not been reviewed.
- .2 Maintain a copy on site of such drawings for reference by the Consultant.
- .3 Provide a copy of such drawings to the Consultant for general information purpose only, upon request.

2.3 OPERATING AND MAINTENANCE DATA

- .1 Provide operation and maintenance data bound in 210 mm x 300 mm x 50mm thick (8½ in x 11 in x 2 in thick) size, vinyl covered, hard back, three-ring covers.
 - .1 Organize material in volumes generally grouped by Division Section; Site services, Power, Lighting, Low Voltage Systems, Fire Alarm and Security.
 - .2 Title sheet in each volume to be labeled "Operating and Maintenance Manual" and to bear Project Name, Project Number, Date, Trade Section, and List of Contents.
 - .3 Provide three hard-copies to Owner.
- .2 In addition, provide Adobe PDF files for each document, produced from original direct-to-digital file creations.
 - .1 Organize documents into separate PDF files for each Division Section identified above, and apply Adobe Bookmarks to create Table of Contents.
- .3 Include in operations and maintenance data:
 - .1 Details of design elements, construction features, component function and maintenance requirements, to permit effective start-up, operation, maintenance, repair, modification, extension and expansion of any portion or feature of installation.
 - .2 Technical data, product data, supplemented by bulletins, component illustrations, exploded views, technical descriptions of items, and parts lists. Advertising or sales literature not acceptable.
 - .3 Wiring and schematic diagrams and performance curves.
 - .4 Names and addresses of local suppliers for items included in maintenance manuals.
 - .5 Copy of reviewed shop drawings.
 - .6 The operating characteristics of the equipment supplied such as calibration curves and coordination data to allow proper co-ordination with owner's equipment.
 - .7 Description of operation of the controls and protective devices used.
 - .8 Maintenance and adjustment procedures, and lifting and jacking instructions.
 - .9 Fault locating guide.
 - .10 Spare parts list and an itemized cost.
 - .11 Name and telephone numbers of service organization and technical staff that will provide warranty service on the various items of equipment.

2.4 OPERATING AND MAINTENANCE INSTRUCTIONS

- .1 Supply the services of a skilled tradesman for a minimum of two consecutive full days to start each system in its proper sequence, and test and calibrate controls and set-up systems.
- .2 During this procedure thoroughly explain the operation and maintenance of each system, incorporating specialized instruction by manufacturers as described under other sections in this Division.
- .3 Arrange suitable time for instructions with Owner's operating and maintenance personnel.
- .4 Keep a record of date and duration of each instruction period together with the names of persons attending. Submit signed records at completion of instruction.

2.5 CARE, OPERATION AND START-UP

- .1 Instruct Consultant and operating personnel in the operation, care and maintenance of equipment.
- .2 Arrange and pay for services of manufacturer's factory service engineer to supervise start-up of installation, check, adjust, balance and calibrate components.
- .3 Provide these services for such period, and for as many visits as necessary to put equipment in operation, and ensure that operating personnel are conversant with every aspect of the operation, care and maintenance thereof.

2.6 RECORD DRAWINGS

- .1 Provide record drawings in accordance with Section 01 78 05.
- .2 A set of design drawings in AutoCad 2016 on CD or DVD ROM will be provided by the Consultant. Make sets of white prints for each phase of Work, and as Work progresses and changes occur mark white prints in coloured inks to show revisions. Dimension locations of drains, pipes, ductwork, conduit, manholes, foundations and similar buried items within the building, with respect to building column centres. Mark level with respect to an elevation which will be provided.
- .3 Survey information from excavation and backfill of site services to be held on site, after approval, and to be similarly transferred to white prints.
- .4 Retain these drawings and make available to Consultant for periodic review.
- .5 On a weekly basis, scan marked-up drawings to Adobe .pdf format. Where a project has a FTP site, post these files on a weekly basis.

2.7 AS-BUILT DRAWINGS

- .1 Prior to testing, balancing and adjusting, transfer site record drawing information to AutoCad 2016 (CAD) files, to record final as-built condition. Obtain a current set of CAD files from the Consultant.
 - .1 Drawings are to remain set to and follow Consultants AutoCad Standards. Do not alter drawing scales, X-refs, colours, layers or text styles.
 - .2 The Consultant's CAD files may not reflect all or any construction changes.
- .2 Where items have been deleted, moved, renumbered or otherwise changed from contract drawings, revise the CAD files to record these changes. "Bubble" these revisions, and place these annotations on a separate and easily identified drawing layer.
- .3 As-built drawings to show the final as-built condition.
- .4 Show on electrical as-built drawings final location of conduit, outlets, panels, branch wiring, system wiring, pull boxes, bus ducts, and equipment.
- .5 Show on site services as-built drawings survey information provided by Ontario Land Surveyor (OLS) monitoring services installation.
- .6 Identify each drawing in lower right hand corner in letters at least 12 mm (½") high as follows "AS-BUILT DRAWINGS. This drawing has been revised to show systems as installed" (Signature of Contractor) (Date). The site services drawings are to include (Signature and Stamp of OLS) attached to note.
- .7 The site services drawings are to include (Signature and Stamp of OLS) attached to note.
- .8 Once "AS BUILT DRAWINGS" white prints are reviewed, transfer Consultant's comments to the CAD files. Return AutoCad drawings modified to "As Built" condition to Consultants on CD or DVD Rom.
- .9 Submit three (3) sets of white prints and three (3) copies of CAD files with Operating and Maintenance Manuals.

PART - 3 REFERENCE CODES STANDARDS AND REGULATIONS

3.1 CODES AND STANDARDS

- .1 Do complete installation in accordance with Ontario Electrical Safety Code (OESC) except where specified otherwise.
- .2 Do underground systems in accordance with CSA C22.3 No.7-M86 except where specified otherwise.
- .3 Abbreviations for electrical terms: to CSA Z85-1983.
- .4 Comply with CSA Certification Standards and Ontario Electrical Safety Code Bulletins in force at time of Tender submission.

- .5 Where requirements of this specification exceed those of the above mentioned standards, this specification to govern.

3.2 **CONFINED SPACES**

- .1 Unless otherwise proscribed by the Constructor's / Owner's workplace safety program, treat spaces not designed and constructed for continuous human occupancy as "confined spaces", including but not limited to:
 - .1 horizontal and vertical service spaces, shafts, and tunnels,
 - .2 inside of equipment which permits entry of the head and/or whole body, and
 - .3 ceiling spaces which are identified as containing a hazardous substance.

3.3 **PERMITS, FEES AND INSPECTIONS**

- .1 Submit to Electrical Safety Authority necessary number of drawings and specifications for examination and approval prior to commencement of work.
- .2 Pay associated fees.
- .3 Consultant will provide drawings and specifications required by Electrical Safety Authority at no cost.
- .4 Notify Consultant of changes required by Electrical Safety Authority prior to making changes.
- .5 Furnish Certificates of Acceptance from Electrical Safety Authority and authorities having jurisdiction on completion of work to Consultant.

PART - 4 FIELD QUALITY CONTROL

4.1 **TESTING**

- .1 Conduct and pay for following tests:
 - .1 Power distribution system including phasing, voltage, grounding and load balancing.
 - .2 Circuits originating from branch distribution panels.
 - .3 Lighting and its control.
 - .4 Motors, heaters and associated control equipment including sequenced operation of systems where applicable.
 - .5 Systems: fire alarm system, communications.
- .2 Arrange and pay for services of applicable manufacturer's factory service engineer or certified independent testing organization to supervise initial start-up of specialized portions of installation and to check, adjust, balance and calibrate components including related wiring and controls. Provide these services for such periods, and for as many visits as may be necessary to put applicable portion of installation in complete working order. Provide a certificate indicating that the equipment is free and clear of deficiencies.
- .3 Furnish manufacturer's certificate or letter confirming that entire installation as it pertains to each system has been installed to manufacturer's instructions.
- .4 Insulation resistance testing.
 - .1 Megger circuits, feeders and equipment up to 350 V with a 500 V instrument.
 - .2 Megger 350-600 V circuits, feeders and equipment with a 1000 V instrument.
 - .3 Check resistance to ground before energizing.
- .5 Carry out tests in presence of Consultant.
- .6 Provide instruments, meters, equipment and personnel required to conduct tests during and at conclusion of project.
- .7 Submit test results for Consultant's review. Test electrical equipment to standards and function of specification and applicable codes in an approved manner. Replace defective

equipment and wiring with new material and leave entire system in complete first class operating condition.

4.2 **LOAD BALANCE**

- .1 Measure phase current to panelboards with normal loads (lighting) operating at time of acceptance. Adjust branch circuit connections as required to obtain best balance of current between phases and record changes.
- .2 Measure phase voltages at loads and adjust transformer taps to within 2% of rated voltage of equipment.
- .3 Submit, at completion of work, report listing phase and neutral current on panelboards, dry-core transformers and motor control centres, operating under normal load. State hour and date on which each load was measured, and voltage at time of test.

4.3 **CO-ORDINATION OF PROTECTIVE DEVICES**

- .1 Ensure circuit protective devices such as overcurrent trips, relays and fuses are installed to required values and settings as per equipment manufacturers recommendations for each piece of equipment.

4.4 **CLEANING**

- .1 Do final cleaning [in accordance with Section 01 74 23.
- .2 At time of final cleaning, clean lighting reflectors, lenses, and other lighting surfaces that have been exposed to construction dust and dirt, including the top surface, whether exposed or in the ceiling space.
- .3 Clean switch, receptacle, and communications outlets, coverplates, and exposed surfaces.
- .4 Clean all other electrical equipment and devices installed as part of this project.
- .5 Electrical, UPS Equipment or Communication Closets:
 - .1 Thoroughly vacuum and clean interiors and all panels, cabinets and other electrical equipment of all construction debris and dust prior to energization using a HEPA vacuum cleaner. Final clean using clean lint free cloths with a cleaning liquid as recommended by the manufacturer for the purpose.
 - .2 HEPA vacuum the top of all panels, cabinets, cable trays and conduits, followed by a thorough HEPA vacuuming of the floors. Thoroughly wash floors with wet mop and clean water. Control access to the room after cleaning. Provide temporary filter media on air supply ducts to these rooms to prevent re-contamination from other areas of construction.
 - .3 Thoroughly re-clean as necessary prior to final turn over.

4.5 **FINAL INSPECTION**

- .1 At project completion submit written request for a final inspection of electrical systems. Include with this submission written certification that:
 - .1 Deficiencies noted during job inspections have been completed.
 - .2 Systems have been balanced and tested and are ready for operation.
 - .3 Completed maintenance and operating data have been submitted and approved.
 - .4 Tags are in place and equipment identification is completed.
 - .5 The cleaning up is finished in every respect.
 - .6 All electrical panels, switchboards, cabinets, and equipment surfaces have been touched up with matching paint, or re-finished as required
 - .7 Spare parts and replacement parts specified have been provided and receipt acknowledged.

- .8 As-built and Record drawings are completed and approved.
- .9 Owner's operating personnel have been instructed in operation and maintenance of systems.
- .10 Fire alarm verification is 100% completed and Verification Certificate has been submitted and accepted.

PART - 5 EQUIPMENT

5.1 WARNING SIGNS

- .1 As specified and to meet requirements of Electrical Safety Authority and Consultant.
- .2 Porcelain enamel decal signs, minimum size 175 mm x 250 mm (7" x 10").

5.2 PROTECTION

- .1 Protect exposed live equipment during construction for personnel safety.
- .2 Shield and mark live parts "LIVE 120 VOLTS", or with appropriate voltage.
- .3 Arrange for installation of temporary doors for rooms containing electrical distribution equipment. Keep these doors locked except when under direct supervision of electrician.

5.3 SLEEVES AND CURBS

- .1 Provide sleeves of galvanized steel for conduit and cable runs passing through concrete walls, beams, slabs and floor. Sleeves for bus ducts, wireways and cable trays to be minimum 3 mm (1/8") galvanized steel.
- .2 Provide concrete curbs, minimum 100 mm (4") high above finished floor surrounding openings where bus ducts, wireways and cable trays rise through slabs above grade to prevent debris and water from falling to floor below. Concrete curb to have sufficient area to adequately carry bus duct support brackets.
- .3 Provide concrete curbs, minimum 100 mm (4") high above finished floor for telephone cable risers and other openings intended for electrical use in slabs above grade.
- .4 Extend galvanized sleeves for conduit rising through slabs 100 mm (4") minimum above finished floors. Provide sleeves, passing through floors having a waterproof membrane, with an integral flashing clamp.
- .5 Where cables or conduits pass through floors and fire rated walls, pack space between wiring and sleeve full with Fireproofing, and seal with caulking compound conforming to CANZ-19.13.

5.4 FIREPROOFING

- .1 The integrity of the fire resistance rating of the floors and walls to be maintained around electrical raceways and/or cables passing through such floors and/or walls.
- .2 Materials used to maintain fire resistance ratings to have a minimum 2 hour ULC or cUL listed rating.
- .3 Wiring may penetrate a fire resistance rated assembly provided it is enclosed in non-combustible conduit, and the passage of the conduit in turn is suitably sealed to the assembly with fire stop material.
- .4 Wiring with a combustible covering and not enclosed in non-combustible conduit penetrating a fire resistance rated assembly shall be grouped into separate fire sealed penetrations to ensure the overall diameter of the combined wire(s) in each penetration does not exceed 25 mm, and that the integrity of the fire rated assembly is not compromised.

- .5 Single conductor metal sheathed cables shall be arranged to individually penetrate the fire rated assembly and be individually fire stopped.
- .6 Where wiring is installed in cable trays and must penetrate a fire rated assembly, stop and independently support the cable tray immediately on each side of the fire rated assembly while allowing sufficient working room to properly install and inspect the fire rating materials and penetration.

Standard of Acceptance

- o Thomas & Betts - Flame-safe
- o Nelson/Wieland (Electrovert) - Flameseal
- o Double A/D Distributors Ltd. - Firebarrier Firestopping
- o Canstrut - Elasta-Seal MBF-KBF sealbags (where open tray passes through floor slab)

5.5 SPRINKLER PROTECTION

- .1 Equipment in sprinklered areas, except for weatherproof equipment, must be provided with hoods or shields and gasketed doors for protection against sprinkler discharge, and to comply with the requirements of OESC.
- .2 Ventilation openings to be overhanging drip proof type
- .3 Weatherproof equipment, where noted in the specifications and/or drawings to have EEMAC type 3 enclosures in accordance with the requirements of CSA C22.2 No. 94 Standard.
- .4 Surface panelboards, switchboards and other electrical equipment in sprinklered areas to be fitted with watertight hubs with insulated throat for all conduit entrances.

Standard of Acceptance

- o Thomas & Betts Ltd. - Series 401
- o Efcor of Canada Ltd. - Series 40-50B

5.6 ACCESS DOORS

- .1 In all cases where electrical elements, requiring access, are concealed above ceilings or in walls this Division is responsible to review, in the presence of the Owner, the Architect, the Consultants and the General Contractor, the exact details, locations and types of proposed access.
- .2 Submit list of proposed access door locations and obtain approval thereof before commencing access door installation.
- .3 Submit access door shop drawings for approval as soon as possible after Award of Contract, showing size, type and exact location of access doors.
- .4 Access doors, unless otherwise specified or shown, to be at least 3 mm (12 gauge) steel, finished prime coat only, with concealed hinges, anchor straps, plaster lock, without screws.
- .5 Access doors in ceilings, where acoustic tile is applied to plaster or gypsum board, to be dish type designed to receive the tile insert.
- .6 Inside frame dimensions to be approximately 300 mm x 450 mm (12" x 18"). However, if it is necessary for personnel to enter through doors, they to be at least 600 mm x 450 mm (24" x 18").
- .7 Access doors to be as manufactured by:

Standard of Acceptance

- o Zurn Industries Canada Ltd. - Inspectors
- o LeHage Industries Ltd.
- o A. G. Baird Limited - ABCO
- o Stelpro Limited - Type 700

- .8 Provide access doors for locations where equipment requiring maintenance or adjustment is "built-in".
- .9 These access doors will be installed under the Division in whose work they occur. Arrange for and pay cost of access door installation.
- .10 Access doors are not required in removable acoustic panel type ceilings.
- .11 Provide approved coloured marking devices after completion of such ceilings, at four corners of each panel below point requiring access.
- .12 Size and locate access doors in applied tile, or in glazed or unglazed structural tile to suit tile patterns. Refer to Architectural Room Finish Schedule and details on Architectural Drawings in this regard.

PART - 6 COORDINATION

6.1 GENERAL

- .1 Consultant drawings are diagrammatic and illustrate the general location of equipment, and intended routing of ductwork, piping, etc, and do not show every structural detail. In congested areas drawings at greater scale may be provided to improve interpretation of the Work. Where equipment or systems are shown as "double line", they are done so either to improve understanding of the Work, or simply as a result of the use of a CAD drawing tool, and in either case such drawings are not represented as fabrication or installation drawings.
- .2 Lay out and coordinate Work to avoid conflict with work under other Divisions. Note: the Mechanical Contractor is responsible for preparing very detailed three-dimensional Co-ordination/ Interference Drawings (refer to Spec Section 20-01-03) and this Division must co-ordinate/ assist with the preparation of these Drawings ensuring Drawings show, in the three-dimension, all Lights, Power Elements, System Components AND CONDUITS (specifically important in the EP Suite areas)
- .3 Make good damage to Owner's property or to other trade's work caused by inaccurate layout or careless performance of work of this Division.
- .4 When equipment provided under other Sections connects with material or equipment supplied under this Section, confirm capacity and ratings of equipment being provided.
- .5 Take information involving accurate measurements from dimensioned Architectural Drawings or at building.
- .6 Install services and equipment which are to be concealed, close to building structure so that furring is kept to minimum dimensions.
- .7 Location of conduit, bus duct, raceways and equipment may be altered without extra cost provided instruction is given or approval is obtained, in advance of installation of items involved. Changes will be authorized by site instructions and are to be shown on Record Drawings.
- .8 Include incidental material and equipment not specifically noted on Drawings or mentioned in Specifications but which is needed to complete the work as an operating installation.

6.2 FIELD, FABRICATION, AND INSTALLATION DRAWINGS

- .1 Prepare field, fabrication, and/or installation drawings to show location of equipment and relative position of services, and to demonstrate coordination with works of other trades.
 - .1 Drawing scale: minimum 1:50 (1/4"=1'-0")
- .2 Use information from manufacturer's shop drawings for each trade and figured dimensions from latest Architectural and Structural Drawings.
- .3 Layout equipment and services to provide access for repair and maintenance.
- .4 Submit drawings to other trades involved in each area and include note in drawing title block as follows;

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

6.3 **CUTTING AND REMEDIAL WORK**

- .1 Cutting and patching of existing work in the areas being renovated under the scope of this project and to accommodate the Work, unless otherwise noted, will be done by the General Trades Contractor. Layout such work for approval before undertaking same.
- .2 However, there are areas where work is delineated for this Division but that does not require work by the General Contractor (specifically, routing of new electrical services through existing un-renovated spaces). In these areas, cutting and patching of existing of general trades work and temporary removal/reinstallation of ceilings to accommodate work of this Division must be arranged and paid for under this Division.
- .3 Assume responsibility for prompt installation of work in advance of concrete pouring or similar work. Should any cutting or repairing of either unfinished or finished work be required because such installation was not done, employ the particular trade, whose work is involved, to do such cutting and patching. Pay for any resulting costs. Layout such work for approval before undertaking same.
- .4 Holes required in existing construction to accommodate cable, raceways, bus duct or cabletray to be cut neatly or drilled.
- .5 Division 26 contractor to be responsible for arranging and paying for all cutting and patching as required. Before cutting, drilling, or sleeving structural load bearing elements, obtain the Consultant's approval of location and methods in writing. Employ original installer or expert in the finishing of material required to perform cutting or patching for weather exposed or moisture resistant elements or sight exposed surfaces.
- .6 All core drilling through floor slabs to be X-rayed and verified with Owner's representative prior to coring. Relocate core drilling location if steel or conduit is found in the proposed location and repeat procedure. Reroute any circuits damaged by core drilling.

6.4 **WORK IN EXISTING BUILDING**

- .1 Refer to Division 01 - General Requirements.
- .2 During the tender period, the Contractor shall perform a site inspection of the place of work and surroundings including the accessible ceiling spaces and other areas where access could be considered reasonable. Make a thorough investigation of As Built conditions to determine scope of renovation or demolition work required prior to submitting tender.
- .3 Work includes changes to existing building and changes at junction of old and new construction. Route cabling, ducts, conduits and other services to avoid interference with existing installation.
- .4 Relocate existing pipes, ducts, conduits, bus ducts and any other equipment or services required for the proper installation of new work.
- .5 Maintain or relocate existing services which pass through the area of renovation or demolition, but which feed items located outside of these areas. Rewire devices to the original circuits.
- .6 Remove existing lighting fixtures, wiring, devices and equipment to suit new construction. Cut back and cap conduits and electrical outlets, not being used, so that finished work presents a neat and clean appearance. Disconnect at point of electrical supply, remove obsolete wiring and conduits, and make existing systems safe. Blank off openings in panels or boxes from removed conduits or ducts.

- .7 Unless noted to be reused, removed conduit, wiring and devices become the property of the Contractor and are to be taken from the site and disposed of appropriately.
- .8 Removed lighting fixtures and equipment shall be reviewed at site with the Owner's representative, and if the Owner instructs they wish to keep any items, they shall be moved to a designated location on the site. Lighting fixtures and equipment that the Owner does not want shall be taken from the site and disposed of appropriately.
- .9 Provide junctions boxes, outlet boxes, wiring, plates, etc..., as necessary for complete relocation of devices, fixtures and equipment.
- .10 Revise panelboard directories accordingly if affected by work.
- .11 Clean and re-lamp relocated lighting fixtures and replace any faulty ballasts.
- .12 On completion of relocations, confirm relocated devices and lighting fixtures are in proper working order.
- .13 Co-ordinate work affecting fire alarm system, fire safety, and detection systems with Consultant, Fire Alarm System Manufacturer, and authorities having jurisdiction prior to commencing work. Retain original fire alarm system manufacturer to verify all relocated fire alarm devices and all revised wiring. Provide temporary fire protection and/or a fire watch as required by authorities having jurisdiction in all areas affected by the demolition.
- .14 Where Owner wishes to take over renovated areas ahead of project completion date and these areas are intended to be fed from distribution systems in new building, make temporary connections to existing services in these areas. Reconnect to permanent services, at a later date, when new distribution systems are available.

6.5 **CONTINUITY OF SERVICES**

- .1 Refer to Division 01 - General Requirements.
- .2 Connections to existing systems to be made at approved times. Obtain written approval recording times when connections can be made. Arrange work so that physical access to existing buildings is not unduly interrupted.
- .3 Be responsible for any damages caused to existing systems when making connections.
- .4 Keep existing buildings in operation with minimum length of shutdown periods. Include overtime work to tie-in piping or wiring at night or on weekends. Provide temporary feeders and connections as required to maintain systems in operation where shutdown periods will exceed 8 hours, or extend beyond the allowable time frame determined by the Owner.

6.6 **VOLTAGE RATINGS**

- .1 Operating voltages: to CAN3-C235-83.
- .2 Motors, electric heating, control and distribution devices and equipment to operate satisfactorily at 60 Hz within normal operating limits established by above standard. Equipment to operate in extreme operating conditions established in above standard without damage to equipment.

6.7 **FINISHES**

- .1 Primary and final painting for Work, other than items specified as factory primed or finished, to be done under Finish Division 9.
- .2 Shop finish metal enclosure surfaces by application of rust resistant primer inside and outside, and at least two coats of finish enamel.
- .3 Clean and touch up surfaces of shop-painted equipment scratched or marred during shipment or installation, to match original paint.

- .4 Leave a quart can or a pressurized spray can of paint, as used with switchboards, with owner for touch-up purposes.
- .5 Clean and prime exposed non-galvanized hangers, racks and fastenings to prevent rusting.
- .6 Store electrical materials and equipment such as switchboards, panels, transformers and luminaires in a dry, clean location and cover with polyethylene plastic to preserve factory finish.
- .7 Protect exposed or free standing equipment with plastic to minimize entry of dust and dirt and marring of finished surfaces during progress of work
- .8 Schedule luminaires, lamps and diffusers for installation as late as possible during construction in order to minimize accumulation of dust and/or dirt on them. Clean luminaires and diffusers, not acceptable because of dust and dirt, in an approved manner as specified by manufacturer. Wrap surface mounted and suspended luminaires, installed prior to painting and other dusty construction being completed in the area, in plastic to prevent dirt and paint from settling on them.

6.8 EQUIPMENT IDENTIFICATION

- .1 Identify electrical equipment with nameplates and labels as follows:
- .2 Nameplates:
 - .1 Nameplates for panels and equipment to be 3 mm (c") thick, black lettering on white background, with bevelled edges and mechanically attached with self-tapping stainless steel screws.

NAMEPLATE SIZES			
Size #	Size	Lines	Letter height
1	10 x 50 mm (½" x 2")	1 line	3 mm (c") high
2	12 x 70 mm (½" x 3")	1 line	5 mm (¼") high
3	12 x 70 mm (½" x 3")	2 lines	3 mm (c") high
4	20 x 90 mm (1" x 4")	1 line	8 mm (d") high
5	20 x 90 mm (1" x 4")	2 lines	5 mm (¼") high
6	25 x 100 mm (1" x 4")	1 line	12 mm (½") high
7	25 x 100 mm (1" x 4")	2 lines	6 mm (¼") high

- .3 Labels: Embossed plastic labels with 6 mm (¼") high letters unless specified otherwise.
- .4 Wording on nameplates and labels to be approved by [Consultant][Engineer] prior to manufacture.
- .5 Allow for average of thirty-five (35) letters per nameplate and label.
- .6 Nameplates for terminal cabinets and junction boxes to indicate system and/or voltage characteristics.
- .7 Disconnects, starters and contactors: indicate equipment being controlled and voltage.
- .8 Terminal cabinets and pull boxes: indicate system and voltage.
- .9 Transformers: indicate capacity, primary and secondary voltages.

- .10 Identify other cabinets for low voltage systems, such as signals and communications, as for panelboards with a directory showing circuit numbers and room locations plus a blank for "Remarks", as well as a lamicon plate designating panel name.
- .11 Typical Identification Standards
- .1 Lighting, Receptacle and Power panels to each be identified with an engraved lamicon plate secured to top interior trim as:
- (a) LP-1A 12 mm (1/2") high lettering
 - (b) 120/208 volts 5 mm (1/4") high lettering
 - (c) Fed from PP 'AA' 5 mm (1/4") high lettering

- .2 Supply each panel with a directory card holder welded to inside of door, complete with a neatly typewritten list showing information as follows:

Panelboard Name	LP-1A
Panel Voltage	120/208 Volts
Circuit Number	Description
1	Lighting Room #34
2	Receptacles Room #34
3	Ice Machine Room #17

- .3 Cover list with a 0.8mm (1/32") minimum thick clear plastic sheet to protect it.
- .4 Identify equipment not listed above, such as incoming service cables, communicating cables, switchgear, transformers, disconnects, contactor motors, instruments, fire alarm, clock and program equipment and control panels, in a similar manner showing name and number of the equipment, voltage and load information.
- .5 Labels for Emergency Lights shall consist of a glue on red dot in one corner of the light lens clearly visible from the floor.
- .12 Identify feeder pull boxes and junction boxes with lettering stamped on brass or aluminum tags showing feeder or system concerned, voltage involved and data for both termination points whether equipment or panel. Tag to be held to boxes under lid screws using steel wire.
- .13 Apply a small dab of paint to inside of each outlet box, pull box and panel as it is installed, using colour code as follows:

Red	Fire Alarm System and Emergency Voice Communication System
Dark Blue	Intercom and Public Address
Dark Green	Telephone and Data Systems
Black	Annunciator and Buzzer System
Grey	Clock System

White	Central Dictation
Orange	Nurse Call
Yellow	Alarm Systems
Pink	Computer Systems
Light Green	TV Systems
Light Blue	Miscellaneous

- .14 Colour code is not required for regular lighting and power circuits.
- .15 Junction boxes in furred ceilings to have colour identification on both inside and outside.
- .16 Provide identification of emergency lights consisting of a glue-on red dot in one corner of the light unit.
- .17 For lighting luminaires specified with both a normal and emergency power connection provide identification on luminaires internal barrier designating dual power feeds.
- .18 Cubicles and/or cells to include main identifier nameplate on rear of cells
 - Standard of Acceptance*
 - o W. M. Brady Co. of Canada Limited - B350
 - o IDI Electric (Canada) Ltd. - Style A

6.9 WIRING IDENTIFICATION

- .1 Identify wiring with permanent indelible identifying markings, either numbered or coloured plastic tapes, on both ends of phase conductors of feeders and branch circuit wiring.
- .2 Maintain phase sequence and colour coding throughout.
- .3 Colour code: to CSA C22.1-1990.
- .4 Use colour coded wires in communication cables, matched throughout system. Schedule and chart marker number or colour with corresponding equipment and include with record drawings or operation and maintenance data.
- .5 Connections in equipment to be Phase A, B, C from left to right when viewing from front or accessible direction.
- .6 Carry colour coding through from incoming utility supply down to and including panels as follows:
 - .1 Identify incoming utility service lines by Red - Phase "A", Black - Phase "B", Blue - Phase "C", with enamel paint.
 - .2 Band switchgear buswork in each switchboard and unit substation cubicle with tape identified in accordance with service lines colour-coding. In addition, where neutral bus is introduced, it to be banded white. Ground bus to be banded green.
 - .3 Band feeder and sub-feeder bus or conductors as above.
 - .4 Band main bus on lighting and power panels with tape as follows, to conform to the Electrical Safety Code.

Red	Phase A
Black	Phase B
Blue	Phase C
White	Neutral

Green	Ground
Orange	Control

- .7 Identify control conductors for motors and equipment by pressure sensitive tape markers or permanent PVC sleeve markers at each main terminal point and wherever they are introduced into ducts or equipment. Schedule and chart marker numbers with corresponding machine numbers and locations and include with Record Drawings.

6.10 CONDUIT AND CABLE IDENTIFICATION

- .1 Label feeder conduits.
- .2 Locate labels as follows:
- .1 At every end of every conduit, duct or cable run, adjacent to item of equipment serviced.
 - .2 On each exposed conduit, duct or cable passing through a wall, partition or floor (one on each side of such wall partition or floor).
 - .3 At intervals of 15 m (50') along every exposed conduit, duct or cable run exceeding 15 m (50') in length.
 - .4 At every access point on concealed conduit duct or cable.
- .3 Labels to be visible from 1.5 m (5') above adjacent floor or platform.

6.11 WIRING TERMINATIONS

- .1 Lugs, terminals, screws used for termination of wiring to be suitable for either copper or aluminum conductors.
- .2 Manufacturers and CSA labels to be visible and legible after equipment is installed.

6.12 LOCATION OF OUTLETS

- .1 Locate outlets in accordance with Division 01 - General Requirements.
- .2 Do not install outlets back-to-back in wall; allow minimum 150 mm (6") horizontal clearance between boxes.
- .3 Change location of outlets at no extra cost or credit, providing distance does not exceed 3000 mm (10'), and information is given before installation.
- .4 Locate light switches on latch side of doors. Locate disconnect devices in mechanical and elevator machine rooms on latch side of door.

6.13 MOUNTING HEIGHTS

- .1 Mounting height of equipment is from finished floor to centreline of equipment unless specified or indicated otherwise.
- .2 If mounting height of equipment is not specified or indicated, verify before proceeding with installation.
- .3 Install electrical equipment at following heights unless indicated otherwise.

Description	General Area	Barrier Free
Local switches	1200 mm (47")	1200 mm (47")
Wall receptacles: General	600 mm (24")	600 mm (24")

Description	General Area	Barrier Free
Wall receptacles: above top of continuous baseboard heater	200 mm (8")	200 mm (8")
Wall receptacles: above top of counters or counter splash backs	175 mm (7")	175 mm (7")
Wall receptacles: In Mechanical rooms	1200 mm (47")	1200 mm (47")
Panelboards	As required by code or as indicated	
Telephone outlets	600 mm (24")	600 mm (24")
Wall mounted telephone outlets	1500 mm (60")	1200 mm (47")
Fire alarm pull stations	1500 mm (60")	1200 mm (47")
Fire alarm bells	2100 mm (83")	
Television outlets	300 mm (12")	450 mm (18")
Wall mounted speakers	2100 mm (83")	
Clocks	2100 mm (83")	

6.14 CONDUIT AND CABLE INSTALLATION

- .1 Sleeves through concrete: galvanized steel, minimum 3 mm (1/8") sized for free passage of conduit, and protruding 50 mm (2").
- .2 Arrange for holes through exterior walls and roof to be flashed and made weatherproof under Division 7.
- .3 Install cables, conduits and fittings to be embedded or plastered over, neatly and close to building structure so furring can be kept to minimum.
- .4 Supply and deliver inserts to site in ample time to be built into work of other trades. Provide necessary templates and adequate instructions and assistance to locate and install inserts.
- .5 Secure inserts firmly to form work before concrete is poured.
- .6 Provide sleeve and insert drawings as required.

6.15 PLYWOOD BACKBOARDS

- .1 Provide plywood backboards in electrical and telecommunications rooms and closets where indicated on drawings and where referenced under various sections of the specifications for mounting of equipment.
- .2 Plywood to be securely fixed to the building structure.
- .3 Plywood to be 19mm, void free, good one side, mounted with good side exposed
- .4 Plywood to be Class A fire retardant, FSC certified, contain no added urea formaldehyde, and be suitable for compliance with LEED credits MR 5.1 + 5.2 (Manufactured and

Extracted Regionally), MR 7.0 (Certified Wood), and EQ 4.4. (Low Emitting Materials).
Provide necessary documentation to support LEED credit application process.

- .5 Plywood to be treated as follows on all surfaces:
 - .1 Initially seal the plywood with one coat of Sherwin Williams part No. B49 W 2 wood primer
 - .2 Follow with one coat of Flame Control 10-10 Intumescent Fire Retardant Paint
 - .3 Finish with one coat of Flame Control 40-40 Fire Resistant Paint

6.16 **WIRING OF MECHANICAL TRADES MOTORS**

- .1 To limit responsibility and to specifically define the Work under this Division, use the following procedure with regard to motors provided under Mechanical Division 20..
- .2 The Contractor under Mechanical Division 20 will be responsible for installing equipment which he supplies including motors, starters, disconnect switch, Motor Control Centres and miscellaneous controls of the type specified. **For Refrigeration Equipment compressor and D/X Air Conditioning Equipment, Division 26 is to provide a weather-proof disconnect at the equipment, mounted independent of the A/C Equipment and complete final connection to the equipment using a minimum of 610mm (24") length of seal-tight flex conduit**
- .3 In every instance whether pertaining to Plumbing, Air Conditioning, Refrigeration, Heating or Ventilating equipment, wire to line side of the Motor Control Centre, disconnect switch, or starter provided by these trades, in reasonable proximity to equipment being controlled.
- .4 From this point, unless otherwise noted, the cost of electrical material and labour will be borne by the particular trade whose work is involved. That trade will mount starter and wire from it to motor being controlled, together with control wiring, remote switches, and pilot lights.
- .5 Where individual starters and controls are grouped together, the Contractor under Mechanical Division 20 will provide a panel for mounting his equipment. Provide a feeder, main fused disconnect, a splitter of adequate size and capacity, [individual fused disconnect switches,] and wire to line side of the Division 20 starters.
- .6 For Refrigeration Equipment compressor and D/X Air Conditioning Equipment, Division 26 is to provide a weather-proof disconnect at the equipment, mounted independent of the A/C Equipment and complete final connection to the equipment using a minimum of 610mm (24") length of seal-tight flex conduit.
- .7 In the case of unit heaters, reheat coils, electrical control devices, and cabinet unit heaters, terminate wiring in an outlet immediately adjacent to motor or device being electrically powered. Wiring from this point to starter, thermostat, or other devices will be done under Mechanical Division 20.
- .8 Provide branch circuit wiring and an outlet for each motorized damper or heating control.
- .9 Ascertain exact locations of starters, Motor Control Centres and motors, from Mechanical Drawings.
- .10 Motors up to and including 0.25 kW (¼ HP) to be 120 volt, 60 Hz, single phase.
- .11 Motors .37 kW (½ HP) and above to be 3 phase, 60 Hz, voltage as noted

6.17 **TEMPORARY AND TRIAL USAGE**

- .1 Temporary and trial usage by Owner of equipment or any other work or materials supplied before final completion and written acceptance is not to be construed as evidence of acceptance by Consultant.
- .2 Consultant to have the privilege of such temporary and trial usage, as soon as supplier claims that said work is completed and in accordance with specifications, for such

reasonable length of time as is deemed to be sufficient for making a complete and thorough test of same.

- .3 Claims for damage not to be made by supplier for the damage to or breaking of any parts of such work which may be used, whether caused by weakness or inaccuracy of structural parts or by defective materials or workmanship of any kind whatsoever.

6.18 **COMMISSIONING**

- .1 Equipment supplied on this project will be subject to detailed factory inspection and on-site testing and commissioning prior to being placed in service. The electrical contractor, their major system and equipment suppliers, and the Independent Testing Agent (ITA) will be required to participate in special commissioning meetings to review progress and status of the commissioning program.
- .2 Include in Bid amount for licenced electricians to participate in the commissioning program, to undertake temporary power connections, operation of equipment, opening and closing of panel boards and switchboards, testing of power and control wiring, and assisting the ITA and the equipment suppliers' field personnel in the start up and testing of the equipment.
- .3 The contractor and equipment suppliers to include in the Bid amount for all costs to accommodate and undertake factory and site testing.

6.19 **TRAINING**

- .1 Include in the major equipment supply tender prices the services of a qualified technical representative to conduct "hands-on" training programs for the Owner's staff.
- .2 The training to include an overview of equipment function and operation, basic inspection, housekeeping and logging procedures.
- .3 Submit an outline of the training program for review, adjustment and approval by the Consultant. Training will occur in up to 3 separate sessions, at a time convenient to the Owner, to suit multiple shift maintenance staff schedules.
- .4 Sessions may be videotaped by the Owner as an aid to ongoing training of Owners staff.

6.20 **PROTECTION DURING CONSTRUCTION**

- .1 Provide protection required to enable existing building and equipment to remain in continuous and normal operation, and maintain construction schedule.
- .2 Take the necessary precautions to protect equipment, existing building and service from damage during rearrangement. Accept responsibility for any damage which may occur and make good without cost to the Owner. Accept responsibility for damage to existing services and make good without cost to the Owner.
- .3 It is of vital importance, during work of this Contract, that all existing surfaces and items, including walls, floors, ceilings, windows, doors and frames, piping, ductwork and light fixtures, are not damaged in any way whatsoever by the work of all trades. Take all precautions required or necessary to prevent any such damage, supplying all protection, hoarding, tarpaulins and dust sleeves. Any damage caused because of lack of such protection or lack of preventative measures to be made good at no cost to the Owner. Ensure that the work in the existing building, such as floors, finishes and trim, is protected as completely as possible to hold the replacing of damaged work by each sub-contractor to a minimum.
- .4 Care to be taken when working above or around UPS modules, batteries and switchgear as this equipment must remain in service. Care to be taken to eliminate dust in these equipment areas.

- .5 Switchgear fronts must be protected from accidental breaker trips when working around or above them. Provide a extended shield with 12 mm (½") plywood coated with fire retardant paint a minimum of 450 mm (18") from board front to allow access to board.

6.21 **HOUSEKEEPING**

- .1 Scrap and refuse to be removed from the work area daily. Whenever possible, clean up immediately following completion of work. A high level of cleanliness must be maintained. Sweep and damp mop daily.
- .2 Oily and waste solvent rags are a fire hazard and to be deposited in approved containers.
- .3 Conduit, wires or cables, tools or equipment are not be left in such a way that they constitute a hazard.
- .4 Openings in the roof or floor to be guarded to prevent to prevent stock or scrap from dropping down.
- .5 Loose equipment and tools shall be cleaned off overhead areas before leaving each day.
- .6 Boards with protruding nails shall not be left on the floor.
- .7 Bolts shall be cut off at floor level to eliminate a possible tripping hazard.

6.22 **OWNER'S SPECIAL REQUIREMENTS**

- .1 Contractor must provide a written list of names for employees and sub-trades entering the building, advising which areas they need access to at least 48 hours prior to expected time of arrival. This lead time is required to prearrange security passes.
- .2 Security Passes must be visibly worn at all times by all employees.
- .3 All trades people must strictly adhere to Building Security regulations or entrance into the building will be denied.
- .4 All trades people are to enter the entrance identified by the Owner. Vehicles are to be parked in proper designated areas. Driveways are not to be blocked.
- .5 Freight elevator must be used at all times to transport tools and material. Freight elevator door must be shut immediately after exiting the cab.
- .6 Under no circumstances are any electrical or mechanical systems to be disabled or activated without prior knowledge and approval by the Owner's Project Manager. Prior to disabling or activation of any electrical or mechanical systems, Building Operations and Building Security must also provide approval.
- .7 Prior notification must be forwarded to Building Security Staff before any construction activity can start which will result in heat, smoke, dust or fumes, such as sawcutting, soldering, spray painting, which can affect the sensitive fire protection equipment.
- .8 Contractor responsible for scheduling and meeting the sub-trades daily on site, showing all trades people the work areas and work to be done.
- .9 Trades-people are to supply and use their own tools. No tools, ladders or equipment, etc. will be loaned.
- .10 Contractor is responsible for all associated environmental cleaning to the job site, daily during construction and upon completion. This includes both under raised floor and above ceiling. No materials or garbage will be permitted to be stored on the loading dock.
- .11 Special care and attention must be adhered to at all times when transporting equipment and materials to prevent accidental damage to the fire protection equipment and all furnishings and fixtures.
- .12 "No Smoking" - smoke free building. Violators will be denied entry. Smoking is not allowed on the roof.

- .13 If Building Operations deems that work on a particular system requires security escort, the Contractor should allow 48 hours to make appropriate arrangements.
- .14 For any fire system isolation requests, the Contractor should allow for 24 hours notification to Building Operations.
- .15 For any open flame work, a fire extinguisher and security fire watch is required, and will be provided and paid for by Owner. Provide 24 hour notice prior to work to allow Owner to make necessary arrangements.
- .16 Storage of materials on site must be cleared through the Building Manager.
- .17 Contractors must perform a daily cleanup prior to leaving the site.
- .18 Oxygen and acetylene cylinders are to be secured at all times and capped nightly.
- .19 Work performed on operating and redundant systems must be restored to their normal condition at the end of each work day.
- .20 At the conclusion of each work day, the Contractor's supervisor is to advise the Building Manager on the day's activities and plans for the next day's work. A security escort will be required for any work being done in secured areas, e.g. raised floor, computer room and mechanical/electrical rooms.

6.23 **CONTRACTORS SITE OFFICE & LUNCHROOM**

- .1 Contractor to provide site office and lunchroom facility.
- .2 Contractor to provide and pay for temporary telephone/fax/ internet (email) service. Contractor will be responsible for all charges.
- .3 Owner's cafeteria is off limits.

6.24 **CORE DRILLING**

- .1 Wherever core drilling is required, provide temporary dust proof screens as specified.
- .2 In areas where core drilling through existing slab is necessary, the areas to be drilled to be marked out clearly on the underside of slab. Owner's representative to be notified at least 1 week prior to core drilling operation. Tarping of equipment will be responsibility of Contractor supervised by the Owner.
- .3 During all core drilling operations, ensure that a minimum of one person is stationed directly below the area of drilling with a large plastic container pressed to underside of slab to hold core and water upon completion of operations.
- .4 A wet/dry commercial quality vacuum to be used continuously at location of drilling operation to remove all excess water from area.
- .5 Prior to core drilling, approval shall be obtained in writing from the [Consultant][Engineer]. Hole locations are to be x-rayed prior to drilling. Costs for x-rays are to be carried by the Contractor. X-raying will typically be required to occur during premium time

6.25 **TEMPORARY DUST PROOF SCREENS**

- .1 Provide temporary dust proof screens where required to separate areas of new work from existing areas and to prevent dust to settle on the Owner's plant and equipment. Dust proof material to be neoprene coated nylon tarpaulin or other types of fabric as approved by the [Consultant][Engineer].
- .2 Extend dust proof screens from floor to underside of floor or roof above. Lap all sections of screen sheets 150 mm (6") minimum. Tape all lapped sheets.
- .3 Provide all temporary framing required. Secure all screen sheets at top, bottom and ends. Tape perimeter of screen to ensure dust proof environment.

- .4 Co-operate with Owners in the erection of temporary dust proof screens. Remove screens when and as directed by Consultant.

6.26 **PROTECTION OF FLOORS DURING EQUIPMENT INSTALLATION**

- .1 Provide protection of existing floor finishes during installation or removal of equipment, and at any other time when moving or installing heavy equipment.
- .2 Protect floors in rooms noted
- .3 Install 19mm ($\frac{3}{4}$ ") plywood over 5 mil plastic over finished floor areas when moving heavy equipment that could damage floor finish.
- .4 Repaint or re-tile any floors or walls damaged or scratched during construction.

6.27 **CONSTRUCTION POWER AND TEMPORARY ELECTRICAL SERVICES**

- .1 Provide temporary electrical power services during construction for temporary lighting and operating of power tools and other equipment. Provide necessary Revenue Canada approved kWhr metering unit.
- .2 Arrange for connection with the Owner into existing switchboards as indicated. Pay all costs for installation, maintenance and removal.
- .3 Provide and maintain temporary lighting throughout project. Level of illumination on all floors and stairs to not be less than 162 Lux.
- .4 Temporary electrical power service are available at site in locations designated by Owner.
- .5 Contractor and sub-contractors to provide transformers and suitable fused disconnect switches and wiring from locations as and where required and to maintain temporary services for use of light, tools, and apparatus, in order to facilitate completion of work, in accordance with applicable local by-laws.
- .6 Notwithstanding the above, where a Contractor proposes to use electric welding, a portable motor generator set to be provided by Contractor to avoid undue disturbances on the building's electrical distribution system, located to the satisfaction of Owner.
- .7 Electrical demand and consumption charges are to be metered
 - .1 Costs for this shall be paid by the General Contractor and all costs for the duration of the project shall be included in the Bid Amount.
- .8 If, during installation phase of project, it becomes necessary to have a temporary interruption in the Owner's utilities, Owner will inform Contractor as soon as possible before any such interruption. Contractor and sub-contractors to then take such action as is necessary to accommodate said interruption in their installation schedule.

6.28 **PRICING OF CHANGE NOTICES**

- .1 The value of a proposed change in the work shall be determined in one or more of the following methods:
 - .1 by time and material;
 - .2 by unit prices set out in the Contract or subsequently agreed upon;
 - .3 by labour and material costs submitted in a detailed quotation.
- .2 In the case of changes in the Work to be paid for under the time and material or the unit price methods, the form of presentation of costs and methods of measurement shall be agreed to by the Consultant and Contractor before proceeding with the change. The Contractor shall keep accurate records, as agreed upon, of quantities or costs and present an account of the cost of the change in the Work, together with vouchers, material receipts and invoices where applicable.

- .3 In the case of changes in the Work to be paid for under the time and material or the labour and material method, the material costs are to be less trade discounts. The discount to be provided from list price for items included in the Allpriser catalogue or Electrical Price Guide is 20%.
- .4 The detailed quotation referenced under the labour and material method is to include a summary of charges made up of three components: labour charges, material costs and fees.
- .1 Labour Charges
- (a) The labour hour estimates are to be based on the current NECA Column 2 manual of labour units.
 - (b) Labour costs are to include burden on wages such as taxes, worker compensation charges, CPP, EI, project insurance, safety meetings, estimating, as-built drawings, supervision, small tools, site facilities, labour warranty and clean up.
 - (c) The all inclusive hourly labour rate applicable for quotations submitted for changes to the work is 1.90 times the BASE RATE of the current Collective Agreement (ie if current rate for a Journeyman Electrician is \$31.70 x 1.9 = \$60.23 per hour per hour. The hourly labour rate for specialists not governed by union agreements (technicians or engineers) is 2.25 times the base rate for Electricians.
 - (d) The all inclusive hourly labour rate indicated above is to include:
 - Collective Agreement relevant to the place of work (vacation pay, RRSP, Health & Welfare, RST of Health & Welfare, Pension, Union admin fund, ECA fund (or others), Secretariat.)
 - Legislation as relevant to the place of work (Emp. Health Tax, E.I., CPP, WSIB, taxes)
 - Project insurance, safety meetings, estimating, lay outs, site facilities, warranties, storage,
 - clean up, office supervision and miscellaneous charges.
 - (e) Foreman Electrician, General Foreman, Superintendent rates shall be as for the calculated Journeyman rate above plus 15% of the base rate. A maximum of 10% of the total calculated journeymen hours on a change may be charged as overhead supervision hours at the Foreman rate.
 - (f) A maximum combined amount of 3% of the total calculated journeymen hours on a change may be charged as overhead supervision hours at the General Foreman / Supervisor rate.
 - (g) No other overhead supervision hours will be permitted.
- .2 Material Charges
- (a) Material costs are to be less trade discounts. The discount for items included in the Allpriser catalogue or Electrical Price Guide is 20%.
- .3 Fees
- (a) The overhead and profit fee is to include for the Contractor's head office and site office expenses, project manager, assistants, site office and storage facilities, utility charges, site security, telephone and facsimile transmission costs, As Bults, expendable small tools, financing costs, coffee breaks, site facilities, general clean up and disposal, security, storekeeper, and all other non-productive labour.
 - (b) **Refer to General Conditions.**

PART - 7 CONSULTANT REVIEWS

7.1 GENERAL

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

7.2 **SITE REVIEWS**

- .1 General reviews and progress reviews do not record deficiencies during the course of the Work until such time as a portion or all of the work is declared complete. In some instances before the work is completed, deficiencies may be recorded where the item is indicative of issues such as poor workmanship, incorrect materials or installation methods, or may be difficult to correct at a later date. Any such reported items, or lack thereof, shall not be relied on in any way as part of the Contractors quality assurance program nor relieve the Contractor in the performance of the Work.
- .2 Deficiency reviews conducted by the Consultant are performed on a sampling basis, and any deficiency item is to be interpreted as being indicative of similar locations elsewhere in the Work, unless otherwise shown.
- .3 Milestone Reviews
 - .1 Specific milestone reviews are conducted at key stages by the Consultant, including:
 - (a) Before backfilling of buried drainage,
 - (b) Before closing of shafts
 - (c) Before closing of ceilings
 - (d) Before closing of walls
 - (e) Equipment demonstration
 - (f) Substantial Performance deficiency review
 - (g) Total Performance deficiency review.
 - .4 Coordinate with the Consultant the type and quantity of milestone reviews required and incorporate these requirements in the construction schedule.
 - .5 Notify the Consultant in writing seven (7) calendar days in advance of work to be concealed to arrange a site review prior to the Work being concealed. Any noted deficiencies are to be corrected and reviewed again by the Consultant before being concealed. Failure to provide notification can result in the Work being exposed for review at the Contractor's cost.

PART - 8 CONTRACTOR DUTIES DURING INSPECTION

- .1 Inspection from the Consultant's team will be provided in accordance with Regulation 941/90 of the Professional Engineers Act. Inspections will be performed on a periodic basis to ensure general compliance only. Unscheduled random inspections and scheduled pre-occupancy inspections will be conducted to ensure installation generally meets specified quality standards and intent of the design according to the Ontario Building Code. Not all work will be inspected as walls and ceilings are closed in and buried services covered to meet schedule deadlines. It is the Contractor's responsibility to ensure that work is complete and constructed to specified standards.
- .2 The Division 26 Contractor shall each assign one person responsible for ensuring that work from all Division trades is complete prior to closing in wall, ceilings or burying services, and prior to Pre-occupancy Inspections. In conjunction with the Mechanical and Electrical Co-ordinator, the Contractor shall walk the site and thoroughly review that the work is complete, in good workmanship and installed according to the drawings and specifications. The Contractor shall then submit a "Statement of Completion" Report. In the case of pre-occupancy inspections, the Statement of Completion report will be submitted 24 hours prior to the scheduled Inspection.
- .3 Services to be covered (behind drywall or buried) shall be photographed and assembled in a journal to form a comprehensive documentation of the completed services. The photos

- will be turned over to the Inspector for review prior to pre-occupancy inspection and will again be turned over to the Owner for his use at the end of the Project.
- .4 In preparation for the pre-occupancy inspection of the area or phase being turned over to the Owner, the Division Contractor shall perform a comprehensive inspection of their own to ensure that their contractual obligations are met before requesting the pre-occupancy inspection. The written report or Statement of Completion shall consist of the following items:
- .1 date and time of the inspection, signed by the person who conducted the inspection
 - .2 confirmation that previously noted deficiencies have been completed
 - .3 confirmation that the work is 100% complete, tested, balanced and deficiency free or include a list of outstanding work with a reason why work has not been completed (ie another trade has to complete their work)
 - .4 a plan of action to complete in-complete work with estimate of completion time.
- .5 The format of the Statement of Completion will be agreed upon with the Consultant. The Consultant's Inspector shall sign off the Statement of Completion Report and return a copy to the Contractor. The Contractor will retain on site a log of all signed off Statement of Completion reports.
- .6 If Statement of Completion is not received, the Consultant reserves the right to withhold pre-occupancy inspection.
- .7 If the Statement of Completion is received and the Inspector enters an area that is obviously not ready for inspection (ie the report was falsified), the Inspector shall immediately leave the site without completing the inspection. The Division Contractor shall request another inspection 72 hours in advance and shall resubmit the Statement of Completion 24 hours prior to the inspection.

PART - 9 CORRECTION AFTER COMPLETION

9.1 GENERAL

- .1 At completion, submit written guarantee undertaking to remedy defects in work for a period of one year from date of substantial completion. This guarantee is not to supplant other guarantees of longer period called for on certain equipment or materials.
- .2 Guarantee to encompass replacement of defective parts, materials or equipment, and to include incidental fluids, gaskets, lubricants, supplies, and labour for removal and reinstallation work.
- .3 Submit similar guarantee for one year from date of acceptance for any part of work accepted by Owner, before completion of whole work.

9.2 FINAL REVIEW

- .1 At project completion submit written request for final review of mechanical and electrical systems.
 - .1 Refer to section 26 08 19 Project Close-Out.



H.H. Angus & Associates Limited Consulting Engineers

SHOP DRAWING COVER SHEET

1127 Leslie Street Toronto Ontario M3C 2J6 Canada

T: (1) 416 443 8200 F: (1) 416 443 8290

***Include this cover page with each shop drawing submission.
Submissions without this form will be returned without review.***

Client/Architect: **ABC Architects Ltd**
Project Name: **University Healthcare Wing**
HHA Project No: **2081001**

Contractor to complete the following for each submission.

Date: _____

Contractor Reference No: _____

Manufacturer Name: _____

Product Type: _____

Specification Section No: _____

Contractor Trade:

☐ Mechanical

☐ Electrical

☐ Elevators

☐ General Trades

If this is a resubmission, check here: ☐

Previous submission reference no.: _____
(HHA reference No. only)

HHA distribution - for internal use only:

Mechanical review: John Smith

Electrical review: Joan Smith

Elevators review:

END OF SECTION

PROJECT PHASING

26 05 05

PART - 1 GENERAL

1.1 GENERAL REQUIREMENTS

- .1 Conform to Sections of Division 1 as applicable.

1.2 REFERENCE PHASING REQUIREMENTS

- .1 Portions of the Work impact on the existing hospital. Notify the Owner and the Consultant, in writing, at least one week in advance of the work where work requires shut-down or isolation of existing services.
- .2 Except as identified below, shut-downs of existing services will be restricted to the hours from 10:00 PM to 5:00 AM.
- .3 The Contractor shall be responsible for isolation of applicable systems under strict supervision from Hospital Staff. The Contractor shall be responsible for temporary services as required to suit their work.
- .4 Access to the existing ceiling spaces is to be considered hazardous due to possibility of Infection Controls concerns. Entry is restricted and Contractors shall comply to the hospitals Health and Safety regulations for work in this area. Arrange with Health and Safety at least 48 hours prior to access. All members of construction crew must be trained in Infection Controls procedures.
- .5 Carefully examine the phasing plan from the Architectural drawings and develop an Electrical construction plan to ensure all services will be complete and available for occupancy of the phased spaces. Route all services within the boundaries of the phased areas to ensure services are ready when required for occupancy.
- .6 The Electrical work necessary to maintain services will not be restricted to the architectural phased areas of work. This Division will have work in the existing building, obtaining and modifying services for new phased areas.
 - .1 The Contractor shall maintain existing systems until the new services are ready for use. In some areas provide additional feeders, lighting, circuits, wiring, etc as required to maintain services in phased areas. Remove temporary redundant Electrical services used for phasing at end of project.
 - .2 In new work, provide temporary Electrical services and connections between phased areas to avoid un-necessary system shutdowns.

1.3 WORK IN OCCUPIED AREAS

- .1 Work in Owner occupied areas to be scheduled with the Hospital. Access to these area will be during after normal working hours; schedule the work with the hospital for availability of work areas.
- .2 The phasing of the construction work as recommended has been coordinated with the Client and meet the Hospital's need to maintain the life activities operational during construction work. The General Contractor will schedule the construction work to meet the

requirements of starting completing the work as per the phasing listed in the Contract Documents.

1.5 **PHASED OCCUPANCY, EQUIPMENT MAINTENANCE, EQUIPMENT OPERATION AND WARRANTY.**

- .1 *Although there are several phases to this project, it is one project and substantial performance will be granted at the end of the project. There will be no phased substantial performance or phased release of holdback.*
- .2 *The Electrical Contractor to ensure Lighting Systems, UPS Systems (if included in the Construction) are operational for the appropriate phase of construction.*
- .3 *The Electrical Contractor will be responsible to maintain and operate the new equipment (and systems) supplied under this project until the project is formally handed over to the Owner. Maintenance shall include all manufacturer recommended maintenance and cleaning. Maintenance and system downtime to be minimized and scheduled to suit the Hospital.*
- .4 *The Electrical Contractor shall operate the systems to the Owners benefit to ensure that the occupied phases are fully serviced to the Owners schedule. Provide a list of emergency contacts so they can respond 24/7 to issues with their system. Repairs to be made quickly to minimize disruption to the Hospital.*
- .5 *Training of Owners maintenance personnel to be done at end of project prior to formal turnover to Hospital. Training will not be required at the end of each phase as the contractor will be maintaining and operating the equipment/systems installed under this project.*
- .6 *Equipment and system warranties to start after substantial performance even though equipment may be operating during early phases. **Notify equipment supplier of this situation during bidding and include any additional costs related to operating the equipment during the construction period or include extended equipment warranty to cover contract duration plus the standard warranty period starting after substantial performance.***

END OF SECTION

FIRE STOPPING & SMOKE SEALS

26 05 10

PART - 1 GENERAL

1.1 GENERAL REQUIREMENTS

.1 Comply with the General Conditions of the Contract, Supplementary Conditions and other Sections of Division 1 and with Section 26 05 01, Electrical General Requirements.

1.2 SYSTEM DESCRIPTION

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

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

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

.4 Firestopping and smoke seals within electrical assemblies (i.e. inside electrical cable ducts/ trays if applicable) shall be provided as part of the Work of Divisions 26. Refer to Section 26 05 01, Article 5.4 and include firestopping and smoke seals around the outside of such mechanical and electrical assemblies where they penetrate fire-rated separations shall be part of the Work of this Section unless otherwise indicated by the Contractor.

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

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

1.3 RELATED SECTIONS

.1 Sealing around service penetrations through rated floors and walls - under Division 26, Division 27 and Division 28.

1.4 QUALITY ASSURANCE

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

.2 Applicator Qualifications:

.1 Applicator shall have at least three years experience in installing materials of types specified and shall have successfully completed at least three projects of similar scope and complexity.

.2 Applicator shall designate a single individual as project foreman who shall be on site at all times during installation.

.3 Applicator shall be approved for this Work by Product Manufacturer or listed below:

- (a) Beverly F.S. (Tel: 905-659-3367)
- (b) Dominion Caulking (Tel: 905-883-8355)
- (c) Profirestop (Tel: 416-293-0993)
- (d) RILI Firestopping (Tel: 905-349-3779)

- .4 Obtain firestop materials from single manufacturer for each different product required.
- .5 Manufacturer shall instruct applicator in procedures for each material.
- .6 Refer to notes on Drawings for additional information, instructions and clarifications.
- 1.5 **REGULATORY REQUIREMENTS:**
 - (a) Firestop System installation must meet requirements of CAN/ULC-S 115-11 tested assemblies that provide a fire rating equal to that of construction being penetrated.
 - (b) Proposed firestop materials and methods shall conform to applicable governing codes having local jurisdiction.
- 1.6 Arrange a pre-job conference between Contractor, applicator, inspection and testing representative, manufacturer's representative and Consultant.
- 1.7 Fire Protection Consultant will test (Review) up to 2% of completed Work (Penetrations). Contractor to provide installer and enclosures at Consultant's discretion.
- 1.8 Consultant may or may not require destructive testing to be done. Contractor shall cover costs of repairing fire separation after destructive tests are performed.
- 1.9 **SUBMITTALS**
 - .1 Shop Drawings
 - .1 Submit drawings indicating the ULC or Warnock Hersey assembly number, the required temperature, hose stream, and flame rating, material thicknesses, installation methods and materials of firestopping and smoke seals, primer, supports, damming materials as applicable, reinforcements, anchorages, fastenings and methods of installation for each condition to be encountered.
 - .2 Designate on shop drawings both fixed and moving penetrants, relative positions, expansion and control joints in rated slabs and walls, firestopping details at receptacles and similar poke-through devices and surrounding permanent materials. Identify re-entry locations.
 - .3 Manufacturer's Product Data: Submit data for materials and prefabricated devices, providing descriptions sufficient for identification on Site.
 - .4 Certificates: Submit manufacturer's certification that installed firestopping and smoke seal material comply with specified requirements.
 - .5 ULC or Warnock Hersey Listings: Submit copies of Listing cards for review.
 - .2 Samples
 - .1 Submit only as requested various types of firestopping and smoke seal material.
 - .2 Mock-Up
 - 1. Construct mock-up for each separation type prior to commencing Work at locations as designated by Consultant in accordance with Section 01 00 00.
 - 2. Mock-ups shall be reviewed and approved by manufacturer and Consultant.
 - 3. Accepted mock-ups may remain as part of completed work.
 - 4. Mock-ups shall be modified as many times as necessary to obtain acceptance.
 - .3 Delivery, Storage and Handling
 - .1 Deliver the materials to the job site in the manufacturer's unopened

- containers, containing the classification label, with labels intact and legible at time of use.
- .2 Store material in accordance with manufacturer's recommendations with proper precautions to ensure fitness of material when installed.
- .3 Before handling, read product data sheets and material safety data sheets. Do not use damaged or expired materials.
- .4 Identification
 - .1 Identify, through-penetration fire stopping and smoke seal systems with pressure sensitive, self adhesive, printed vinyl labels. Attach labels permanently to surfaces of penetration construction on both sides. Labels must be visible from 5'-0" above the floor. Labels must show the following information:
 - (a) the words "Warning: through-penetration firestopping system, Do not disturb"
 - (b) the applicators name, address and telephone number
 - (c) designation of applicable testing and inspection agency
 - (d) date of installation
 - (e) manufacturers name for materials
- .5 Photography
 - .1 Provide digital photography of every fire separation penetration showing both the before and after installations. Picture must indicate day and time and be labelled to show exact location.
 - .2 Duplicate copies of digital photo records are to be submitted directly to the Hospital at the completion of the installation in each building/ wing.

PART - 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS / INSTALLATION SPECIALISTS

.1 General

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

.2 Approved manufacturers:

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

2.2 MATERIALS

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

.1 Asbestos free materials and systems.

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

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

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

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

PART - 3 EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 PREPARATION

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

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

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

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

3.3 INSTALLATION

.1 General

.1 Mix and apply firestopping, gas and smoke seals in strict accordance with manufacturer's instruction and tested designs to provide required flame rated seal, to prevent the passage of gas and smoke, and where specifically designated, the passage of fluids.

.2 Provide temporary forming and packing as required. Apply materials with sufficient pressure to properly fill and consolidate the mass to seal openings.

.3 Tool or trowel exposed surfaces.

.4 Notify Consultant when random completed installations are ready for review, as directed by Consultant, prior to concealing or enclosing firestopping and as applicable, smoke seals.

3.4 IDENTIFICATION

.1 Provide identification of all firestopping as specified.

3.5 PHOTOGRAPHY

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

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

3.6 CLEAN UP

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

END OF SECTION

WIRES & CABLES 0-1000 VOLTS

26 05 19

PART - 1 GENERAL

1.1 PRODUCT DATA

- .1 Submit product data in accordance with Section 26 05 01 Electrical General Requirements.

PART - 2 PRODUCTS

2.1 BUILDING WIRES

- .1 Copper conductors: size as indicated, stranded for 10 AWG and larger, with 1000 V insulation for 347/600 Volt systems, and 600 V insulation for 120/208 V systems, of chemically cross-linked thermosetting polyethylene material rated RW90 and/or RWU90 to CSA C22.2 No. 38.
- .2 Use RWU90 for wiring installed underground.
- .3 Wiring in channel back of luminaires shall be 600 volt type GTF or TEW, temperature rating as required by CSA and/or manufacturer requirements..
- .4 Conductors shall be colour coded. Conductors No. 10 AWG and smaller shall have colour impregnated into insulation at time of manufacture. Conductors No. 8 AWG and larger may be colour coded with adhesive colour coding tape but only black insulated conductors shall be employed in this case, except for neutrals which shall be white wherever possible.
- .5 Minimum wire size shall be No. 12 AWG. Home runs to lighting and receptacle panels which exceed 25 m (75') in length shall be minimum No. 10 AWG. Home runs which exceed 40 m (120') in length shall be minimum No. 8 AWG. Home runs which exceed 60 m (180') in length shall be minimum 6 AWG.
- .6 Colour coding shall be as follows: Red - Phase A, Black -Phase B, Blue - Phase C, White - Neutral, Green - Ground, Orange - Control.

Standard of Acceptance

- o Aetna Insulated Wire
- o General Cable
- o Nexans Canada Inc
- o Pirelli Cables Ltd.
- o Southwire

2.2 MINERAL INSULATED CABLE

- .1 Cable shall have ULC listed 2 hour fire rating.
- .2 Cable shall be shipped with ends temporarily sealed and shall be stored under dry conditions.
- .3 Cable shall be of capacities and types noted on drawings and shall be terminated using suitable terminating hardware.

Standard of Acceptance

- o Pyrotanax

2.3 INSTRUMENTATION AND CONTROL CABLING

- .1 Control cables shall be designed according to CSA Standard Can3-C2.1-M86 Control Cables - 600 Volts.

- .2 Control cables shall be as follows:

Conductors	Quantity, arrangement and gauge shown on drawings or specified elsewhere
Identification	Colour coded or numbered
Insulation	XLPE
Armour	Steel (No armour required if installed in conduit or approved wireway)
Jacket	FT4 Flame Retardant PVC FT6 Plenum rated in open style cable trays in ceiling spaces

- .3 Shielded cables shall provide 100% shield coverage and be complete with drain wire.

- .4 Multipair twisted shielded cables shall have individual pairs shielded, overall shield and drain wires and overall rated jacket.

Standard of Acceptance

- o BICC
- o Belden
- o Nexans Canada Inc

PART - 3 EXECUTION

3.1 GENERAL

- .1 Provide grounding / bonding conductor in all conduits whether metallic or non-metallic, sized as per Ontario Electrical Safety Code, and connect to grounding bus. All receptacles, lighting fixtures, panels, transformers, motors, heaters, communications conduits and other powered devices shall be grounded via ground wires.

- .2 A dedicated neutral conductor shall be provided for each single phase branch wiring power circuit.

3.2 INSTALLATION OF BUILDING WIRES

- .1 Install wiring as follows:

- .1 In conduit systems in accordance with Section 26 05 33.

- .2 In wireways and auxiliary gutters in accordance with Section 26 05 37.

- .2 Neatly train circuit wiring in cabinets, panels, pullboxes and junction boxes and hold with nylon cable ties.

- .3 Splice wire, up to and including No. 6 AWG with nylon insulated expandable spring type connectors. Connector body shall be moulded of thermoplastic and spring insert shall be an expandable square-edged design. Splice larger conductors using split-bolt or compression type connections wrapped with PVC tape.

- .4 Where colour coding tape is utilized, it shall be applied for a minimum of 50 mm (2") at terminations, junction and pullboxes. Do not paint conductors under any conditions. Colour coding shall also apply to bussing in panels and bus duct.

3.3 INSTALLATION OF MINERAL INSULATED CABLES

- .1 Cable shall be installed in trays or exposed on walls, beams, purlins or ceilings, using clamps available from the manufacturer. Fire rated circuits shall be supported on centres not exceeding 1000 mm (3'). Care shall be taken when handling the cable to avoid cable kinks; it is recommended that cable be

uncoiled from supply reel by rolling. Cables shall be bent using a suitable hickey with a minimum bending radius of six times the cable diameter.

- .2 Embedded cables shall be protected against punctures and mechanical damage.
- .3 Single conductor cables forming part of a circuit shall be run in contact with one another throughout their length.
- .4 Single conductors in parallel shall be arranged in groups and the groups shall be at least two cable diameters apart.
- .5 Cables shall be terminated with manufactured gland and seals. Gland and seal assembly shall be prepared with tools specifically designed for the purpose. Upon completion of termination, the insulation resistance of the cable shall be checked with an insulation tester in accordance with values to be determined by the [Engineer][Consultant].
- .6 Cables forming part of circuits rated 200 A and above shall be terminated at each end on a suitably sized minimum 6 mm thick brass plate, installed by removing the steel of the termination panel. A copper bonding conductor, sized per Table 16 of the Safety Code, shall be connected to the termination plate via a Burndy Servit type KC connector or type YA compression connector, and extended to the equipment ground bus and terminated with a Burndy YA compression connector with 12mm stainless steel bolt and hardware.
- .7 The entire installation shall be made in accordance with the recommendations of the manufacturer, who shall be retained by the Contractor under this Section to inspect the cable installation and termination methods.

3.4 INSTALLATION OF INSTRUMENTATION, COMMUNICATION AND CONTROL CABLING

- .1 Install wiring as follows:
 - .1 In conduit systems in accordance with Section 26 05 33.
 - .2 In wireways and auxiliary gutters in accordance with Section 26 05 37.
 - .3 In open style corridor cable trays in ceiling spaces, using FT6 plenum rated cable assemblies.
- .2 Neatly train circuit wiring in cabinets, panels, pullboxes and junction boxes and hold with nylon cable ties.
- .3 Run all instrumentation, communication and control cabling point to point and terminate on terminal strips. Do not splice communication or control cabling. Where long runs make a continuous point to point installation impractical, make splices on labelled terminal blocks installed in an accessible labelled terminal cabinet, installed at 1200 mm (48") above floor, and indicate cabinet location, terminal And wire numbers on As-built drawings.
- .4 Terminate control cables in equipment with suitable connectors.
- .5 All control cables shall be clearly identified, at both ends, with permanent PVC wire markers, Electrovert type Z or equal, indicating Cable Number and wire numbers.

END OF SECTION

GROUNDING SECONDARY

26 05 27

PART - 1 GENERAL

1.1 REFERENCES

- .1 IEEE 837, Qualifying Permanent Connections Used in Substation Grounding.
- .2 CSA C22.1 Electrical Safety Code
- .3 CSA-Z32, Electrical Safety and Essential Electrical Systems in Health Care Facilities.

1.2 GENERAL REQUIREMENTS

- .1 Conform to Sections of Division 1 as applicable.
- .2 Conform to Section 26 05 01, Electrical General Requirements.

1.3 SHOP DRAWINGS AND PRODUCT DATA

- .1 Submit shop drawings and product data in accordance with Section 26 05 01 Electrical General Requirements.
- .2 Nameplates shall be in accordance with Article "Equipment Identification".

1.4 WORK INCLUDED

- .1 Work to be done under this Section shall include furnishing of labour, materials, and equipment required for installation, testing and putting into proper operation complete systems as shown as specified and as otherwise required.

1.5 OPERATION AND MAINTENANCE DATA

- .1 Provide operation and maintenance data for incorporation into manual specified in Section 26 05 01 Electrical General Requirements.

PART - 2 PRODUCTS

2.1 EQUIPMENT

- .1 Clamps for grounding of conductors, size as required to electrically conductive underground water pipe.
- .2 Insulated grounding conductors: green, type RW90 copper.
- .3 Non-corroding accessories necessary for grounding system, type, size, material as indicated, including but not necessarily limited to:
 - .1 Grounding and bonding bushings.
 - .2 Protective type clamps.
 - .3 Bolted type conductor connectors.
 - .4 Thermit welded type conductor connectors.
 - .5 Bonding jumpers, straps.
 - .6 Pressure wire connectors.

- .4 Perimeter ground bus, 6 mm x 50 mm (¼" x 2") copper, mounted 150 mm (6") above floor on insulated spacers 600 mm (24") on centre.
- .5 Ground bus mounting spacers
 - .1 stand off insulators to UL 891
 - .2 25 to 32 mm high waterproof glass fibre reinforced polyamide
 - .3 750V insulated
 - .4 UL 94VO self extinguishing
 - .5 bichromated zinc plated threaded steel inserts
- Standard of Acceptance*
 - Erico ISO I series c/w insulator mounting kits
 - Approved equal
- .6 Communication and Computer room raised floor ground clamps: Burndy Uniground

PART - 3 EXECUTION

3.1 INSTALLATION

- .1 Install complete permanent, continuous, system and circuit, equipment, grounding systems including, electrodes, conductors, connectors, accessories, as indicated, to conform to requirements of local authority having jurisdiction over installation.
- .2 Ground electrical equipment and wiring in accordance with Ontario Electrical Safety Code and ANSI/IEEE Standard 142-1982.
- .3 Install connectors in accordance with manufacturer's instructions.
- .4 Protect exposed grounding conductors from mechanical injury.
- .5 Make buried connections, and connections to conductive water main, electrodes, using copper welding by thermit process.
- .6 Use mechanical connectors for grounding connections to equipment provided with lugs.
- .7 Soldered joints not permitted.
- .8 Install bonding wire for flexible conduit, connected at both ends to grounding bushing, solderless lug, clamp or cup washer and screw. Neatly cleat bonding wire to exterior of flexible conduit.
- .9 Install separate ground conductor in all conduits. Ground conductor shall be sized as per Table 16 of CSA C22.1 with one ground conductor for every three hot conductors. Minimum size of ground conductor shall be #12 AWG copper.
- .10 Connect building structural steel and metal siding to ground by welding copper to steel.
- .11 Make grounding connections in radial configuration only, with connections terminating at single grounding point. Avoid loop connections.
- .12 Install grounding conductors outside electrical rooms and electrical closets in conduit and conceal where possible.
- .13 Provide separate ground wire for every feeder, sized as per Table 16 of the OESC.

3.2 **ELECTRODES**

- .1 Make ground connections to continuously conductive underground water pipe on street side of water meter. Install water meter shunt.
- .2 Install [rod], [plate] electrodes and make grounding connections.
- .3 Provide rod electrodes at corners of main electrical room and connect to perimeter ground bus.
- .4 Bond separate, multiple electrodes together.
- .5 Use size 4/0 AWG copper conductors for connections to electrodes.
- .6 Make special provision for installing electrodes that will give acceptable resistance to ground value where rock or sand terrain prevails.

3.3 **SYSTEM AND CIRCUIT GROUNDING**

- .1 Install system and circuit insulated copper grounding connections to neutral of secondary systems and for common grounding conductors per CSA C22.1 Table 17.
- .2 Install insulated copper grounding conductor for service raceways and service equipment per CSA C22.1 Table 18.
- .3 Install grounding conductors in conduit.

3.4 **EQUIPMENT GROUNDING / BONDING**

- .1 Install insulated copper bonding connections per CSA C22.1 Table 16 to typical equipment including, but not necessarily limited to following list: Service equipment, transformers, frames of motors, starters, control panels, building steel work and panels, outdoor lighting.
- .2 Install bonding conductors in conduit.

3.5 **COMMUNICATIONS SYSTEMS**

- .1 Install grounding connections for telephone, sound, fire alarm, intercommunication systems as follows:
 - .1 Telephones: make telephone grounding system in accordance with telephone company's requirements.
 - .2 Communications system grounding in accordance with ANSI/EIA/TIA 607, 568A, 569 standards.
 - .3 Sound, fire alarm, intercommunication systems as indicated

3.6 **RAISED FLOOR GROUNDING**

- .1 Install [#2] [#6] bare copper grounding conductors in a grid pattern on four foot centres in each direction of the floor grid. Install Burndy Uniground ground clamp to raised floor pedestals on four foot centres, at each intersection of the ground grid conductors.
- .2 Bond each item of equipment on the raised floor to the raised floor ground grid with minimum #6 tinned copper flat braid extra flexible bonding jumper.
- .3 Extend #1/0 green insulated copper ground conductor in EMT conduit from ground grid to the building main grounding system. Terminate using NEMA 2 hole compression connectors.

3.7 PERIMETER GROUND BUS

- .1 Provide exposed perimeter ground bus in main electrical rooms and generator room.
- .2 Mount on stand off insulated spacers to wall using zinc plated steel studs, washers, lock washer and nuts.
- .3 Connect exposed metal work in electrical rooms and generator room to perimeter ground bus with insulated stranded copper connections, size 2/0 AWG copper in conduit.
- .4 Protect ground bus with one coat of insulating varnish.

3.8 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section 26 05 01 - Electrical General Requirements.
- .2 Perform ground continuity and resistance tests using method appropriate to site conditions and to approval of Consultant and local authority having jurisdiction over installation.
- .3 Perform tests before energizing electrical system.

END OF SECTION

FASTENINGS AND SUPPORTS
26 05 29

PART - 1 GENERAL

1.1 RELATED WORK

- .1 Fastenings and supports: Section 01 61 00 - Common Product Requirements.
- .2 Concrete bases and housekeeping pads for electrical equipment shall be arranged and paid for by Division 26, and installed by trade specialists under respective Carpentry, Concrete, and Painting Divisions.

1.2 SHOP DRAWINGS

- .1 Submit design drawings for custom fabricated trapeze hangers, sealed by a professional engineer licensed in the project location jurisdiction.
 - .1 Shop drawing details:
 - (a) construction detail drawings for each loading condition,
 - (b) span deflection calculations,
 - (c) building attachment load calculations and type.
- .2 Provide services of engineer who sealed the custom trapeze hanger shop drawings to conduct a general review of the completed installation on site.

PART - 2 PRODUCTS

2.1 SUPPORT CHANNELS

- .1 Hot dipped galvanized steel, U shape, size 41 mm x 41 mm x 2.5 mm (1e" x 1e" x 1/10") thick, surface mounted, suspended or set in poured concrete walls and ceilings.

2.2 INSERTS

- .1 Inserts for conduits and raceway hangers, for single, double and multiple runs shall be galvanized.
 - Standard of Acceptance*
 - Unistrut Canada
 - Burndy (Canada) Ltd. - Flexibar
 - Pilgrim Technical Products Ltd. - Tufstrut

2.3 HANGERS

- .1 Hangers for electrical conduit shall be hot dipped galvanized after fabrication.
 - Standard of Acceptance*
 - Burndy Canada Ltd.
 - Canstrut
 - Electrovert Ltd.
 - E. Myatt & Co. Ltd
 - Steel City Electric Ltd.
 - Pilgrim Technical Products Ltd.

2.4 **TRAPEZE HANGERS**

- .1 Performance:
 - .1 Manufactured:
 - (a) to product load listings.
 - .2 Custom fabricated:
 - (a) maximum deflection between supports: 1/250 (0.4%) of span
 - (b) minimum factor of safety : 5 times load to ultimate tensile or compressive strength.
- .2 Construction:
 - .1 Carbon steel shapes, to suit load application:
 - (a) hollow steel section,
 - (b) equal leg EI section, or
 - (c) double C channel "strong-back", with welded clips.
 - .2 Hanger rods:
 - (a) as specified above, and
 - (b) minimum two support rods,
 - (c) rods selected for minimum factor of safety of 5 times load to ultimate tensile or compressive strength of rod.
- .3 Finish:
 - .1 hot dipped galvanized finish in mechanical rooms and outdoors.
 - .2 black steel finish in other areas.

Standard of Acceptance

 - ° Anvil Fig 45, 46, 50

PART - 3 EXECUTION

3.1 **INSTALLATION**

- .1 Supply and deliver inserts to site in ample time to be built into work of other trades. Provide necessary templates and adequate instructions to locate and install inserts.
- .2 Secure equipment to masonry, tile and plaster surfaces with lead anchors.
- .3 Secure equipment to poured concrete with expandable inserts.
- .4 Secure surface mounted equipment with T-bar support hanger fastened to inverted T bar ceilings. Ensure that T bars are adequately supported to carry weight of equipment specified before installation.

Standard of Acceptance

 - ° Caddy model No. 512 c/w BHC clip
- .5 Support equipment, conduit or cables using clips, spring loaded bolts, cable clamps designed as accessories to basic channel members.
- .6 Fasten exposed conduit or cables to building construction or support system using straps.
 - .1 One-hole steel straps to secure surface conduits and cables 50 mm (2") and smaller.
 - .2 Two-hole steel straps for conduits and cables larger than 50 mm (2").
 - .3 Beam clamps to secure conduit to exposed steel work.
- .7 Suspended support systems.
 - .1 Support individual cable or conduit runs with 6 mm (¼") dia threaded rods and spring clips.
 - .2 Support 2 or more cables or conduits on channels supported by 6 mm (¼") dia threaded rod hangers where direct fastening to building construction is impractical.

- .8 For surface mounting of two or more conduits use channels.
- .9 Provide galvanized after fabrication metal brackets, frames, hangers, clamps and related types of support structures where indicated or as required to support conduit and cable runs.
- .10 Ensure adequate support for raceways and cables dropped vertically to equipment where there is no wall support.
- .11 Do not use wire lashing or perforated strap to support or secure raceways or cables.
- .12 Do not use supports or equipment installed for other trades for conduit or cable support except with permission of other trade and approval of [Engineer][Consultant].
- .13 Install fastenings and supports as required for each type of equipment cables and conduits, and in accordance with manufacturer's installation recommendations.
- .14 Supply and erect special structural work required for the installation of electrical equipment. Provide anchor bolts and fastenings unless noted otherwise. Mount equipment required to be suspended above floor level, where details are not shown, on a frame or platform bracketed from the wall or suspended from the ceiling. Carry supports to either the ceiling or the floor, or both as required, at locations where, because wall thickness is inadequate, it is not permitted to use such brackets.
- .15 Electrical panels, switches or other electrical equipment shall be complete with suitable bases or mounting brackets. Install angle or channel iron supports to bear the equipment where it is shown in or on structural tile walls, or walls that are inadequate to bear the equipment.
- .16 Provide channel iron or other metal supports where necessary to adequately support lighting fixtures. Do not use wood. Lighting fixtures shall be supported totally independent of ceiling and supported from structure above.
- .17 Support hangers, in general, from inserts in concrete construction or from building structural steel beams, using beam clamps. Provide additional angle or channel steel members required between beams for supporting conduits.
- .18 Do not use explosive drive pins in any section of work without obtaining prior written approval.
- .19 Provide re-enforced concrete pads under switchboards, generators, and all other floor mounted electrical equipment. Pads are to be formed with chamfered edges to prevent chipping. Pads are to be sealed and painted to prevent dust from entering and interfering with electrical equipment.

END OF SECTION

SPLITTERS, JUNCTION AND PULL BOXES, CABINETS
26 05 32

PART - 1 GENERAL

1.1 SHOP DRAWINGS AND PRODUCT DATA

- .1 Submit shop drawings and product data for cabinets in accordance with Section 26 05 01 Electrical General Requirements.

1.2 REFERENCE

- .1 CSA C22.2 No. 76 Splitters.
- .2 CSA C22.2 No. 40 Junction and Pull Boxes.
- .3 Cabinets to Section 26 27 18 Panel Trim.

PART - 2 PRODUCTS

2.1 SPLITTERS

- .1 Sheet metal enclosure, welded corners and formed hinged cover suitable for locking in closed position.
- .2 Main and branch lugs and connection bars to match required size and number of incoming and outgoing conductors as indicated.
- .3 At least three spare terminals on each set of lugs in splitters.
- .4 Distribution riser splitters shall be of special construction with hinged access door, copper bus bars predrilled to accept two hole compression connectors for all incoming and outgoing cables.

2.2 JUNCTION AND PULL BOXES

- .1 Welded steel hot dipped galvanized construction with screw-on flat covers for surface mounting.
- .2 Covers with 25 mm (1") minimum extension all around, for flush-mounted pull and junction boxes.

2.3 CABINETS

- .1 Type E: sheet steel, hinged door and return flange overlapping sides, handle, lock and catch, for surface mounting.
- .2 Type T: sheet steel cabinet, with hinged door, latch, lock, 2 keys, containing sheet steel backboard for surface or flush mounting as indicated.
- .3 Surface mounted cabinets shall be finished in ASA 61 grey.

2.4 INSTRUMENTATION AND CONTROL TERMINAL CABINETS

- .1 Surface mounted, gasketed, drip proof and dust tight, JIC enclosure, CEMA type 12 With hinged door, lock, 2 keys, white raised and removable internal mounting panel, diagram pocket, finished with ASA 61 grey.

Standard of Acceptance

 - ° Hammond
- .2 Panel wiring to be contained in PVC wiring ducts complete with cover strips, minimum 50 mm x 50 mm (2" x 2"). Wireway fill to be limited to 60%. Where there are a large number of door mounted devices, door wiring harnesses shall also be contained in wiring ducts at rear door. All door wiring devices to emanate from the control panel terminal strips. Wiring to panel face mounted devices to be bundled neatly on hinge side of panel, enclosed in flexible spiral wrap, and installed such that wiring will not be damaged when opening and closing door. Ground panel door to panel with a flexible copper bonding strap. Label all wiring with permanent PVC sleeve type markers.
- .3 Phoenix contact terminal blocks with mounting rails, end covers, terminal markers, partition plates and accessories: UK 2.5 termination of wiring 22 to 12 AWG; UK 5 and UK 10 series for current transformers and other leads #10 AWG and #8 AWG; UDK or UK 5 twin for connecting two or more conductors to one terminal block; DIK 1.5 for three wire sensor device wiring; MTKD for thermocouple leads.
- .4 Provide lamacoid nameplates for all panel mounted control and indicating devices, and all internal components such as terminal strips, control transformers, control devices, relays, etc. as per 26 05 01.

PART - 3 EXECUTION

3.1 SPLITTER INSTALLATION

- .1 Install splitters and mount plumb, true and square to the building lines.
- .2 Extend splitters full length of equipment arrangement except where indicated otherwise.

3.2 JUNCTION, PULL BOXES AND CABINETS INSTALLATION

- .1 Install pull boxes in inconspicuous but accessible locations.
- .2 Mount cabinets with top not higher than 2 m (6'-6") above finished floor.
- .3 Install terminal block as indicated in Type T cabinets
- .4 Only main junction and pull boxes are indicated. Install pull boxes so as not to exceed 30 m{100} of conduit run between pull boxes.

3.3 IDENTIFICATION

- .1 Provide equipment identification in accordance with Section 26 05 01 - Electrical - General Requirements.
- .2 Install size 2 identification labels indicating system name, voltage, phase and source of power.

- .3 Provide a typed directory in cabinets showing following information: Nature, actual quantities and room number of device or devices connected to each terminal, as well as signal circuit number where applicable.

END OF SECTION

CONDUITS, FASTENINGS AND FITTINGS

26 05 33

PART - 1 GENERAL

1.1 GENERAL REQUIREMENTS

- .1 Conform to Sections of Division 1 as applicable.
- .2 Conform to Section 26 05 01, Electrical General Requirements.

1.2 SHOP DRAWINGS AND PRODUCT DATA

- .1 Submit shop drawings and product data in accordance with Section 26 05 01 Electrical General Requirements.

1.3 WORK INCLUDED

- .1 Work to be done under this Section shall include furnishing of labour, materials, and equipment required for installation, testing and putting into proper operation complete systems as shown as specified and as otherwise required.
- .2 Location of Conduit
- .3 Drawings do not indicate all conduit runs. Those indicated are in diagrammatic form only.

1.4 REFERENCES

- .1 CSA C22.2 No. 83 Electrical Metallic Tubing
- .2 CSA C22.2 No. 56 Flexible Metal and Liquid-Tight Flexible Metal Conduit
- .3 Conduit accessories, conduits and fittings to CSA C22.2 No. 18.

1.5 WIRING METHODS

- .1 Install wiring in surface mounted EMT conduit unless otherwise specified. In finished areas, conceal conduit in walls and ceiling spaces.
- .2 Where shown on drawings, armoured cable shall be Teck 90 type. Jackets of cable shall have FT-4 rating identified. Connectors shall be equal to T&B Star Teck Type
- .3 Runs of conduit and cables, where shown, are indicated only by general location and routing. Install conduits and cables so as to provide maximum head room and to interfere as little as possible with free use of spaces through which they pass.
- .4 Use EMT conduit for branch circuit and signal wiring in ceilings, furred spaces, and in hollow walls and partitions.
- .5 Flexible conduit and armoured cable will be accepted in parts of existing building, where furred spaces above ceilings are too congested to permit conduit to be installed, but only with Consultants written permission. Terminate armoured cable, where shown, in accordance with the manufacturer's recommendations.

- .6 Flexible steel conduit with integral insulated green ground wire is permitted for the final connection to luminaires mounted in suspended ceilings from the branch wiring junction box above, with flexible conduit length not to exceed 3 m (10'), and be neatly installed and attached to luminaire support chain
- .7 Flexible armoured conduit (or BX) with an integral insulated green ground wire may be used where concealed in walls for wiring to receptacles, and for the final connection to luminaires.
 - .1 The junction box interfacing the horizontal EMT conduit to the flexible conduit shall be located within 3 m (10') horizontally from the end device in open areas, and in enclosed rooms, located in the same room as the devices being served, in reasonable proximity to the walls, in order to keep the horizontal portion of the run of flexible conduit to less than 3 m (10').
 - .2 The flexible conduit shall be neatly installed parallel or perpendicular to building lines, and independently supported from the slab structure above.]
- .8 Conduit shall be of sufficient size to permit easy removal of conductors at any time. Conduit sizes, where shown, are minimum and shall not be reduced.
- .9 Arrange conduits, installed in suspended ceilings, to provide minimum interference with removal of tiles.
- .10 Where existing locations of flush mounted electrical devices (switches, receptacles, etc.) correspond to new devices shown, the existing dropdown conduit and outlet box may be re-used. Provide new devices, new coverplates, new home-run conduit and complete new wire.
- .11 Vertical raceways to be provided with insulated cable support bushings or other approved method of supporting the weight of the cable, where vertical runs exceed those of Table 21 of the Electrical Code.

PART - 2 PRODUCTS

2.1 CONDUITS

- .1 Electrical metallic tubing (EMT), [hot dipped] galvanized: with couplings.
- .2 Flexible metal conduit and liquid-tight flexible metal conduit.
- .3 Conduit shall be of sufficient size to allow easy removal of conductors at any time. Conduit sizes, where shown, are minimum and shall not be reduced.

2.2 CONDUIT FASTENINGS

- .1 One hole steel straps to secure surface conduits 50 mm (2") and smaller. Two hole steel straps for conduits larger than 50 mm (2").
- .2 Beam clamps to secure conduits to exposed steel work.
- .3 Channel type supports for two or more conduits.
- .4 Six mm dia threaded rods to support suspended channels.

2.3 CONDUIT FITTINGS

- .1 Fittings: manufactured for use with conduit specified. Coating: same as conduit.

- .2 Factory "ells" where 90° bends are required for 25 mm (1") and larger conduits
- .3 Insulated throat steel set screw or raintight insulated throat steel compression] connectors and couplings for EMT.
- .4 Threaded or compression type raintight/concrete tight insulated throat zinc plated steel connectors and couplings for rigid steel conduit.
- .5 Raintight insulated throat steel connectors at all surface panelboards, switchboards and other electrical equipment in sprinklered areas for all conduit terminations.

2.4 **EXPANSION FITTINGS**

- .1 Electrogalvanized steel with internal grounding for EMT suitable for 100mm linear conduit movement.

Standard of Acceptance

- Cooper Crouse Hinds XJG-EMT
- .2 Weatherproof expansion fittings with internal bonding assembly suitable for 100mm (4") linear expansion.
- .3 Watertight expansion fittings with integral bonding jumper suitable for linear expansion and 19 mm (3/4") deflection in all directions.
- .4 Concrete type, water tight, corrosion resistant for conduit installations embedded in concrete
- .5 Weatherproof expansion fittings for linear expansion at entry to panel.

2.5 **FISH CORD**

- .1 Polypropylene

PART - 3 EXECUTION

3.1 **INSTALLATION**

- .1 Install conduits to conserve headroom in exposed locations and cause minimum interference in spaces through which they pass.
- .2 Conceal conduits except in mechanical and electrical service rooms and in unfinished areas.
- .3 Use electrical metallic tubing (EMT).
- .4 Use liquid tight flexible metal conduit for connection to motors or vibrating equipment
- .5 Install conduit sealing fittings in hazardous areas. Fill with compound.
- .6 Use raintight connectors or hubs for terminating conduits at all surface or floor mounted panelboards, switchboards, and other equipment located in sprinklered areas or where at risk of exposure to dripping liquids.
- .7 Install wiring in conduit unless otherwise specified.

- .8 Bend conduit cold. Replace conduit if kinked or flattened more than 1/10th of its original diameter.
- .9 Mechanically bend steel conduit over 19mm (3/4") dia.
- .10 Field threads on rigid conduit must be of sufficient length to draw conduits up tight.
- .11 Install fish cord in empty conduits.
- .12 Run two 25 mm (1") spare conduits up to ceiling space and two 25 mm (1") spare conduits down to ceiling space from each flush panel. Terminate these conduits in 152 x 152 x 102 mm) 6" x 6" x 4") junction boxes in ceiling space or in case of an exposed concrete slab, terminate each conduit in flush concrete type box.
- .13 Where conduits become blocked, remove and replace blocked section. Do not use liquids to clean out conduits.
- .14 Dry conduits out before installing wire.
- .15 Conduit manufacturer's touch up enamel shall be used to repair all scratches and gouges on epoxy-coated conduit.
- .16 Install junction boxes or cable anchor boxes wherever necessary for proper pulling or anchoring of cables. Install so as to be accessible after building is completed and set to come within finished lines of building.
- .17 Where EMT is used, run green insulated ground wire in conduit, with minimum one ground conductor per three ungrounded conductors.
- .18 Provide expansion couplings, with bonding jumper and ground clamps where raceways cross building control joints.
- .19 Runs of conduit and cables, where shown, are indicated only by general location and routing. Install conduits and cables so as to provide maximum head room and to interfere as little as possible with free use of spaces through which they pass. They shall be installed as close to building structure as possible such that, where concealed, necessary furring can be kept to a minimum. Arrange conduits, installed in suspended ceilings, to provide minimum interference with removal of tiles.

3.2 **SURFACE CONDUITS**

- .1 Run parallel or perpendicular to building lines.
- .2 Locate conduits behind infrared or gas fired heaters with 1.5m (5') clearance.
- .3 Run conduits in flanged portion of structural steel.
- .4 Group conduits wherever possible on suspended or surface channels.
- .5 Do not pass conduits through structural members except as indicated.
- .6 Do not locate conduits less than 75 mm (3") parallel to steam or hot water lines with minimum of 25 mm (1") at crossovers.

3.3 **CONCEALED CONDUIT**

- .1 Do not install horizontal runs in masonry walls.
- .2 Do not install conduits in terrazzo or concrete toppings.

END OF SECTION

OUTLET BOXES, CONDUIT BOXES AND FITTINGS
26 05 35

PART - 1 GENERAL

1.1 RELATED WORK

- .1 Box connectors to Section 26 27 28.

1.2 REFERENCES

- .1 CSA C22.2 No. 18.
- .2 CSA C22.1 Canadian Electrical Code, Part 1, Ontario Hydro Electrical Safety Code.

PART - 2 PRODUCTS

2.1 OUTLET AND CONDUIT BOXES - GENERAL

- .1 Size boxes in accordance with CSA C22.1
- .2 102 mm (4") square or larger outlet boxes as required for special devices
- .3 Gang boxes where wiring devices are grouped.
- .4 Blank cover plates for boxes without wiring devices.
- .5 Combination boxes with barriers where outlets for more than one system are grouped.

2.2 SHEET STEEL OUTLET BOXES

- .1 Hot dipped galvanized steel single and multi gang flush device boxes for flush installation, minimum size 76 mm x 50 mm x 38 mm (3" x 2" x 1½") or as indicated. 102 mm (4") square outlet boxes when more than one conduit enters one side with extension and plaster rings as required.
- .2 102 mm (4") square or octagonal outlet boxes for lighting fixture outlets.
- .3 102 mm (4") square outlet boxes with extension and plaster rings for flush mounting devices in finished plaster or tile walls.

2.3 MASONRY BOXES

- .1 Hot dipped galvanized steel masonry single and multi gang boxes for devices flush mounted in exposed block walls.

2.4 CONCRETE BOXES

- .1 Hot dipped galvanized sheet steel concrete type boxes for flush mount in concrete with matching extension and plaster rings as required.

2.5 FLOOR BOXES

- .1 Concrete tight hot dipped galvanized sheet steel floor boxes with adjustable finishing rings to suit floor finish with brass or brushed aluminum faceplate. Device mounting plate to

accommodate short or long ear duplex single or receptacles. Minimum depth: 28 mm (1¼") for receptacles; 73 mm (3") for communication equipment.

- .2 Adjustable, watertight, concrete tight, cast floor boxes with openings drilled and tapped for 12 mm (½") and 19 mm (¾") conduit. Minimum size: 73 mm (3") deep.

2.6 CONDUIT BOXES

- .1 Cast FS boxes with factory-threaded hubs and mounting feet for surface wiring of switches and receptacle, outside building and where weatherproof boxes are required.
- .2 Explosion proof boxes in areas indicated on drawings.

2.7 FITTINGS - GENERAL

- .1 Bushing and connectors with nylon insulated throats.
- .2 Knock-out fillers to prevent entry of debris.
- .3 Conduit outlet bodies for conduit up to 32 mm (1½") and pull boxes for larger conduits.
- .4 Double locknuts and insulated bushings on sheet metal boxes.

PART - 3 EXECUTION

3.1 INSTALLATION

- .1 Support boxes independently of connecting conduits.
- .2 Fill boxes with paper, sponges or foam or similar approved material to prevent entry of debris during construction. Remove upon completion of work.
- .3 For flush installations mount outlets flush with finished wall using plaster rings to permit wall finish to come within 6 mm (¼") of opening.
- .4 Provide correct size of openings in boxes for conduit, mineral insulated and armoured cable connections. Reducing washers are not allowed.
- .5 Provide a suitable outlet box for each light, switch, receptacle or other outlet, approved for the particular area in which it is to be installed.
- .6 Locate outlet boxes, mounted in hung ceiling space, so they do not obstruct or interfere with the removal of lay-in ceiling tiles.
- .7 Offset outlet boxes, shown back to back in partitions, horizontally to minimize noise transmission between adjacent rooms.
- .8 Use gang boxes at locations where more than one device is to be mounted. Use combination boxes with suitable barriers where outlets for more than one system are shown.

Where 100 mm (4") square boxes are installed in exposed concrete or cinder block in finished areas, blocks will be cut under masonry division as instructed under this section. Openings shall be cut to provide a close fit to boxes and covers so that edges of openings are not visible after installation of plates. Mortar shall not be used to patch up openings that are cut too large or to patch ragged edges.

END OF SECTION

WIREWAYS AND AUXILIARY GUTTERS
26 05 37

PART - 1 GENERAL

1.1 PRODUCT DATA

- .1 Submit product data in accordance with Section 26 05 01 Electrical General Requirements.

PART - 2 PRODUCTS

2.1 WIREWAYS (LAY-IN CABLE DUCT)

- .1 Fabricated from code gauge sheet steel and complete with hinged covers and standard knockouts on 300 mm (12") centres, unless noted otherwise. Inside and outside shall be treated with a rust inhibiting etching process.
- .2 Finish: **Inside and outside shall be treated with a rust inhibiting process and outside shall be finished in Sherwin Williams Paint, #F65Y4 (Yellow).**
- .3 Elbows, tees, couplings and hanger fittings manufactured as accessories to wireway supplied.
- .4 Cross-section dimensions as indicated.

Standard of Acceptance

- W. C. Pursley Ltd.
- Square D Company Canada Ltd.
- G. A. Harding Ltd.
- Pilgrim technical Products Ltd.

PART - 3 EXECUTION

3.1 INSTALLATION

- .1 Install wireways and auxiliary gutters.
- .2 Keep number of elbows, offsets, connections to minimum.
- .3 Install supports, elbows, tees, connectors, fittings.
- .4 Install barriers where required.
- .5 Install gutter to full length of equipment.

END OF SECTION

SPECIAL HOSPITAL WIRING
26 07 05

PART - 1 GENERAL

1.1 DESCRIPTION

- .1 Patient care areas are as follows:
 - .1 Intermediate Patient Care Areas

PART - 2 PRODUCTS

2.1 RECEPTACLES

- .1 Receptacles connected to the emergency power system shall be coloured red.
- .2 Receptacles in patient care areas shall be Hospital Grade.
- .3 Receptacles in patient care areas shall have a circuit identification lamaroid in accordance with CSA Z32-99 Lamaroid shall be secured to the wall above the receptacle and shall be engraved with panel name and circuit number. Lettering shall be minimum 1/4" (6 mm) high and shall be:
 - .1 Black letter, white lamaroid for normal power
 - .2 Red letter, white lamaroid for emergency power

PART - 3 EXECUTION

3.1 BONDING TO GROUND

- .1 Bonding to ground of receptacles and permanently wired electrical equipment in the patient care areas shall be carried by installing an insulated green equipment bonding conductor in the same conduit as the branch circuit conductors. The bonding conductor shall be terminated in the outlet box and the device at the load end and a ground bar in the panel supplying the equipment or outlet at the source end. A separate bonding conductor shall be provided for each circuit and the bonding conductor shall be sized equal to the branch circuit conductors. In critical care areas the minimum bonding conductor size shall be #10 AWG.
- .2 Where the single phase receptacles in a patient care environment are supplied from two 2-wire branch circuits in the same conduit, a single bonding conductor may be provided for the two circuits.
- .3 Items to be grounded shall include all receptacles, wall-mounted lights and any other equipment located within 1.5 m horizontally from the nominal position of the bed and 2.3 m vertically above the floor.
- .4 Interconnect the ground bus in emergency and normal electrical panels which serve patient care areas with an insulated green copper conductor installed in conduit and sized as in Table 16 of the Electrical Safety Code, but not less than #6 AWG.

3.2 **NEUTRAL CONDUCTORS**

- .1 In both Intermediate Patient Care Areas, a separate neutral conductor shall be provided for each branch circuit phase conductor back to the panel supplying the outlet. Since the neutral is a full current carrying conductor, it is suggested that not more than two beds have a 25 mm conduit home run to the panel to avoid conductor de-rating.

END OF SECTION

WIRING TO MOTORIZED DOORS
26 07 16

PART - 1 GENERAL

1.1 RELATED WORK

- .1 Door control panel will be provided with door. Interconnecting power and control wiring and on-off switch will be provided by Division 26.

PART - 2 PRODUCTS

2.1 DISCONNECT

- .1 On-off switch shall be rated 15A, 120 volt.

PART - 3 EXECUTION

3.1 INSTALLATION

- .1 Provide conduit, wiring and on-off switch for each motorized door. Mount door control panel. Install interconnecting power and control wiring to motor, controller, sensors and limit switches.
- .2 On-off switch shall be mounted in ceiling space above door.
- .3 Wire to fire alarm system to de-energize doors when fire alarm system is activated.

END OF SECTION

SYSTEM COORDINATION, VERIFICATION AND TESTING
26 08 05

GENERAL

GENERAL REQUIREMENTS

Conform to Section 26 05 01, Electrical General Requirements.

PART - 1

WORK INCLUDED

1.1

.1

The Division 26 contractor shall retain and pay for the services of an Independent Testing Organization (ITO) to provide System Co-ordination Study, Verification and On-Site Commissioning Service in accordance with the details specified herein:

1.2

.1

System Co-ordination Study related to the new 208 volt Moulded Case Circuit Breakers being added in the existing 120/208 volt Emergency Power Panel and the 120/208 volt Normal Power Panel

.1

In order to ensure the requirement for independence, the ITO must be retained directly by the Division 26 contractor. The ITO must not be retained by an equipment manufacturer or their distributor as part of an equipment package.

.2

.3

The Division 26 Contractor shall include in the Bid Amount the cost for the services of tradesmen to handle equipment, make temporary connections, operate equipment and make repairs and adjustments and assist the testing organization's on-site specialists during the on-site pre-service inspection, testing, calibration, on-site witness testing and supplementary Commissioning phase of the work and as required by the Consultant until the equipment and systems are accepted by the Owner.

1.3

APPROVED TESTING ORGANIZATIONS

System co-ordination and verification shall be done by a firm with detailed knowledge of the complete Sunnybrook Health Sciences Centre's K Wing Electrical Distribution System. System co-ordination and verification agent shall, to maintain consistency of engineering studies completed for other K Wing projects and for records consistency be:

PART - 2

2.1

Haronitis and associates ltd. (905-474-0800) - haronitisandassociatesltd@bellnet.ca.

.1

PRODUCTS

.2

PRELIMINARY CO-ORDINATION STUDY

.3

Include liaison with the equipment manufacturers to obtain appropriate information and to recommend appropriate devices to obtain co-ordination of the system, immediately after award of Contract.

For the new 208 volt Systems, investigate the overcurrent settings and determine the correct setting.

The recommended breaker settings should be documented in a report format and submitted as a shop drawing for review by the Consultant within 2 weeks of award of Contract. The purpose of this report is to allow the breaker to be released to production.

PRE-SERVICE ON-SITE INSPECTION, TESTING OF EQUIPMENT AND DEVICES

Upon Completion of the installation and prior to energization of components and systems, perform a complete inspection and testing to verify phase and polarity match of feeders with equipment and the tightness of power wiring terminations.

In addition perform the following tests and functions:

2.2

.1

Power Feeders

(a) Thorough physical inspection

.2

(b) Insulation resistance of the feeder

.1

(c) Polarity and rotation tests of power terminations

EXECUTION

TESTING, ADJUSTING AND VERIFICATION

PART - 3

3.1

Provide necessary test equipment, material, labour and miscellaneous services during the testing, adjusting, verification and commissioning procedure.

.1

REPORTS

3.2

Completed Study and Test Report shall be submitted simultaneously to the Consultant as well as part of the requirements of the Maintenance Manuals.

END OF SECTION

ARC FLASH ANALYSIS

26 08 06

PART - 1 GENERAL

1.1 GENERAL REQUIREMENTS

Conform to Sections of Division 1 as applicable.
Conform to Section 26 05 01, Electrical General Requirements.

1.2 WORK INCLUDED

The Division 26 contractor shall retain and pay for the services of an Independent Testing Organization (ITO) to provide Arc Flash Analysis in accordance with the details specified herein:

- provide ARC FLASH ANALYSIS for the existing 600 volt Power Distribution Panels and the new 120/208 volt Electrical Panels

1.3 APPROVED TESTING ORGANIZATIONS

ARC FLASH ANALYSIS shall be done by a firm with detailed knowledge of the complete Sunnybrook Health Sciences Centre's T Wing Electrical Distribution System. System co-ordination and verification agent shall, to maintain consistency of engineering studies completed for other M Wing projects and for records consistency be:

Haronitis and associates ltd. (905-474-0800) - haronitisandassociatesltd@bellnet.ca.

2.1 Arc Flash Hazard Analysis

.1 Definitions

.1 Electrical Hazard

.1 A dangerous conduction such that contact or equipment failure can result in electrical shock, arc flash burn, thermal burn, or blast.

.2 Electrical Safety

Recognizing hazards associated with the use of electrical energy and taking protections so that hazard do not cause injury or death.

.3 Flash Hazard Analysis

A study investigating a worker's potential exposure to arc flash energy, conducted for the purpose of injury prevention and the determination of safe work practices and the appropriate levels of PPE.

.4 Flash Protection Boundary

An approach limit at a distance from exposed live parts within which a person could receive a second degree burn if an electrical arc flash were to occur.

.5 Flame Resistant(FR)

The property of a material whereby combustion is prevented, terminated, or inhibited, following the application of a flaming or non-flaming source of ignition, with or without subsequent removal of the ignition source.

.2 Provide Arc Flash Hazard Analysis performed according to IEEE 1584 equations that are presented in NFPA70E-2004, Annex D.

.3 When appropriate, the Short Circuit calculations and clearing times of the Phase Over-current Devices shall be referenced.

.4 Safe working distances shall be determined and identified for the calculated fault locations based on the calculated arc flash boundary considering an incident energy of 1.2 cal/ cm squared.

.5 The Arc Flash Hazard Analysis shall include calculations for maximum and minimum contributions of fault current magnitude. The minimum calculation shall assure that the utility contribution is at a minimum and shall assume a minimum motor load. Conversely, the maximum

calculation shall assume a maximum contribution from the utility and assume motors are operating under full load conditions.

.6 Arc Flash computation shall include both line and load side of main breaker calculations where necessary.

.7 Arc Flash calculations shall be based on actual over-current protective device clearing time. Maximum clearing time will be capped at two seconds based on IEEE 1584-2002, Section B.1.2.

.8 Incident Energy and Flash Protection boundary calculations

- .1 Arc Fault magnitude
- .2 Device clearing time
- .3 Duration of Arc
- .4 Arc Flash boundary
- .5 Working Distance
- .6 Incident Energy
- .7 Hazard Risk Category
- .8 Recommends for Arc Flash Energy reduction

.9 RECOMMENDATIONS

.1 Provide recommendations as follows:

- .1 Approach Boundaries
- .1 Approach Boundaries shall be calculated and labels prepared and affixed to each piece of electrical equipment covered by this study as follows:
 - .2 Flash Hazard Protection Boundary:
 - .3 Limited Approach Boundary:
 - .4 Restricted Approach Boundary:
 - .5 Prohibited Approach Boundary:
 - .6 Recommend Personal Protective Equipment
 - .7 When an employee is working within the Flash Protection Boundary, he/she shall wear protective clothing and other personal protective equipment.
 - .8 The required minimum arc rating of PPE : xxx Cal/CM2
 - .9 Hazard/ Risk Category
 - .10 Shock Hazard when cover is removed
 - .11 Arc flash label:
 - .11 Personal Protective Equipment
 - .12 Non-melting(according to ASTM F1506-00) or Untreated Natural Fiber(100% cotton):
 - (a) Shirt
 - (b) Pants
- .13 FR Clothing
 - a) Shirt: and pants
 - b) Coverall:
 - c) Jacket, parka, or rainwear:
- .13 FR Protective Equipment:
 - a) Head protection hard hat:
 - b) Face, head, eye and ear area protection shall be: xxx
 - c) leather gloves: Class xxx
 - d) leather work shoes

2 EXECUTION

3.1 Arc Flash Hazard Analysis

- .1 Arc Flash Warning Labels
 - .1 Provide minimum 88mm x 125 (3.5" x 5") thermal transfer type labels of maximum adhesion polyester for each arc flash hazard location addressed in the Arc Flash Hazard Analysis.
 - .2 Labels shall have an orange coloured header reading "WARNING, ARC FLASH HAZARD" and shall include the following information:
 - .1 location designation
 - .2 nominal voltage
 - .3 Flash Protection boundary
 - .4 Hazard Risk category
 - .5 Incident Energy
 - .6 Working Distance
 - .7 Engineering Report identification including Revisions and Date
 - .3 Labels must be machine printed with no field markings
 - .4 Arc Flash labels shall be provided in the following manner and all labels shall be based on the recommended over-current device settings:
 - .1 new Arc Flash Labels shall be provided for all new on-floor Electrical Panels.
- .5 Labels shall be field installed by the specialty agent during Start-up, Acceptance Testing.

END

**TESTING OF INTEGRATED ELECTRICAL LIFE SAFETY AND FIRE PROTECTION
SYSTEMS
26 08 11**

1 GENERAL

1.1 Scope

- .1 Provide testing of integrated life safety and fire protection systems and related equipment provided under Divisions 26 to 28 with those provided under other Divisions of the Work, in accordance with specification Section 01 75 11.
- .2 This specification is limited to testing of the interconnections between life safety and/or fire protection systems. Refer to separate technical specification sections for the individual testing and commissioning requirements for those systems.

1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
 - .1 Section 01 75 11 Testing of Integrated Life Safety and Fire Protection Systems
 - .2 Section 26 08 15 Commissioning – Electrical

1.3 Definitions and Abbreviations

- .1 Refer to Section 01 75 11.

1.4 Applicable Codes and Standards

- .1 Installation codes and standards:
 - .1 CAN/ULC-S1001 Integrated Systems Testing of Fire Protection and Life Safety Systems

1.5 Qualified Tradesperson

- .1 Work to be performed by qualified, licensed and recognized firm with an established reputation in this field, using tradesperson holding applicable certificates of competency.

2 PRODUCTS

- .1 Not used.

3 EXECUTION

3.1 General Requirements

- .1 Conduct complete and thorough testing and documentation of the systems interface and integration between various LSFP systems provided under Divisions 26 to 28 and those provided under other Divisions of the Work.
- .2 Include all labor and material as required to participate in and implement the integrated LSFP testing process for equipment and systems provided under Division 26 to 28.

3.2 Integrated Test Plan and Procedures - Development

- .1 Participate in the development of the integrated LSFP test plan and procedures in accordance with the requirements of specification Section 01 75 11.
- .2 Supply manufacturer's operating and testing instructions to the ITC prior to the development of the integration LSFP test plan.

3.3 Integration Test Plan – Implementation

- .1 Complete related LSFP system acceptance testing in accordance with the applicable technical specification sections of Divisions 26 to 28, prior to implementation of integrated LSFP testing. Where acceptance testing of such systems inherently test the LSFP system interconnection(s), such testing is not required to be duplicated for the integrated LSFP testing provided the results of the integration test are recorded in accordance with the requirements of the integrated LSFP test plan.
- .2 Prior to implementing any integrated LSFP test,
 - .1 provide written confirmation from each trade contractor under Divisions 26 to 28 of the Work, that their respective LSFP related equipment or systems, or parts thereof, have been installed in accordance with the design and are ready for integrated LSFP testing,
 - .2 where applicable, provide test verification reports from the organization that verified the installation of any LSFP system as required by referenced codes or standards, such as NFPA or ULC.
 - .3 provide a copy of any inspection report from an authority having jurisdiction governing a LSFP system.
- .3 Coordinate with the ITC and provide all necessary resources to implement the integrated LSFP test plan.

3.4 Final Test Results Report

- .1 The final test report will be prepared by the ITC.

END OF SECTION

TESTING OF HOSPITAL WIRING

26 08 13

PART - 1 GENERAL

1.1 RELATED SPECIFICATION SECTIONS

- .1 Comply with all requirements of Division 1
- .2 Section 26 05 01 Electrical General Requirements

1.2 DESCRIPTION

- .1 Test and check all portions of the electrical system for satisfactory operation. All tests and checks to be done in the presence of the Consultant, suitably logged, tabulated, signed and incorporated into the Operating and Maintenance Brochures. Testing and checking to be carried out under this Contract at no extra cost to Owner. Procedures and tests outlined below are electrical tests required in addition to normal visual and mechanical inspection which shall be carried out prior to placing equipment in service.
- .2 Provide certified copies of all production tests required by CEMA and CSA for all power distribution equipment.
- .3 All work found to be defective as a result of the testing procedures covered by this Section shall be made good at no cost to the Owner and on completion of remedial work the tests shall be repeated. The costs of such second and subsequent tests is the responsibility of the Contractor and is a pre-requisite to establishing "Substantial Completion" as referred to in "Supplementary Instructions to Bidders".
- .4 Give timely notice to the Consultant that the work is ready for testing. The satisfactory completion of all tests is a prerequisite to establishing Substantial Completion of the project.
- .5 Testing of electrical systems shall be done by only one of the following acceptable professional independent testing organizations and one complete copy of all reports, studies and test results shall be submitted directly to the Consultant:
 - .1 Haronitis & Associates
 - .2 Rondar
 - .3 Brosz & Associates
 - .4 Schneider Canada Service
- .6 Refer to CSA Standard Z32 for test circuits.

1.3 REPORTS

- .1 Prepare and submit the following reports. Submit separate reports for each area to suit construction phasing and occupancy requirements within 5 days of completion of testing in each area. Simultaneously submit one copy directly to the Consultant and a further 6 copies to the contractor to be processed as a shop drawing:
 - .1 Conductor Insulation Integrity Test
 - .2 Receptacle retentive force test.
 - .3 Receptacle polarity test.
 - .4 Branch circuit impedance.

- .5 Test of ground point voltage rise under fault conditions at patient and bed locations.
- .6 Potential difference between ground points.
- .2 One complete copy of all reports, studies and test results shall be submitted directly to the Consultant and the Owner along with a certificate, bearing a professional engineer's seal and signature, stating that the installation meets the requirements of the CSA Z32-04 standard, and is suitable for patient use.
- .3 Submit additional copies of all reports, studies and test results to the contractor for inclusion in the Maintenance Manuals as required under Section 26 05 01.

PART - 2 PRODUCTS

2.1 NOT USED

PART - 3 EXECUTION

3.1 PRELIMINARY CHECKS

- .1 All equipment and devices to be visually inspected and cleaned. Document that all equipment and devices have correct services, connections, settings, supply voltages, alarm circuits, heater elements, etc., and that they are operational and in accordance with the requirements of contract specifications and drawings, and the manufacturers specifications and recommendations.

3.2 ELECTRICAL TESTS

- .1 This Section outlines the tests to be carried out and submitted to the Consultant for approval. Be responsible at no cost to the Owner for rectifying all equipment or installations which do not meet the requirements of the various tests listed.
- .2 The following tests shall be carried out in accordance with the latest edition of CAN/CSA-Z32-04 "Electrical Safety and Essential Electrical Systems in Health Care Facilities":
 - .1 Conductor Insulation Integrity Test
 - .2 Receptacle retentive force test.
 - .3 Receptacle polarity test.
 - .4 Branch circuit impedance.
 - .5 Test of ground point voltage rise under fault conditions at patient and bed locations.
 - .6 Potential difference between ground points.

3.3 CONDUCTOR INSULATION INTEGRITY TEST

- .1 Using a 500V dc megohmmeter, measure the insulation resistance of each branch circuit conductor with all wiring devices connected.
- .2 Isolate the branch circuits under test as required to ensure that other circuits serving patients or sensitive equipment are not exposed to the test voltage.
- .3 Record all results on tests forms.
 - .1 Submit tests forms to Consultant for approval.
 - .2 Where measured values are below the values listed in Z32, the Contractor shall replace the wiring and the independent testing organization shall test the replaced

wiring. This process shall be repeated until satisfactory results are obtained. The cost of such work shall be the responsibility of the Contractor.

3.4 RECEPTACLE RETENTIVE TEST FORCE

- .1 Requirements: A force of 1.1 Newtons shall not remove a test pin from the ground slot of a receptacle. A force of 13.3 Newtons shall not remove a test attachment plug of the same configuration for a receptacle.
- .2 Method: Test pins and methods of test specified in CSA Standard C22.2 No. 42 shall be used. As an alternative, a commercially available "tension tester" complying with CSA Standard C22.22 No. 42, General Use Receptacles, Plugs and Similar Wiring Devices may be employed.
- .3 Implementation:
 - .1 Using tension checker, ensure device has calibration as to tension (Newtons) for single-ground pin and tension (Newtons) for multiple pin testing.
 - .2 For each outlet within a designated area, check tension of ground pin (minimum 1.1 Newtons) and tension of entire plug (minimum 13.3 Newtons).
 - .3 Record go/no go tension reading for each outlet on a per room and branch circuit basis.
 - .4 Replace any receptacle which does not meet the requirements listed in method.

3.5 RECEPTACLE POLARITY TEST

- .1 Requirements: Ensure all receptacles are connected in accordance with configurations listed in Canadian Electrical Code CSA C22.1, latest edition Section 26.
- .2 Method: Utilizing polarity test set, check all receptacles on a room by room basis.
- .3 Implementation: Correct connection of receptacles where polarity indication is incorrect.

3.6 BRANCH CIRCUIT IMPEDANCE TEST (VOLT DROP)

- .1 Requirements:
 - .1 Ensure that all branch circuit wiring from panelboards to receptacles does not exceed a maximum voltage drop of 3% when 80% of the breaker rating is applied at the receptacle. The Contractor shall test all receptacles on a room by room, circuit by circuit basis.
 - .2 The equipment to be utilized by the Contractor for this test shall be approved by the Consultant. See Figure 1 in standard sheet "Test Circuit Configurations" for test circuit.
- .2 Method:
 - .1 Ensure that all circuits other than the one under test are de-energized.
$$\frac{V_o - V_L}{V_o} \times 100$$
 - .2 Record no load voltage at receptacle (Vo).
 - .3 Apply current to 80% of the rating of the overcurrent device protecting the circuit under test record voltage (VL).
 - .4 Remove load and reconfirm value of Vo.

- .5 Calculate voltage drop at receptacle by the formula:
- .3 Implementation:
 - .1 Record all results on tests forms.
 - .2 Submit tests forms to Consultant for approval.
 - .3 Where volt drop exceeds 3% by calculation in method, the Contractor shall take all necessary steps to reduce the voltage drop to the required value. The cost of such work shall be the responsibility of the Contractor.

3.7 **GROUND POINT VOLTAGE RISE**

- .1 Requirements: Bonding conductors shall be sized and installed so as to limit the voltage rise at the ground point of any receptacle within a patient care area to 3 V when tested. Bonding conductors for branch circuits shall be insulated.
- .2 Method: Using the test circuit of Figure 3 in standard sheet "Test Circuit Configurations":
 - .1 Connect the test circuit to the outlet. With switch SW open, record the voltage indicated by voltmeter V1 as VN, the neutral to ground voltage without load. If it exceeds about 2 V, determine the cause and correct the defect.
 - .2 Using the low voltage supply, (nominally 5 V open circuit) apply a load of 80% of the rated current of the circuit, between the neutral and the bonding conductor for a period of from 1 to 5 s. To ensure accuracy, the low voltage supply should be energized from a circuit other than the one being tested. Record the current I, the voltage indicated by voltmeter V1 as VR, and the voltage indicated by voltmeter V2 as VO.
- .3 Implementation
 - .1 Record all results on tests forms. Submit test forms to Consultant for approval.
 - .2 The return path voltage rise VO shall be not greater than 3 V where voltage rise exceeds 3 V. The Contractor shall take all steps necessary to correct the situation.

3.8 **POTENTIAL DIFFERENCE BETWEEN GROUND POINTS**

- .1 Requirements: The maximum potential difference between the grounding poles of all receptacles at a patient care location and between these poles and all other exposed conductive non-current-carrying parts at the same patient care location, shall be:
 - .1 less than 20 mV in Basic Care Areas
 - .2 less than 20 mV in Intermediate Care Areas; and
 - .3 less than 10 mV in Critical Care Areas
- .2 Method:
 - .1 Using the standard frequency-weighted test circuit of Figure 2 in standard sheet "Test Circuit Configurations", the following test procedure shall be performed.
 - .2 Confirm that all receptacles have been installed and that no utilization equipment, either permanently wired or cord-connected, is connected to the system.
 - .3 Energize the system.
 - .4 Select a local reference point known to be bonded to ground and record the measured voltage between this chosen reference and each receptacle ground pole and each exposed conductive non-current-carrying metal part in turn. If the test

leads are long, the readings should be corrected for pickup (zero reading) when connected together.

- .3 Implementation:
 - .1 Using the standard frequency-weighted test circuit of Figure 2 in standard sheet "Test Circuit Configurations", the procedure shall be carried out.
 - .2 The voltage measured shall meet the requirements above.
 - .3 Record all results on tests forms and submit test forms to Consultant for approval.

END OF SECTION

ELECTRICAL COMMISSIONING

26 08 15

PART - 1 GENERAL

1.1 SCOPE

- .1 The Hospital will retain an Independent Commissioning Agent (CA) who will provide actual Commissioning Services including witness Testing and Commissioning Services as required.
- .2 Include all labor and material as required to participate in the commissioning process, as outlined in this section, for equipment installed under Division 26.

1.2 WORK INCLUDED

- .1 Commissioning work of Division 26 includes, but is not limited to:
 - .1 Participation in regular construction meetings as well as separate Commissioning Meetings during the construction period associated with the scheduling, coordination, and implementation of the various commissioning activities within the overall construction program.
 - .2 Site Testing and start-up of equipment.
 - .3 Detailed acceptance testing as described under various equipment specifications including supplementary testing required by Commissioning Authority
 - .4 Cooperation with the Commissioning Authority in developing and implementation of the commissioning plan.
 - .5 Providing qualified personnel for participation in implementing commissioning test procedures.
 - .6 Providing equipment, materials, and labor as necessary to correct construction and/or equipment deficiencies found during the commissioning process.
 - .7 Providing operation and maintenance manuals, and as-built drawings to the Commissioning Authority for verification in a timely manner.
 - .8 Providing training and demonstrations for the systems specified in this Division prior to turnover to Owner.
- .2 Conduct complete and thorough evaluation and documentation of the operation and performance of all components, systems, and sub-systems, including the following equipment and systems:
 - .1 Fire Alarm System Verification
 - .2 Nurse Call System Verification
 - .3 Security System Verification
 - .4 Emergency Battery Lighting System Verification

Note:

All of the above Electrical Systems are to be tested/ verified by this Contractor. Commissioning Scope is to ensure the work is completed and acceptable. Requires some active witnessing of some testing.

PART - 2 PRODUCTS (NOT USED)

PART - 3 EXECUTION

3.1 COMMISSIONING MEETINGS

- .1 Participate in periodic commissioning team meetings, and trade commissioning meetings.
- .2 Construction and Post-Construction:
 - .1 participate in commissioning meetings as scheduled by the General Contractor.
 - .2 participate in trade commissioning meetings as required, in addition to the regular commissioning team meetings,
 - .3 identify to the commissioning group problems relating to the commissioning schedule, identification of start-up issues, etc, and participate in the resolution of these problems.

3.2 COMMISSIONING PROCEDURES

- .1 The Owner's designated Commissioning Authority provides the commissioning procedures (checklists, etc) for use by the contractor.
- .2 Each commissioning procedure tests the equipment and systems, and consists of the following elements:
 - .1 Document sign-off
 - .2 Pre-start and Initial test
 - .3 Installation Verification - Equipment
 - .4 Installation Verification - Systems
 - .5 Performance Validation
- .3 Document Sign-Off:
 - .1 each completed procedure is signed off by the following parties:
 - (a) Contractor, for testing,
 - (b) Commissioning Consultant, for review and witnessing,
 - (c) Owner, for test acceptance.
- .4 Installation Verification - Equipment
 - .1 Checklists to verify the installation of equipment, including: design specification requirements, drawing requirements, manufacturer installation requirements, and other experience-related items.
 - .2 Use of pre-printed manufacturer installation and start-up checklists are permitted and encouraged; however, the commissioning procedure checklists may contain supplemental items.

- .5 Installation Verification - System: Checklists to verify the installation of the system associated with the equipment.
- .6 Performance Validation: Specific test procedures and record documentation requirements for performance measurements of the various systems.

3.3 COMMISSIONING TEST METHODOLOGY

- .1 Step 1 : Notify the Commissioning Consultant in accordance with an agreed schedule and notification period when testing will begin on each procedure type. The Commissioning Consultant will witness the testing on an audit basis, including the first instance, the last instance, and at random during other times.
- .2 Step 2 : complete the commissioning procedures including recording results, and sign-off and date separately the completion of Part "A" Verification, and Part "B" Validation. Any deficiencies discovered during this testing are to be corrected prior to sign-off of the test.
- .3 Step 3 : on completion of systems which do not require witness demonstration, finalize the report and submit to the Commissioning Consultant and the Consultant for review.
- .4 Step 4 : on completion of systems which have been witnessed by the Commissioning Consultant, the Commissioning Consultant is to sign-off the completed procedure document as being witnessed.

3.4 COMMISSIONING IMPLEMENTATION

- .1 Conduct operating tests and checks to verify that all components, equipment, systems, and interfaces between systems, operate in accordance with contract documents.
- .2 Demonstrate and verify operating modes, interlocks, specified control sequences, specific responses to abnormal or emergency conditions, and verification of the proper response to the Building Automation System, security system, and fire alarm system as applicable.
- .3 Roles and Responsibilities:

Organized by:	General Contractor
Test sheets provided by:	Commissioning Authority
Testing Conducted by:	Division 26 Contractors Equipment Suppliers Technical Personnel as appropriate Independent Testing Agent as specified
Testing recorded by:	Division 26 Contractors Equipment Suppliers Technical Personnel as appropriate Independent Testing Agent as specified Commissioning Authority
Tests witnessed by:	Commissioning Consultant Owner (selected tests)
Reports reviewed by:	General Contractor Commissioning Consultant Design Consultant Owner / Commissioning Authority
Reports Accepted by:	Owner

3.5 OPERATING CHECKS

- .1 The Commissioning Consultant witnesses selected equipment and system tests on an audit basis.
- .2 Set the system equipment into operating mode to be tested including but not limited to:
 - .1 Normal start up, operation, and shut-down
 - .2 Normal auto position
 - .3 Normal manual position
 - .4 Unoccupied cycle
 - .5 Emergency power operation, including transition states.
 - .6 Status and Alarm conditions
- .3 Inspect and verify the position of each device and interlock identified on the checklist.
- .4 Repeat the above tests for each operating mode that applies to the system being tested.
- .5 For failed test items, provide appropriate comments to the checklist data sheet and classify whether it is a "Major" or "Minor" deficiency.
 - .1 The Consultant retains the right to make the final decision regarding classifications of deficiencies.
- .6 Test failure is defined as:
 - .1 Refer to relevant specification sections.
- .7 Acceptance
 - .1 The final reports will be reviewed by the Commissioning Consultant and the Consultant, to determine if verification is complete and the operating systems are functioning in accordance with the contract documents.
 - .2 The Commissioning Consultant, in conjunction with the Consultant, reviews and makes final classification of all noted deficiencies. Correct deficiencies classified as "Major" before acceptance of the Verification stage.
 - .3 The Owner will make the final acceptance of test results.

3.6 PERFORMANCE VALIDATION TESTING

- .1 Conduct performance tests and checks to validate that equipment and system components are providing the required performance (capacity) for each equipment and system.
- .2 Special testing requirements:
 - .1 Conduct acoustic measurement tests outside the building when generators are running, in accordance with local noise by-law procedures.
 - .2 Conduct acoustic measurement tests inside of generator room when generators are running.

3.7 PROBLEM RESOLUTION

- .1 In the event that additional work is required to either correct systems, misapplied or improperly installed equipment, and/or deficient performance under varying load conditions, assist the Owner and Commissioning Consultant in developing an acceptable resolution to the problem, including the resources of equipment suppliers.

- .2 The Owner has final approval over any additional work required to achieve the required level of performance.
- .3 Complete corrective work in a timely fashion to permit the completion of the commissioning process.

3.8 **ACCEPTANCE**

- .1 Any identified deficiencies will be reviewed by the Consultant in conjunction with the General Contractor/Construction Manager to determine if correction of the deficiency is as a result of a defect in the equipment or installation.
- .2 If it is determined the performance deficiency is as a result of a defect in the equipment or its installation, rectify the deficiency and repeat the performance test until the required performance levels are achieved.
- .3 If it is determined the equipment or system has been constructed in accordance with the contract documents, the Owner will decide whether to accept the performance as is, or, direct the installation contractor to make changes to the system as required to obtain performance levels which meet the design intent, and retest the system.

3.9 **POST-SUBSTANTIAL PERFORMANCE COMMISSIONING**

- .1 Provide commissioning after Substantial Performance:
 - .1 Performance testing which is weather or live-load dependent;
 - .2 For out-of-season system performance testing, conduct initial performance tests to demonstrate off-peak load performance. Schedule peak load performance testing over the succeeding nine (9) months to ensure all equipment is tested at peak load prior to the expiry of the warranty period.
 - .3 Infra-red thermal imaging of equipment under peak building live-load conditions,
 - .4 90 day security system testing,
 - .5 Alternatively, provide temporary equipment (load banks, etc) to simulate full load conditions. Submit proposed methodology for review by the Commissioning Authority and Consultant.

3.10 **ADDITIONAL COMMISSIONING**

- .1 Additional commissioning activities may be required after completion of system performance testing. Include in the tender cost a reasonable reserve to complete this work, including assistance from manufacturers' service technicians.

3.11 **SYSTEMS OPERATING MANUALS**

- .1 Provide Operating and Maintenance Manuals in accordance with the requirements of section 16010.
- .2 The Systems Operating Manuals (SOM) are in addition to the Operating and Maintenance Manuals (OMM) required under Section 16010.
 - .1 Provided by Commissioning Authority and/or Consultant.

3.12 **TRAINING**

- .1 Equipment Training:
 - .1 Provide equipment training in accordance with Section 26 05 01 and the relevant equipment specification sections. The manufacturer's representative training will emphasize operating instructions and preventative maintenance.[]
- .2 Systems Training:
 - .1 In addition to the equipment training described above, provide additional training to describe the operational requirements and design intent of each system.
 - .2 Include classroom instruction, delivered by competent instructors. Place emphasis on overall systems diagrams and descriptions, and design criteria and conditions.
 - .3 If required, obtain and pay for the services of the Design Consultant to provide the instructor services and to provide lecture material for inclusion in the training manual.
 - .4 Training topics to include:
 - (a) Types of installed systems
 - (b) Design intent and design criteria
 - (c) Design constraints
 - (d) Different operating modes – occupied, unoccupied, emergency conditions, etc.
 - (e) Seasonal operating modes
 - (f) Energy efficiency
 - (g) System operation
 - (h) Automatic controls
 - (i) Service, maintenance, diagnostics and repairs
 - (j) Use of reports and logs
 - (k) Troubleshooting
 - .5 Structure each session to start with the classroom instruction for the overall system, followed by hands-on instruction for each equipment, with the services of the manufacturers' representative as required. Demonstrate the start-up and shut-down of each system.
 - .6 Organize and schedule each training session to deliver the required instruction in an efficient and effective manner on a schedule agreed upon with the Owner. Allow for two (2) training sessions for each topic, separated by approximately one week each, to allow for shift coverage.
 - .7 Structure each training session based on type of maintenance personnel attending the training session, ie. Plumbers, fitters, general maintenance, controls technicians, etc. Develop the proposed training plan and obtain approval from the Owner before commencing the training.
 - .8 Complete the training as close to Substantial Performance as possible, so that the Owner's operations staff are prepared to operate the system after Substantial Performance is certified.

- .3 Training Manuals
 - .1 Provide training material hand-outs for each session.
 - .2 Collect training material and bind into separate binders.

END OF SECTION

PROJECT CLOSE-OUT ELECTRICAL
26 08 19

PART - 1 GENERAL

1.1 SCOPE

- .1 Provide documentation deliverables at completion of the Work.

1.2 SUBSTANTIAL PERFORMANCE

- .1 Complete the Substantial Performance Checklist and submit with required documentation when applying for Substantial Performance of the Work.
- .2 Where the work is sub-divided into separate scopes of Work, each requiring a separate Substantial Performance application, provide a separate checklist for each application.
- .3 Prepare and submit to the Consultant a comprehensive deficiency list of items to be completed or corrected, as part of the application for a review by the Consultant to establish Substantial Performance of the Work, or for each designated portion of the Work in the case of phased Substantial Performance.
 - .1 Failure to include an item on the list does not alter the Contractor's responsibility to complete the Work.
- .4 Within five working days of the Consultant's review report which indicates that Substantial Performance of the Work has been achieved, provide a detailed schedule for completion and/or correction of the Work of all items described in the Contractors' and the Consultants' deficiency list.

1.3 TOTAL PERFORMANCE

- .1 Submit the following documentation with the application for Total Performance. Application for Total Performance cannot be submitted any earlier than the date of Alternate Season testing.
 - .1 Where documentation has already been submitted to the Owner, provide a copy of the transmittal.

SUBSTANTIAL PERFORMANCE APPLICATION CHECKLIST	
Project Name:	
Contract:	
Contract Scope:	
Application Date:	
Signed:	

The following requirements are completed and included in this application. Where documentation has been issued directly to the Owner, a copy of the transmittal is enclosed.

- ☐ Contractor has compiled and submitted a detailed deficiency list, identifying work still to be completed, incomplete, or requires correction.
- ☐ Equipment start-up reports (Interim).
- ☐ Building department inspection reports.
- ☐ ESA field inspection reports.
- ☐ Fire alarm verification certificate.
- ☐ Independent testing company, coordination study and testing reports submitted.
- ☐ Equipment and wiring identification completed
- ☐ Clean-up completed.
- ☐ Spare parts and replacement parts turned over to Owner; transmittal attached.
- ☐ Warranty certificates
- ☐ Operating and Maintenance Manuals, draft, submitted.
- ☐ As-built drawings submitted
- ☐ Training completed and attendance logs submitted.
- ☐ Commissioning reports submitted and reviewed by Consultant

Consultant Review	
Status:	☐ Reviewed ☐ <u>Incomplete or deficient - resubmit</u>
Signed:	
Date:	

TOTAL PERFORMANCE APPLICATION CHECKLIST	
Project Name:	
Contract:	
Contract Scope:	
Application Date:	
Signed:	

The following requirements are completed and included in this application. Where documentation has been issued directly to the Owner, a copy of the transmittal is enclosed.

- ☐ All known deficiencies have been corrected, including latent deficiencies reported by the Owner.
- ☐ Final commissioning reports submitted and accepted by Owner.
- ☐ Operating and Maintenance manuals - finalized and submitted (if final version was issued at time of Substantial Performance indicated here:
- ☐ As-built drawings final version submitted (if final version was issued at time of Substantial Performance indicate here: ☐ Date of delivery: _____

Consultant Review	
Status:	☐ Reviewed ☐ Incomplete or deficient - resubmit
Signed:	
Date:	

END OF SECTION

LIGHTING & RECEPTACLE PANELS
26 27 16

PART - 1 GENERAL

1.1 REFERENCES

- .1 CSA C22.2 No. 29-M1989.

1.2 RELATED WORK

- .1 Plywood Backboard: Section 06 10 00 - Rough Carpentry

1.3 GENERAL REQUIREMENTS

- .1 Conform to Sections of Division 1 as applicable.
- .2 Conform to Section 26 05 01, Electrical General Requirements.

1.4 SHOP DRAWINGS

- .1 Submit shop drawings in accordance with Section 26 05 01 Electrical General Requirements.
- .2 Drawings to include electrical detail of panel, branch breaker type, quantity, ampacity and enclosure dimension.
- .3 Nameplates shall be in accordance with Article "Equipment Identification".

1.5 WORK INCLUDED

- .1 Work to be done under this Section shall include furnishing of labour, materials, and equipment required for installation, testing and putting into proper operation complete systems as shown as specified and as otherwise required.

1.6 OPERATION AND MAINTENANCE DATA

- .1 Provide operation and maintenance data for incorporation into manual specified in Section 26 05 01 Electrical General Requirements.

1.7 MAINTENANCE MATERIALS

- .1 Provide maintenance materials as required and as specified in Section 26 05 01 Electrical General Requirements.

1.8 OPERATING AND MAINTENANCE INSTRUCTIONS

- .1 Provide operating and maintenance instructions as specified in Section 26 05 01 Electrical General Requirements.

1.9 PLANT ASSEMBLY

- .1 Install circuit breakers in panelboards before shipment.
- .2 In addition to CSA requirements manufacturer's nameplate must show fault current that panel including breakers has been built to withstand.

1.10 **IDENTIFICATION**

- .1 Panels shall be identified with lamacoid plate with shall include panel designation 12 mm (½") lettering, voltage and phase 5 mm (¼") lettering and where panel is fed from 5 mm (¼") lettering.

PART - 2 PRODUCTS

2.1 **PANELBOARDS**

- .1 Product of one manufacturer. **Overall Cover shall be hinged to permit access to breakers and wiring compartment.**
- .2 Sequence phase bussing with odd numbered breakers on left and even on right, with each breaker identified by permanent number identification as to circuit number and phase. When numbering breakers, number from top to bottom and from left to right.
- .3 Panelboards: mains, number of circuits, and number and size of branch circuit breakers as indicated.
- .4 Two keys for each panelboard and key panelboards alike.
- .5 Copper bus with neutral of same ampere rating as mains.
- .6 Panels shall be constructed and finished in accordance with details specified in Section 26 27 18 "Panel Trim".
- .7 Panels shall be surface or flush mounted type, as shown.
- .8 Panels shall be dead front type in code gauge steel enclosure.
- .9 Each panel shall be complete with a typewritten directory which shall be mounted inside door with clear plastic cover.
- .10 Panels shall have mains of voltage and capacity, and main and branch breakers and contactors, as shown on the "Lighting and Receptacle Panel Schedule". Spaces shall include the necessary bus work such that Owners, at a later date, need buy only the breakers.
- .11 Breakers shall have bolted type connections.
- .12 **Panels shall include non-automatic Main Breaker and a bus-mounted, 120/ 208 volt, 3 phase, 4 wire, 200,000 ampere maximum surge capacity built-in transient surge suppression device.**
- .13 Panels for 120/208 volts, three phase, four wire systems shall be complete with full size breakers, having a symmetrical interrupting rating of at least 10,000 A.
- .14 Where indicated breakers shall have a ground fault interrupter.

Standard of Acceptance

- **PANELS MUST MATCH EXISTING HOSPITAL STANDARDS AND BE AS MANUFACTURED BY SQUARE D**

2.2 **BREAKERS GENERAL**

- .1 Bolt-on moulded case circuit breaker: quick-make, quick-break type, for manual and automatic operation.

- .2 Common-trip breakers: with single handle for multi-pole applications.
- .3 Magnetic instantaneous trip elements in circuit breakers to operate only when value of current reaches setting. Trip settings on breakers with adjustable trips to range from 5 - 10 times current rating.
- .4 Circuit breakers with interchangeable trips over 150 A.
- .5 Lock-on devices for clock outlet, fire alarm, security systems, battery chargers, door supervisory, intercom, stairway, exit and night light circuits.

2.3 **THERMAL MAGNETIC BREAKERS**

- .1 Moulded case circuit breaker to operate automatically by means of thermal and magnetic tripping devices to provide inverse time current tripping and instantaneous tripping for short circuit protection.

2.4 **TRIM**

- .1 Front panel trim shall be overall hinged type, door within door construction. Trim assembly shall provide hinged access to the internal tub and wiring channels for access to wiring and breaker terminals without removal of the trim assembly. With overall trim assembly closed and secured, a second integral hinged door forming part of the trim assembly shall provide access to the circuit breakers only for opening and closing purposes
- .2 Panels shall be given a rust-resistant treatment to both tub and trim. Locks shall be chrome plated.
- .3 Flush panels shall have concealed hinges and flush type combination lock latch. Doors shall open minimum 135 degrees. Trims shall have fasteners concealed and shall be prime coated to receive room finish paint.
- .4 Surface mounted panels shall be constructed in accordance with CSA Type 2 enclosures with overall door assembly protecting all circuit breakers. Door(s) shall be gasketed, with overhanging drip shield, with T-handle 2 point locking system complete with lock and latch.
- .5 **Panels shall be finished with two coats of paint in accordance with the following Sherwin Williams colour code:**
 - .1 **Normal Power: #F65L7, Pale Blue**
 - .2 **Emergency Power: #F65E37 International Orange**
- .6 Panel locks shall be common to one key throughout project.

2.5 **EQUIPMENT IDENTIFICATION**

- .1 Provide equipment identification in accordance with Section 26 05 01 - Electrical General Requirements.
- .2 Nameplate for each panelboard size 4 engraved, Submit nameplate wording.
- .3 Complete circuit directory with typewritten legend showing location and load of each circuit. Cover directory with a 0.8 mm (1/32") thick clear plastic sheet.
- .4 Nameplates for electrical panels shall indicate panel designation and mains voltage, i.e. 120/208 V, 3 ϕ , 4 W and panel and circuit number from which this panel is fed

PART - 3 EXECUTION

3.1 INSTALLATION

- .1 Locate panel boards as indicated and mount securely, plumb, true and square, to adjoining surfaces.
- .2 Install surface mounted panelboards on plywood backboards. Where practical, group panelboards on common backboard.
- .3 Mount panelboards to height specified in Section 26 05 01 - Electrical General Requirements, or with top of trim at uniform height of 2000 mm (6' -6") or to match door heads or to suit tile layout, or as indicated.
- .4 Co-ordinate panel finish with Room Finish Schedule.
- .5 Deliver ten (10) duplicate keys for panel locks to Owner.
- .6 Connect loads to circuits.
- .7 Connect neutral conductors to common neutral bus with respective neutral identified.
- .8 Provide minimum #6 AWG green insulated copper bonding conductor in conduit to interconnect normal and emergency power panels serving common patient care areas.

END OF SECTION

MULTI OUTLET ASSEMBLIES

26 27 19

PART - 1 GENERAL

1.1 PRODUCT DATA

- .1 Submit product data in accordance with Section 26 05 01.
- .2 Indicate type of multi-outlet assemblies with similar terminology to these documents.
- .3 Product is generally referred to as "Wiremold"

PART - 2 PRODUCTS

2.1 SURFACE RACEWAY FOR WIRING DEVICES

- .1 Two piece assembly manufactured for mounting wiring devices and associated wiring.
- .2 Cross-section dimensions: as indicated.
- .3 Finish: buff enamel.

Standard of Acceptance

- ° Wiremold
- ° Canadian Electric Raceways

2.2 SERVICE POLES

- .1 Service poles shall be constructed of extruded aluminum trim and shall have snap-on covers. Poles shall be complete with necessary hardware for floor and ceiling attachment. Unless otherwise noted, poles shall be suitable for installation against ceiling of 10'-0" $\pm$ 2" (confirm exact floor to ceiling height prior to purchasing).
 - .2 Standard Receptacles in Service Poles raceways are, unless otherwise noted, to be 15/20 ampere type.
 - .3 Service poles minimum 2" square with snap-on covers to provide access to wiring without removing unit. Barrier to isolate Normal Power from Emergency Power where applicable.
 - .4 Service poles with fastening accessories at top of pole to secure to inverted T-Bar ceiling using set screws to permit relocation. Flange at ceiling to conceal wiring.
 - .5 Metal sleeve at bottom of pole to conceal vertical adjustment. Reversible grip-tight devices for carpet and tile floors to prevent movement of poles
 - .6 Service poles for Communications shall have cut-outs for telephone jacks and data outlets as detailed.
-

Standard of Acceptance

- **Canadian Electrical Raceways**
- **Wiremold Canada Inc.**
- **Pilgrim Technical Products**

2.3 WIRING DEVICES

- .1 Wiring devices: as indicated, refer to Section 26 27 26 - Wiring Devices including specified stainless steel cover plates.
- .2 Data Jacks, as indicated, refer to Section 27 15 00 – Communication Cabling

2.4 GROUNDING

- .1 Ground system through raceway separate insulated conductor.

2.5 FITTINGS

- .1 Elbows, tees, couplings and hanger fittings manufactured as accessories to product line supplied.

PART - 3 EXECUTION

3.1 FITTINGS

- .1 Install supports, elbows, tees, connectors, fittings.
- .2 Keep number of elbows, offsets and connections to minimum.
- .3 Install barriers where required.

3.2 WIRING

- .1 Install wiring as indicated.
- .2 Where Normal and Emergency Power wiring are required to “share” the power section, Contractor is to utilize BX Cable to provide the required separation between sources. Cover is to include suitable labeling noting two sources.

2.2 SERVICE POLES

- .1 Service poles shall be constructed of extruded aluminum trim and shall have snap-on covers. Poles shall be complete with necessary hardware for floor and ceiling attachment. Unless otherwise noted, poles shall be suitable for installation against ceiling of 10'-0" ± 2" (confirm exact floor to ceiling height prior to purchasing).
- .2 Standard Receptacles in Service Poles raceways are, unless otherwise noted, to be 15/20 ampere type. Specialized Receptacles in Service Poles (208 volt type) are to be mounted in a surface mounted box to facilitate the actual device..
- .3 Service poles minimum 2" square with snap-on covers to provide access to wiring without removing unit. Barrier to isolate Normal Power from Emergency Power where applicable.
- .4 Service poles with fastening accessories at top of pole to secure to inverted T-Bar ceiling using set screws to permit relocation. Flange at ceiling to conceal wiring.
- .5 Metal sleeve at bottom of pole to conceal vertical adjustment. Reversible grip-tight devices for carpet and tile floors to prevent movement of poles

- .6 Service poles for Communications shall have cut-outs for telephone jacks and data outlets as detailed.
- Standard of Acceptance*
- **Canadian Electrical Raceways**
 - **Dualite Wiring Products**
 - **Wiremold Canada Inc.**
 - **Pilgrim Technical Products**
- .2 Wiring Devices
- .1 Wiring devices, **unless otherwise noted, to be 15/ 20 ampere type as specified** in Section 16141, Wiring Devices (including specified stainless steel coverplates). Provide lamicaid circuit identifiers as specified elsewhere.
- .3 Grounding
- .1 Ground system through raceway separate insulated conductor.
- .4 Fittings
- .1 A full complement of fittings for the surface metal raceway/ Service Poles shall be provided including but not limited to elbows (internal and external), couplings for joining raceway sections, wire clips for holding conductors or cables in place, blank end fittings for closing open ends of raceway, transition connectors to other surface metal raceways and to 12mm to 38mm trade size conduit or armored cable. In addition, device brackets to install two gang devices both horizontally or vertically within the raceway and combination receptacle and telephone outlet covers shall be provided.
- .5 EXECUTION
- .1 Provide surface aluminum raceways/ Service Poles and appropriate fittings for a complete installation. Ensure raceway is painted to a colour as identified by the Consultant. Provide receptacles with stainless steel coverplates as specified elsewhere. Provide lamicaid nameplate for each receptacle identifying panel and circuit number feeding same.
- .2 Provide wiring from receptacles to panel designated and ground outlets throughout.
- .3 Fittings
- .1 Install supports, elbows, tees, connectors, fittings.
 - .2 Keep number of elbows, offsets and connections to minimum.
 - .3 Install barriers where required.
- .4 Wiring
- .1 Install wiring as indicated.

END OF SECTION

WIRING DEVICES

26 27 26

PART - 1 GENERAL

1.1 REFERENCES

- .1 CSA C22.2 No. 111-M1986 Switches.
- .2 CSA C22.2 No. 42-M1984 Receptacles.
- .3 Section 26 28 19 - Ground Fault Circuit Interrupters.

1.2 SHOP DRAWINGS AND PRODUCT DATA

- .1 Submit shop drawings and product data in accordance with 26 05 01 Electrical General Requirements.

1.3 IDENTIFICATION

- .1 Receptacles shall have a circuit identification lamacoid in accordance with CSA Z32 - 09.
 - .1 Lamacoid shall be secured to the wall above the receptacle and shall be engraved with panel name and circuit number from which the receptacle is fed. Lettering shall be minimum 6 mm (¼") high and as follows:
 - (a) normal power: black lettering on white lamacoid.
 - (b) emergency power: red lettering on a white lamacoid.
 - .2 Provide additional lamacoid for dedicated circuit receptacles, of matching colour, indicating the words: "Dedicated Circuit"

1.4 PRE/ POST OCCUPANCY PROVISIONS

- .1 Assuming the Hospital will, as the time for occupancy approaches or even after occupying, resolve that some additional receptacles/ power outlets will be required. Include, in the Contract, the following additional installations:
 - a) **two (2) Emergency Power 15 amp, 120 volt Duplex Receptacles**
 - b) **two (2) Normal Power 15 amp, 120 volt Duplex Receptacles**
 - c) **two (2) 15 amp, 120 volt direct connection outlets**
 - d) **two (2) 15 amp, 208 volt direct connection outlets**
 - e) **one (1) 120-24 volt Power Supplies for "Paper Towel Dispensers"**
 - f) **two (2) LED compatible Dimmers**
- .2 Each component with an average of 50'-0" of wire in conduit installed and terminated at the nearest Electrical Panel will be required. Include outlet box, wire, conduits, face-plates, labels, terminations, testing, and documentation for each. Assume, for bidding purposes, that these can be added at any time during construction including at the end of the construction and in any location as directed on site. Devices not installed at the construction completion are to be turned over to the Hospital as spare parts for future installation.

PART - 2 PRODUCTS

2.1 SWITCHES

- .1 20 A, 120 V, silent, AC type, CSA listed, single pole, double pole, three-way, four-way switches "decorative type".
- .2 Manually-operated general purpose ac switches with following features:
 - .1 Terminal holes approved for No. 10 AWG wire.
 - .2 Silver alloy contacts.
 - .3 Urea or melamine moulding for parts subject to carbon tracking.
 - .4 Suitable for back and side wiring.
 - .5 White coloured "rocker" toggle.
- .3 Toggle operated fully rated for tungsten filament and fluorescent lamps, and up to 80% of rated capacity of motor loads.
- .4 Switches of one manufacturer throughout project.
- .5 Catalogue numbers listed below have been used for convenience only to indicate quality standards:

TYPE	APPROVED CATALOGUE NUMBERS	
	HUBBELL(120 VOLT)	
SINGLE POLE	HBL2121WA	
DOUBLE POLE	HBL2122WA	
THREE-WAY	HBL2123WA	
FOUR-WAY	HBL2124WA	

- .6 Combination switches shall have neon pilot light and jewel on stainless steel plate
- .7 Switches controlling lights on 120 volt emergency circuits shall be with lighted handle as follows:

TYPE	APPROVED CATALOGUE NUMBERS	
	HUBBELL(120 VOLT)	
SINGLE POLE	HBL2121ILWA	
THREE-WAY	HBL2123ILWA	

Standard of Acceptance

- Pass & Seymour
- Harvey Hubbell of Canada Ltd.
- Bryant Electric
- Cooper Wiring Devices
- Leviton

2.2 DIMMER SWITCHES

- .1 Dimmers for use on LED Luminaires shall be equal to Lutron, "Nova Series", LED compatible as noted and white cover plates.
- .2 Matching switches shall be used adjacent to dimmers.
- .3 Where more than one dimmer is shown in the same location, mount dimmers in individual backboxes. Provide matching switches where shown adjacent to dimmers.

2.3 RECEPTACLES

- .1 Receptacles shall be decorator style to be complete with following features:
 - .1 urea moulded housing.
 - .2 Suitable for no. 10 AWG for back and side wiring
 - .3 Break-off links for use as split receptacles.
 - .4 Eight back wired entrances, four side wiring screws.
 - .5 Triple wipe contacts and rivetted grounding contacts.
 - .6 receptacles to be Heavy duty Hospital grade type
- .2 Receptacles of one manufacturer throughout project.
- .3 Receptacles shall be colour coded as follows:
 - .1 Normal power: white
 - .2 Emergency power: red
- .4 Receptacles shall be as shown and as specified. For convenience, only one or two catalogue numbers of manufacturers have been shown.

Standard of Acceptance

- Pass & Seymour
- Harvey Hubbell of Canada Ltd.
- Bryant Electric
- Cooper Wiring Devices
- Leviton

- .1 The receptacles listed below represent the most common configurations available and are not necessarily used on this project. Refer to drawings for types used.
- .2 Duplex receptacle: 15 ampere, 120 volt, grounded CSA Configuration 5-15R:

Standard of Acceptance

TYPE	APPROVED CATALOGUE NUMBERS				
	P & S	HUBBELL	BRYANT	LEVITON	COOPER
STANDARD (NON-DECORA) (HOSPITAL GRADE)	5262 8200	5262 8200	5262 8200	5262 8200	5262 8200
DECORA (HOSPITAL GRADE)	26252 26262HG	2152 2172	9252 9200	5280 16262- HG	6262 8262

- .3 Weatherproof, 15 ampere, 120 volt equal to those above but complete with gasketed cast plate and hinged covers, equal to Leviton No. 4926 (vertical).

- .4 Twistlock receptacle: 15 ampere, 120 volt, grounded CSA Configuration L5-15R

Standard of Acceptance

- Single: Hubbell/P&S/Bryant/Leviton/Cooper 4710
- Duplex: Hubbell/P&S/Bryant/Leviton/Cooper 4700

- .5 Duplex receptacle: 15 / 20 ampere, 120 volt, grounded CSA Configuration 5-20R:

Standard of Acceptance

TYPE	APPROVED CATALOGUE NUMBERS				
	P & S	HUBBELL	BRYANT	LEVITON	COOPER
STANDARD (NON-DECORA) (HOSPITAL GRADE)	5362 8300	5362 8300	5352 8300	5362 8300	5362 8300
DECORA (HOSPITAL GRADE)	26352 26362HG	2162 2182	9352 9300	- 16362- HG	6362 8362

2.4 FLOOR OUTLETS

- .1 Duplex floor receptacles in flush mounted floor box, 15 ampere, 120 volts shall be complete with adjustable, watertight floor boxes, CSA Configuration 5-15R.

Standard of Acceptance

- Hubbell B2431 single gang box (brass)
 - Hubbell B2432 double gang box (brass)
 - Hubbell B2433 three gang box (brass)
- .2 Service fitting for floor receptacle shall be complete with receptacle specified above, unless noted otherwise.

Standard of Acceptance

- Hubbell S3625, duplex screw cover (brass)
- Hubbell S3825, duplex flap (brass)

2.5 COVER PLATES

- .1 Switch, receptacle and other plates shall be smooth white nylon decorative style in finished areas and pressed steel in unfinished areas. Cover plates shall be Hubbell "Style Line" or equal as manufactured by:
- Arrow-Hart of Canada Ltd.
 - Pass & Seymour Inc.
 - Smith & Stone Ltd.
 - Leviton
 - Westinghouse Canada Ltd.
- .2 Cover Plates shall be finished as follows:
- .1 Light Switches: White
 - .2 Receptacles, Normal power: gray
 - .3 Receptacles, Emergency power: red
- .3 Cover plates for wiring devices. Cover plates from one manufacturer throughout project.
- .1 Stainless steel 18-8 chrome metal alloy, Type 302, vertically brushed, 1 mm (1/32") thick cover plates for wiring devices mounted in flush-mounted outlet box.
 - .2 Cast cover plates for wiring devices mounted in surface-mounted FS or FD type conduit boxes.
 - .3 Weatherproof double lift spring-loaded cast aluminum cover plates, complete with gaskets for duplex receptacles as indicated.
 - .4 Weatherproof spring-loaded cast aluminum cover plates complete with gaskets for single receptacles or switches.
 - .5 Letters shall be 6 mm (1/4") high filled with red paint where engraving is indicated. Engraving shall be parallel to finished floor level.

Standard of Acceptance

- Pass & Seymour #93000 Series
- Harvey Hubbell of Canada Ltd. #93000 Series

- Bryant Electric #S600 Series
- Leviton #84000 Series
- Cooper #93000 Series

2.6 GROUND FAULT CIRCUIT INTERRUPTERS

- .1 Units shall be CSA approved Type A.
- .2 Ground fault circuit interrupters (GFCI) shall be complete with receptacle, test feature and reset switch.
- .3 Units shall include a 15A grounded duplex decora receptacle, a button to test operation of unit and current transformer and sensing mechanism. Unit to be complete with suitable outlet box.
- .4 Units in Hospitals to be hospital grade.
- .5 Unless noted otherwise, unit shall trip at 6 mA.
- .6 Where shown in outdoor locations, units shall be enclosed in weatherproof surface-mounted enclosures. In other locations units shall be furnished with stainless steel cover plate.

Standard of Acceptance

- Pass & Seymour 1595HG
- Harvey Hubbell of Canada Ltd. GFR8200 Series
- Bryant Electric GF82 Series
- Leviton 7599-HG
- Cooper VGFH15

PART - 3 EXECUTION

3.1 INSTALLATION

- .1 Switches
 - .1 Install single throw switches with handle in "UP" position when switch closed.
 - .2 Install switches in gang type outlet box when more than one switch is required in one location.
 - .3 Mount toggle switches at height specified in Section 26 05 01 - Electrical General Requirements or as indicated.
- .2 Receptacles
 - .1 Install receptacles in gang type outlet box when more than one receptacle is required in one location.
 - .2 Mount receptacles at height specified in Section 26 05 01 - Electrical General Requirements or as indicated.
 - .3 For each type of receptacle 20 ampere or larger, supply and hand to Owner two heavy duty caps.

- .4 For each type of receptacle 30 ampere or larger, supply and hand to Owner two heavy duty caps.
- .5 Connect receptacle grounding terminal to the outlet box with an insulated green ground strap.
- .6 Exact position of service fittings shall be verified to suit furniture layout.
- .7 Do not mount receptacles directly on a column, unless column has been appropriately furred, to avoid breaking fire barrier.
- .3 Cover Plates
 - .1 Protect stainless steel cover plate finish with paper or plastic film until painting and other work is finished.
 - .2 Install suitable common cover plates where wiring devices are grouped.
 - .3 Do not use cover plates meant for flush outlet boxes on surface-mounted boxes.
- .4 Install explosion proof wiring and devices in hazardous locations of Class, Division and Group as indicated on Drawings.
- .5 Ground fault circuit interrupters:
 - .1 Mount receptacles at height indicated in Section 26 05 01 - Electrical General requirements or as indicated.
- .6 Outlets in Movable Partitions
 - .1 Co-ordinate installation of outlet boxes and conduits with the particular trade involved.

END OF SECTION

OCCUPANCY SENSOR SWITCHES

26 27 27

PART - 1 GENERAL

1.1 GENERAL REQUIREMENTS

- .1 Conform to Sections of Division 1 as applicable.
- .2 Conform to Section 26 01 01, Electrical General Requirements.

1.2 WORK INCLUDED

- .1 Work to be done under this Section shall include furnishing of labour, materials, and equipment required for installation, testing and putting into proper operation complete systems as shown as specified and as otherwise required.

1.3 GENERAL DESCRIPTION

- .1 The Lighting Control System is to be a complete motion sensing system. All components and services described herein are part of the Division 26 scope.
- .2 The system and services are comprised of, but not limited to, the following main components
 - .1 Power and auxiliary relay packs.
 - .2 Ultrasonic Occupancy sensors.

1.4 SHOP DRAWINGS

- .1 Submit shop drawings in accordance with Section 01300 - Shop Drawings, Product Data, Samples and Mock-ups and Section 26 01 01 Electrical General Requirements.
- .2 Drawings to include electrical detail of, relay type and quantity, ampacity, power supplies, enclosure construction and dimensions.
- .3 Submit typical wiring diagrams for all components including, but not limited to, relays, occupancy sensors.

1.5 OPERATION AND MAINTENANCE DATA

- .1 Provide operation and maintenance data for incorporation into manual specified in Section 16010 Electrical General Requirements.

1.6 MAINTENANCE MATERIALS

- .1 Provide maintenance materials as required and as specified in Section 26 01 01 Electrical General Requirements.

1.7 OPERATING AND MAINTENANCE INSTRUCTIONS

- .1 Provide operating and maintenance instructions as specified in Section 26 01 01 Electrical General Requirements.

PART - 2 PRODUCTS

2.1 OVERVIEW DESCRIPTION

- .1 The lighting control system consists of occupancy sensors and auxiliary relay packs.

Standard of Acceptance

- ° **Wattstopper** (or approved equal by Consultant)

- .2 Occupancy sensors, and relay packs shall be mounted in the spaces as indicated. Low voltage wiring from the switches and sensors to the relay packs shall be installed in conduit.

- .3 Each low voltage wire shall be labeled with the relay number at each switch or sensor. Use only properly color coded, stranded #20 AWG (or larger) wire. All relays and switches shall be tested after installation to confirm proper operation and the loads recorded on the directory card in each panel.

2.2 SYSTEM OPERATION

- .1 Lighting in areas shown on drawings is to be turned on and turned off by the occupancy sensors after an adjustable 3 minute to 30 minute delay of no action within the space. The system is to be programmed so if there is activity detected by an occupancy in a room that is accessible via another room(s) and not the corridor, then the lights will remain on the adjacent room(s)

2.3 AUXILIARY RELAY PACKS

- .1 Lighting control relay power packs shall have a 120-24 volt transformer for control of 120 volt lighting.
- .2 The power pack shall be plenum rated with teflon coated low voltage leads and plenum rated plastic housed in a ABS, UL-rated 94V-0 enclosure.
- .3 Switching the relay shall be accomplished with ONE signal wire and a common return. The signal wire shall be able to signal ON and OFF and shall also carry status current that indicates if the relay is ON or OFF.

2.4 EQUIPMENT IDENTIFICATION

- .1 Provide equipment identification in accordance with Section 26 01 01 - Electrical General Requirements.

2.5 SWITCH PLATES

- .1 Select switch plates to suit number of switches as shown on the plans. Up to 3 switches can be installed in a 1 gang box.
- .2 All switch plates are to be made of stainless steel

- .3 Provide switch plates for combination of low voltage switches and line voltage dimmer as shown on the drawings.

2.6 **OCCUPANCY SENSORS**

- .1 All ceiling mounted occupancy sensors to be ultrasonic, equal to Watt Stopper WT or UT-300 series.
- .2 Ceiling sensors shall be sized for the particular room controlled, with sufficient coverage area to permit site adjustment to particular occupancy patterns and room layouts.
- .3 All wall sensors are to be passive inferred, equal to Watt Stopper WA-200 series. Mount sensor at a high level above the latching side of the door. Wall sensors are to be complete with manual override.
- .4 Sensors to be integrated into the system that they can provide both on/off switching or off-only switching.
- .5 All sensors shall be directly compatible with the power and auxiliary relay packs described above and shall wire directly to the relays without any auxiliary components or devices above the ceiling.
- .6 Sensitivity and time delay adjustments shall be readily accessible to the user with LED indication of sensed movement to simplify set up.
- .7 User adjustable time delay shall be from 30 seconds to 30 minutes.

2.7 **SYSTEM START UP SERVICES**

- .1 Manufacturer to provide a factory authorized technician to confirm proper installation and operation of all system components.
 - .1 Typical wiring diagrams for each component.
- .2 Manufacturer to provide, install and commission system programming including:
 - .1 Wiring documentation
- .3 Notify Consultant and Commissioning Agent of testing schedule prior to any testing.

PART - 3 EXECUTION

3.1 **INSTALLATION**

- .1 Provide motion sensing switching of the type designated in locations as shown on the drawings.
- .2 Provide wiring as recommended by the manufacturer. Low voltage wiring to local control devices to be installed in conduit. Adhere to manufacturer's recommendations as to maximum wire length and maximum quantity of relays per switch.

END OF SECTION

WIRE AND BOX CONNECTORS 0-1000 V
26 27 28

PART - 1 GENERAL

1.1 REFERENCES

- .1 CSA C22.2 No.65-93 (R1999) Wire Connectors.
- .2 EEMAC 1Y-2, 1961 Bushing Stud Connectors and Aluminum Adapters (1200 Ampere Maximum Rating).

PART - 2 PRODUCTS

2.1 MATERIALS

- .1 Pressure type wire connectors: with current carrying parts of copper sized to fit copper conductors as required.
- .2 Fixture type splicing connectors: with current carrying parts of copper sized to fit copper conductors 10 AWG or less.
- .3 Bushing stud connectors: to EEMAC 1Y-2 to consist of:
 - .1 Connector body and stud clamp for copper conductors or bars
 - .2 Clamp for copper conductors or bars.
 - .3 Stud clamp bolts.
 - .4 Bolts for copper conductors or bars.
 - .5 Sized for conductors or bars as indicated or required.
- .4 Clamps or connectors for armoured cable, mineral insulated cable, and flexible conduit, as required.

PART - 3 EXECUTION

3.1 INSTALLATION

- .1 Remove insulation carefully from ends of conductors and:
 - .1 Install mechanical pressure type connectors and tighten screws with appropriate compression tool recommended by manufacturer. Installation shall meet secureness tests in accordance with CSA C22.2 No.65.
 - .2 Install fixture type connectors and tighten. Replace insulating cap.
 - .3 Install bushing stud connectors in accordance with EEMAC 1Y-2.
 - .4 Install crimp type connectors.
- .2 Install box connectors.

END OF SECTION

**DISCONNECT SWITCHES UP TO 1000 VOLTS
26 27 33**

PART - 1 GENERAL

1.1 REFERENCES

- .1 CSA C22.2 No. 4-M89 Manual Switches.
- .2 CSA C22.2 No. 39 Fuse Holder Assemblies.
- .3 Section 26 28 13 Fuses - Low Voltage

1.2 GENERAL REQUIREMENTS

- .1 Conform to Sections of Division 1 as applicable.
- .2 Conform to Section 26 05 01, Electrical General Requirements.

1.3 SHOP DRAWINGS AND PRODUCT DATA

- .1 Submit shop drawings and product data in accordance with Section 26 05 01 Electrical General Requirements.
- .2 Nameplates shall be in accordance with Article "Equipment Identification".

1.4 WORK INCLUDED

- .1 Work to be done under this Section shall include furnishing of labour, materials, and equipment required for installation, testing and putting into proper operation complete systems as shown as specified and as otherwise required.

1.5 OPERATION AND MAINTENANCE DATA

- .1 Provide operation and maintenance data for incorporation into manual specified in Section 26 05 01 Electrical General Requirements.

1.6 MAINTENANCE MATERIALS

- .1 Provide maintenance materials as required and as specified in Section 26 05 01 Electrical General Requirements.

1.7 OPERATING AND MAINTENANCE INSTRUCTIONS

- .1 Provide operating and maintenance instructions as specified in Section 26 05 01 Electrical General Requirements.

PART - 2 PRODUCTS

2.1 DISCONNECT SWITCHES

- .1 Fusible and non-fusible disconnect switch in sprinkler proof EEMAC 3 enclosure, size as indicated.
- .2 2 pole or 3 pole as required for single phase or three phase circuits

- .3 2 pole with solid neutral or 3 pole with solid neutral for three wire and four wire circuits with neutral
- .4 6 pole for two speed motor applications
- .5 Provision for padlocking in off switch position.
- .6 Mechanically interlocked door to prevent opening when handle in ON position.
- .7 Fuses: size as indicated, to Section 26 28 13 - Fuses - Low Voltage.
- .8 Fuseholders: suitable without adaptors, for type and size of fuse indicated.
- .9 Heavy Duty, quick-make, quick-break action.
- .10 ON-OFF switch position indication on switch enclosure cover.
- .11 Complete with auxiliary NO/NC contact for hydraulic elevator motors.

Standard of Acceptance

- Square D Company (Canada) Ltd.
- Cutler Hammer
- Siemens Canada Ltd.
- Federal Pioneer Ltd.

2.2 THREE POLE DOUBLE THROW SWITCHES

- .1 Non-fusible manual load transfer switch in sprinkler proof EEMAC 3 enclosure, size as indicated.
- .2 Continuous duty rated and suitable for switching HP loads
- .3 Visible blades for positive indication that switch is in the OFF position
- .4 Provision for padlocking in the centre OFF switch position, and in the ON positions.
- .5 Heavy Duty, quick make, quick break operating mechanism
- .6 Phenolic insulating bases
- .7 Compression lugs for switches over 100A
- .8 Mechanically interlocked door to prevent opening when handle in ON position.
- .9 ON-OFF-On switch position indication on switch enclosure cover.

Standard of Acceptance

- Square D Company (Canada) Ltd.

2.3 EQUIPMENT IDENTIFICATION

- .1 Provide equipment identification in accordance with Section 26 05 01 - Electrical General Requirements.
- .2 Indicate name of load controlled on size 4 nameplate.

PART - 3 EXECUTION

3.1 INSTALLATION

- .1 Install disconnect switches complete with fuses.

END OF SECTION

FUSES – LOW VOLTAGE

26 28 13

1.1 GENERAL

1.2 REFERENCES

- .1 To CAN/CSA Standard C22.2 No. 106-M90.

1.3 SHOP DRAWINGS AND PRODUCT DATA

- .1 Submit shop drawings and product data in accordance with Section 26 05 01.
- .2 Submit fuse performance data characteristics for each fuse type and size above 200 A. Performance data to include: average melting time-current characteristics, I^2t (for fuse coordination), and peak let-through current.

1.4 MAINTENANCE MATERIALS

- .1 Provide maintenance materials in accordance with Section 26 05 01.
- .2 Six spare fuses of each type and size installed up to and including 600 A.

1.5 DELIVERY AND STORAGE

- .1 Ship fuses in original containers.
- .2 Do not ship fuses installed in motor control centres, or disconnect switches.
- .3 Store fuses in original containers in storage cabinet.

PART - 2 PRODUCTS

2.1 FUSES GENERAL

- .1 Fuse type references L1, L2, J1, R1 etc. have been adopted for use in this specification.
- .2 Fuses: product of one manufacturer
- .3 Fuses rated to 600A shall be CSA certified HRCI-J.
- .4 Fuses rated 601A and above shall be CSA certified HRCI-L.

2.2 FUSE TYPES

- .1 HRCI-J fuses, current limiting, time delay, with blown fuse indication

Standard of Acceptance

- Ferraz Shawmut: Amptrap 2000 type AJT
- Bussman: LPJ
- Littlefuse: JTD ID series

- .2 HRCI-L fuses, current limiting, time delay.

Standard of Acceptance

- Ferraz Shawmut: Amptrap 2000 type A4BQ

- Bussman: KRP-C
- Littlefuse: KLPC Series Power-Pro

2.3 FUSE STORAGE CABINET

- .1 Fuse storage cabinet, manufactured from 2.0 mm thick aluminum 750 mm high, 600 mm wide, 300 mm deep, hinged, lockable front access door finished in accordance with Section 26 05 01 - Electrical-General Provisions.

PART - 3 EXECUTION

3.1 INSTALLATION

- .1 Install fuses in mounting devices immediately before energizing circuit.
- .2 Ensure correct fuses fitted to physically matched mounting devices
- .3 Ensure correct fuses fitted to assigned electrical circuit.
- .4 Provide a spare set of six fuses of each size and type installed on the project [and turn over to Owner] [and locate in fuse storage cabinet].
- .5 Mount fuse storage cabinet on wall [in main electrical room] [in maintenance shop] [as directed on site by Owner's maintenance personnel]

END OF SECTION

MOULDED CASE CIRCUIT BREAKERS
26 28 16

PART - 1 GENERAL

1.1 REFERENCES

- .1 CAN/CSA C22.2 No. 5.1. Moulded case circuit breakers.

1.2 GENERAL REQUIREMENTS

- .1 Conform to Sections of Division 1 as applicable.
- .2 Conform to Section 26 05 01, Electrical General Requirements.

1.3 SHOP DRAWINGS AND PRODUCT DATA

- .1 Submit shop drawings and product data in accordance with Section 26 05 01 Electrical General Requirements.
- .2 Nameplates shall be in accordance with Article "Equipment Identification".
- .3 Include time-current characteristic curves for breakers with ampacity of 200 A and over or with interrupting capacity of 22,000 A symmetrical (rms) for 120/208 volt and 25,000 A symmetrical (rms) for 600 volt..

1.4 WORK INCLUDED

- .1 Work to be done under this Section shall include furnishing of labour, materials, and equipment required for installation, testing and putting into proper operation complete systems as shown as specified and as otherwise required.

1.5 OPERATION AND MAINTENANCE DATA

- .1 Provide operation and maintenance data for incorporation into manual specified in Section 26 05 01 Electrical General Requirements.

1.6 MAINTENANCE MATERIALS

- .1 Provide maintenance materials as required and as specified in Section 26 05 01 Electrical General Requirements.

1.7 OPERATING AND MAINTENANCE INSTRUCTIONS

- .1 Provide operating and maintenance instructions as specified in Section 26 05 01 Electrical General Requirements.

PART - 2 PRODUCTS

2.1 BREAKERS GENERAL

- .1 Bolt-on moulded case circuit breaker: quick- make, quick-break type, for manual and automatic operation.
- .2 Common-trip breakers: with single handle for multi-pole applications.

- .3 Magnetic instantaneous trip elements in circuit breakers to operate only when value of current reaches setting. Trip settings on breakers with adjustable trips to range from 5 - 10 times current rating.
- .4 Circuit breakers with interchangeable trips over 150 A.
- .5 25,000 Amps symmetrical interrupting rating at 600 volts

2.2 **THERMAL MAGNETIC BREAKERS**

- .1 Moulded case circuit breaker to operate automatically by means of thermal and magnetic tripping devices to provide inverse time current tripping and instantaneous tripping for short circuit protection.

2.3 **SOLID STATE TRIP BREAKERS**

- .1 Moulded case circuit breaker to operate by means of a solid-state trip unit with associated current monitors and self-powered shunt trip to provide inverse time current trip under overload condition, and long time, short time, instantaneous tripping for phase, ground fault and short circuit protection

2.4 **FEATURES**

- .1 Include
 - .1 on-off locking device
 - .2 handle mechanism

2.5 **ENCLOSURE**

- .1 Mount individually mounted breakers in CEMA 3 enclosure.

PART - 3 EXECUTION

3.1 **INSTALLATION**

- .1 Install circuit breakers as indicated.

END OF SECTION

GROUND FAULT CIRCUIT INTERRUPTERS
26 28 19

PART - 1 GENERAL

1.1 SHOP DRAWINGS AND PRODUCT DATA

- .1 Submit shop drawings and product data in accordance with Section 26 05 01 Electrical General Requirements.

PART - 2 PRODUCTS

2.1 BREAKER TYPE GROUND FAULT INTERRUPTER

- .1 Single or Two pole ground fault circuit interrupter for 15A, 120 or 208V, 1 phase circuit c/w test and reset facilities.

2.2 RECEPTACLE TYPE GROUND FAULT INTERRUPTER

- .1 Unit shall include a 15A grounded duplex receptacle, a button to test operation of unit and current transformer and sensing mechanism. Unit to be complete with suitable outlet box.
- .2 Units in Hospitals to be hospital grade.
- .3 Unless noted otherwise, unit shall trip at 6 mA.
- .4 Where shown in outdoor locations, units shall be enclosed in weatherproof surface-mounted enclosures. In other locations units shall be furnished with stainless steel coverplates.

Standard of Acceptance

- Bryant #GFR82 Series
- Pass & Seymour #2091-S
- Hubbell #GF8200 Series

PART - 3 EXECUTION

- .1 Installation
- .2 Provide dedicated branch wiring neutral conductor for each individual breaker type ground fault interrupter.
- .3 Do not ground neutral on load side of ground fault relay.
- .4 Connect wiring to equipment in accordance with manufacturer's recommendations.

3.2 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section 26 05 01 - Electrical - General Requirements.
- .2 Demonstrate simulated ground fault tests.

END OF SECTION

LIGHTING

26 51 13

PART - 1 GENERAL

1.1 GENERAL REQUIREMENTS

- .1 Conform with the requirements of Section 26 05 01 Electrical General Requirements.

1.2 WORK INCLUDED

- .1 Work to be done under this Section shall include furnishing of labour, materials, and equipment required for installation, testing and putting into proper operation complete Electrical systems as shown, as specified and as otherwise required. Complete systems shall be left ready for continuous and efficient satisfactory operation.

1.3 SHOP DRAWINGS AND PRODUCT DATA

- .1 Submit shop drawings in accordance with Section 26 05 01 Electrical General Requirements - Shop Drawings and Product Data.
- .2 Submit complete photometric data prepared by independent testing laboratory for luminaires where specified, for review by Consultant.
- .3 Photometric data to include:
- .4 Total input watts, candlepower summary, candela distribution zonal lumen summary, luminaire efficiency, CIE type, coefficient of utilization, lamp type and lumen rating in accordance with IESNA testing procedures.

1.4 REQUIREMENTS

- .1 Luminaires shall not be delivered to building or stored therein until dry and protected space is available for proper storage of luminaires.
- .2 Submit samples of luminaires which are not catalogue items for approval. Additional luminaires shall not be manufactured until sample has been approved. Each approved sample shall be retained on job site until final completion of project. Luminaires which do not match quality and workmanship of standard sample will be rejected.
- .3 Finishes of luminaires, as specified in the "Luminaire List" must be maintained. Where the description of the luminaire directs a "colour/ finish to suit Architect" it is to be understood that during construction the final colour/finish will be selected. The Architect must be permitted to make their choice from a standard colour/finish range but the selected colour will apply to all of the particular type of luminaire unless otherwise specified.
- .4 "Allowances" when shown, are in Canadian dollars and cover the cost of the lighting luminaires and lamps. Allowances do not include applicable taxes, delivery to the site, handling, installation, overhead or profit.

1.5 SUBSTITUTIONS

- .1 Luminaires included under this Section are specified by approved manufacturer and type. Furnish equipment, as specified, unless substitutions are mutually agreed upon, as follows:
- .2 During the construction period, no substitutions shall be considered unless compelling reasons are given such as inability to meet delivery schedule. This reason shall not be acceptable if delay is caused by Contractor's failure to order luminaires in accordance with

the schedule. In such cases, it is the Contractor's responsibility to provide luminaires as specified without delay to the project and without additional cost to the Owner.

- .3 Substitutions shall be named, samples, catalogue cuts and complete photometric reports submitted, and cost savings documented. Submit a written request for proposed luminaires to be substituted to Lighting Consultant at least two weeks before the end of the bid period. Make the request an alternate, separate proposal, accompanied by complete descriptive and technical data. Indicate addition or deduction from the base bid. Substitutions proposed less than two weeks before the end of the bid period, or not including proper documentation shall not be considered. Lighting Consultant shall accept or reject proposed substitutions.
- .4 Where proposed substitutions alter functional or visual design, or change the space requirements or mounting details indicated here or on the drawings, detail such changes in the proposal and include costs for revised design and construction for trades involved.
- .5 Reimburse Consultant and Sub-Consultants for costs of evaluating proposed substitutions, after the bid period, whether or not such substitutions are accepted.

PART - 2 PRODUCTS

2.1 GENERAL

- .1 Similar luminaires shall be products of same manufacturer.
- .2 Luminaires shall be suitable for individual or continuous mounting.
- .3 Supply recessed luminaires, where installed in plaster or in acoustic ceilings, complete with plaster trim frame or ring and mounting brackets.
- .4 Fluorescent troffers in ceiling shall be equipped with adjustable mounting brackets.
- .5 Luminaires shall be completely assembled in factory and shall be delivered to building in cartons or in palletized form, as directed.

2.2 LAMPS

- .1 Light Emitting Diodes (Accent/Decorative)
 - .1 Greater than 50 lumens per watt
 - .2 30 to 40 lumens per watt (3200°K)
 - .3 0.5 to 1 watt per LED chip
 - .4 Bin number requirements for colour temperature consistency
 - .5 Maximum temperature at the base of the "LED cap" mounted to the sub-strate shall be controlled to ensure full lamp life.
 - .6 Warranty: 5 years

Standard of Acceptance LED Drivers shall be high frequency to prevent "FLICKER"

Standard of Acceptance - Driver Acceptance

- Advance
- Lite Tech
- VLM (Italy)
- Lumi-Drives (UK)
- Osram

Standard of Acceptance - Lamp Acceptance:

- Cree
- Lumileds
- Nichia
- Osram

2.3 LENSES

- .1 K12 distribution acrylic lenses. 3.2mm (125") thick, shall have a recessed prismatic pattern of 5mm (3/16") square based female cones running 45° to the parallel and perpendicular axis to the panel. Panel shall be made of ultraviolet inhibited injection moulded clear virgin acrylic.
- .2 Panels shall be strain-free and uniform in production. There shall be no fade-outs or streaks to detract from job performance.
- .3 Lenses shall be low brightness, sparkling crystal panel that provides maximum efficiency and good brightness control in the direct glare zone.

Standard of Acceptance

- A.L.P. Lighting and Ceiling Products
- I.C.I. Acrylics Canada Inc.
- Holophane Canada Inc.

PART - 3 EXECUTION

3.1 INSTALLATION

- .1 Locate and install luminaires as indicated.
- .2 Locate hangers on tile centres or intersections. Mount recessed incandescents, troffers and surface mounted luminaires in or on full tiles.
- .3 Verify quantity of luminaires before placing orders.
- .4 Verify ceiling types with the latest revised Architectural Drawings and order luminaires to suit the correct ceiling.
- .5 Check lighting luminaires and mountings for their electrical and physical characteristics in relation to conditions due to building construction and mechanical equipment. Make necessary adjustments to luminaires or hanging arrangement without expense to Owners. Give notification at time of shop drawings and before construction if decision on necessary changes is required.
- .6 Co-operate with other trades to ensure proper installation of lighting luminaires.
- .7 Carefully align luminaires, shown in continuous lines or rows, so that rows appear as straight lines.
- .8 Mount luminaires perfectly level or plumb. Luminaires shall fit tightly to ceiling without showing a space or light leak between frame and ceiling.
- .9 Take down any improperly installed luminaires and re-install without expense to Owner.
- .10 Standard octagonal boxes may be supplied where conduits feeding luminaires in finished areas are exposed on ceiling if hanger canopies entirely cover outlet boxes and are neatly notched for conduit. Otherwise, provide cast conduit outlet boxes with a diameter larger than canopies.

- .11 Attach boxes or hickies directly to poured concrete with 6mm (¼") minimum diameter bolts and lead expansion anchors where luminaires are suspended directly from concrete slabs. Use 8mm (5/16") minimum bolts through precast slabs, welded to 100mm x 100mm (4" x 4") minimum, 3.5mm (10 gauge) plate above slabs.
- .12 Do not mount luminaires above pipes, ducts or equipment. In event of unavoidably tight locations, provide hangers to clear obstructions. Check layouts of other trades on job and plan co-operatively. Luminaires in any room shall hang at one height. Obtain approval before any changes are made to layouts shown
- .13 All luminaires mounted in or on ceilings shall be supported independently of ceiling by means of chains.
- .14 Provide continuous 12mm x 38mm (½" x 1½") channel above the ceiling, where luminaires are suspended or mounted on furred ceilings. Fasten luminaires to channel with two 6mm (¼") minimum diameter studs with minimum 1220mm (4'- 0") on centre.
- .15 Luminaires installed in or on "T" bar ceilings shall be equipped with safety chains anchored in an approved manner to the floor slab or roof structure above. Fluorescent luminaires shall have two chains, each supporting two corners of the luminaire. Chain shall be #10 Tensile jack chain, installed as noted below.
- .16 Chain shall be No. 10 Tensile jack chain, bright zinc coated, with a strength of 180 kg (400 lbs.) where luminaires are indicated to be chain hung. Attachments shall be made using a No. 10 "S" hook. Caddy fasteners may be used where applicable. "S" hooks must be closed after installation.
- .17 Industrial luminaires where suspended shall be 12mm (½") conduit hangers and ARB ball aligners. Length and location shall clear equipment, ducts and pipes. Metal strut (Flexibar or equal) may be used for mounting of luminaires in mechanical areas and electrical rooms.

3.2 **LIGHTING LUMINAIRES**

- .1 Provide lighting luminaires exactly as shown and as specified in the following schedule. Luminaires shall be complete with necessary accessories and lamps at time of acceptance.
- .2 All luminaires shall be ULC or CSA certified.
- .3 Each fluorescent luminaire installed on branch circuits with voltage exceeding 150 volts-to-ground shall be provided with a disconnecting means integral to the luminaire that simultaneously opens all circuit conductors between the branch circuit conductors and the supplying ballast(s) and marked in a conspicuous, legible and permanent, manner adjacent to the disconnecting means, identifying the specific purpose in accordance with the Canadian Electrical Code Part 1 Rule 30-308(4).

3.3 **LUMINAIRE LIST**

- .1 Luminaire manufacturers are listed in alphabetical order and not in order of preference.

Title	Description	Lamp Schedule
LA	Recessed 2'-0" x 2'-0" LED Clean Room Luminaire with painted cold rolled steel housing, painted extruded aluminum door frame allowing for room-side serving and acrylic diffuser Luminaire shall be suitable for installation in a lay-in T-Bar ceiling. Luminaire shall include dimmable LED Driver Voltage: 120 volt Manufacturers: Kenall #CSSGI-22-G-33L-35K8-DIM10-120-2AF-4H-ISO 5-8 Note: Include in the Contract an additional TWO (2) spare Type 'LA' luminaires including installation (include an average of 20'0" of wire in conduit for each additional luminaire and connection to an adjacent circuit). Assume, for bidding purposes, that these luminaires can be added at any time during construction including at the end of the construction and in any location as directed on site. Any luminaires not installed shall be turned over to the Hospital	34 watt, 4065 Lumen, 3500K LED
LA-1	Recessed 2'-0" x 2'-0" LED Clean Room Luminaire with painted cold rolled steel housing, painted extruded aluminum door frame allowing for room-side serving and acrylic diffuser Luminaire shall be suitable for installation in a drywall ceiling. Luminaire shall include dimmable LED Driver Voltage: 120 volt Manufacturers: Kenall #CSSGI-22-D-36L-35K8-DIM10-120-2AF-4H-IP65-ISO 5-8	38 watt, 4692 Lumen, 3500K LED

Title	Description	Lamp Schedule
LB	Recessed 4" (nominal) round LED Clean Room Downlight complete with clear polycarbonate lens and aluminum heat sink Luminaire shall be suitable wet locations and installation in a drywall ceiling. Luminaire shall include dimmable LED Driver Voltage : 120 volt Manufacturer: Kenall #CDL4-FF-2FW-XXX-11L-35K8-CD-G-RIG4-120-DIM1-IP65 Note: Include in the Contract an additional TWO (2) spare Type 'LB' luminaires including installation (include an average of 20'0" of wire in conduit for each additional luminaire and connection to an adjacent circuit). Assume, for bidding purposes, that these luminaires can be added at any time during construction including at the end of the construction and in any location as directed on site. Any luminaires not installed shall be turned over to the Hospital	13 watt, 1231 lumen, 3500 degree K LED
LC	Recessed 2'-0" x 4'-0" LED Clean Room Luminaire with painted cold rolled steel housing, painted extruded aluminum door frame allowing for room-side serving and acrylic diffuser Luminaire shall be suitable for installation in a lay-in T-Bar ceiling. Luminaire shall include dimmable LED Driver Voltage: 120 volt Manufacturers: Kenall #CSSGI-24-G-54L-35K8-DIM10-120-2AF-4H-IP65-ISO 5-8	57 watt, 6796 lumen, 3500 degree K LED

Title	Description	Lamp Schedule
LD	Suspended 3" diameter x 20" high "Matte Black" extruded aluminum LED Luminaire with 12" suspension pendent as required. Luminaire to have powder coated finish as noted Luminaire to be complete with "Bridgelux VERO Series LED Array, 90 CRI" Volt: 120 volt Manufacturer: Altura #P3AUDAL-1-B-20-9-VR15-35K-30-9-VR15-35K-MB c/w frosted acrylic "glow ring" Include in the Contract an additional one (1) spare Type 'LD' luminaires including installation (include an average of 20'0" of wire in conduit for each additional luminaire and connection to an adjacent circuit). Assume, for bidding purposes, that these luminaires can be added at any time during construction including at the end of the construction and in any location as directed on site. Any luminaires not installed shall be turned over to the Hospital	15 Watt, 3500K LED
LE	Wall mounted 8"x 12" x 2" deep (nominal) L.E.D. luminaire sign with custom wording to read as follows: "ROOM OCCUPIED". Luminaire shall be constructed of extruded aluminum. Message shall be red letters screened onto a black background and complete with "black-out" feature. Frame to be black. Verify mounting height with Architect prior to installation. Voltage: 120V Manufacturer: Beghelli #BE2000 "ROOM OCCUPIED" Emergi-lite #CLLPEX52B-120V "ROOM OCCUPIED" Lumacell #LE450SW "ROOM OCCUPIED"/Back/Blank out of face Notes: Luminaire shall have double the amount of LED's that are standard. They will require a strip of High Brightness LED's on the top as well as on the bottom of the interior of the luminaire. Wording must not be visible when light is "off" and must be readily visible when light is "on".	

Title	Description	Lamp Schedule
X	L.E.D. edge lit, wall mounted exit sign, with RECESSED trim plate shall be constructed of brushed aluminum. Faceplate stencil without arrows will be required Voltage: 120 volt Manufacturers: Beghelli "Guida Series" Lumacell "LER 1100 Series" Emergi-lite, Uniglo, Ready-Lite, Dual-lite, Stanpro & Aimlite equal Notes: - Exit sign shall not exceed 5 watts (including transformer). - Exit lights shall be listed to CSA Standard #C860. Note: Include in the Contract an additional TWO (2) spare Type 'X' luminaires including installation (include an average of 20'0" of wire in conduit for each additional luminaire and connection to an adjacent circuit). Assume, for bidding purposes, that these luminaires can be added at any time during construction including at the end of the construction and in any location as directed on site. Any luminaires not installed shall be turned over to the Hospital	
X1	Universal (Running man) green L.E.D. all climate exit sign. The surface mounted exit sign shall be constructed with a polyvinyl chloride enclosure to ensure protection from high abuse environments, vibrations, strong impacts, water and temperature fluctuations. The exit sign shall be surface mounted where shown in drawings. Voltage: 120 volt Manufacturers: Emergi-lite LPEX Series Lumacell LER 3000 Series Equals: Uniglo, Ready-Lite, Dual-lite, Aimlit Notes: - Exit sign shall not exceed 3 watts. - Exit lights shall be listed to CSA Standard #C860.	

END OF SECTION

**UNIT EQUIPMENT FOR EMERGENCY LIGHTING
26 52 00**

PART - 1 GENERAL

1.1 REFERENCE

- .1 CSA C22.2 No. 141 Unit Equipment for Emergency Lighting.

1.2 GENERAL REQUIREMENTS

- .1 Conform to Sections of Division 1 as applicable.
- .2 Conform to Section 26 05 01, Electrical General Requirements.

1.3 SHOP DRAWINGS AND PRODUCT DATA

- .1 Submit shop drawings and product data in accordance with Section 26 05 01 Electrical General Requirements.
- .2 Nameplates shall be in accordance with Article "Equipment Identification".

1.4 WORK INCLUDED

- .1 Work to be done under this Section shall include furnishing of labour, materials, and equipment required for installation, testing and putting into proper operation complete systems as shown as specified and as otherwise required.

1.5 OPERATION AND MAINTENANCE DATA

- .1 Provide operation and maintenance data for incorporation into manual specified in Section 26 05 01 Electrical General Requirements.

1.6 MAINTENANCE MATERIALS

- .1 Provide maintenance materials as required and as specified in Section 26 05 01 Electrical General Requirements.

1.7 OPERATING AND MAINTENANCE INSTRUCTIONS

- .1 Provide operating and maintenance instructions as specified in Section 26 05 01 Electrical General Requirements.

1.8 WARRANTY

- .1 For batteries, the 12 months warranty period is extended to 120 months, with a no-charge replacement during the first 60 months and a pro-rate charge on the second 60 months.

1.9 TESTING

- .1 Conduct witnessed testing of battery lighting systems including disconnecting power to each battery unit for the minimum length of time required for full run down time and verify each and every light head. Record exact length of time the battery maintains the full lighting and "certify" both the battery life and remote lighting operation. Notify Consultant and Commissioning Agent of testing schedule prior to conducting tests.
- .2 Submit test reports directly to the Consultant and the Commissioning Agent.

PART - 2 PRODUCTS

2.1 EQUIPMENT

- .1 Supply voltage: 120 V, AC.
- .2 Output voltage: 12 V DC.
- .3 Operating time:
 - .1 12 volt units: 180 watts for 60 minutes.
- .4 Battery: sealed, maintenance free, lead acid or lead calcium.
- .5 Charger: solid state, multi-rate, voltage/current regulated, inverse temperature compensated, short circuit protected. Unit shall have externally accessible means for testing of unit and shall have two lamps indicating A.C. on, and high charge. Unit shall include a low voltage cut-off protection circuit and self diagnostic auto test.
- .6 Solid state transfer.
- .7 Low voltage disconnect: solid state, modular, operates at 80% battery output voltage.
- .8 Signal lights: solid state, life expectancy 100,000 h minimum, for 'AC Power ON' and 'High Charge'.
- .9 Lamp heads: integral on unit and remote, 360° horizontal and 180° vertical adjustment.
- .10 Lamp type (integral and remote):
 - .1 Finished Areas:
 - (a) Wall mounted adjustable type LED, 12 VDC, glare free mounted in a Lexan cube approximately 113 mm square
- .11 Cabinet: suitable for direct or shelf mounting to wall and c/w knockouts for conduit. Removable or hinged front panel for easy access to batteries.
- .12 Cabinet finish: Painted steel enclosure
- .13 Units shall include "Flasher" remote test system with one hand-held controller.
- .14 Auxiliary equipment for central battery units:
 - .1 Ammeter.
 - .2 Voltmeter.
 - .3 Lamp disconnect switch.
 - .4 Test switch.
 - .5 Time delay relay.
 - .6 Battery disconnect device.
 - .7 ac input and dc output terminal blocks inside cabinet.
 - .8 Shelf.
 - .9 RFI suppressors.

2.2 WIRING OF REMOTE HEADS

- .1 Conduit: type EMT, to Section 26 05 33 - Conduits Fastenings and Fittings.
- .2 RFI suppressors.
- .3 Conductors: RW90 type to Section 26 05 19 - Wires & Cables 0-1000 Volts, sized in accordance with manufacturer's recommendations.

Standard of Acceptance

- Emergi-Lite
- Lumacell Inc.
- Beghelli

PART - 3 EXECUTION

3.1 INSTALLATION

- .1 Provide complete emergency battery lighting system as shown and specified.
- .2 Unless otherwise noted, mount units on the wall 2440mm above floor. Unit shall be hardwired to source. Provide lock-on devices on breakers.
- .3 Where heads are shown remote from unit, provide suitable outlet box at 2440 mm and install head. Connect with conduit to battery and charger unit. Wire size to suit manufacturer's recommendations, but not less than #10 gauge, and for a minimum of 3% voltage drop at remote heads. Ensure remote head wiring lengths are reviewed with manufacturer prior to installation. Voltage drops will be tested by Engineer and Building Inspector. Replace any wiring not passing the 3% voltage drop test with new size and retest.
- .4 Direct heads as indicated. Allow for re-adjustment of head directions as requested by Consultant after completion of emergency light review.

END OF SECTION

INTERCOM SYSTEM
27 05 14

PART 1 - GENERAL

- 1.1 Overview
 - .1 Local Intercom Systems shall consist of Intercom Stations, Power Supply and necessary interconnecting cables. Intercom System shall include communication from the Master Station to each Remote Stations. Master Stations are to include a remote door release control
 - .2 The exterior Station and the Station in the Decontam Room need to be weather-proof.
- 1.2 General Requirements
 - .1 Conform to Sections of Division 1 as applicable. Conform to Section 16010, Electrical General Requirements. The system shall be CSA and/or UL approved Standard 1069 Hospital Signaling Equipment.
 - .2 Transistors, capacitors, integrated circuits, and other components shall not be operated to exceed their rated values. Design systems for 24-hour continuous operation.
- 1.3 Shop Drawings and Product Data
 - .1 Submit shop drawings and product data in accordance with Section 01300 - Shop Drawings, Product Data, Samples and Mock-ups and Section 16010 Electrical General Requirements.
- 1.4 Work Included
 - .1 Work to be done under this Section shall include furnishing of labour, materials, and equipment required for installation, testing and putting into proper operation complete systems as shown as specified and as otherwise required.
 - .2 System as provided by the manufacturers will include the following:
 - .1 Control equipment including auxiliary power supplies.
 - .2 All system equipment and devices.
 - .3 All wiring required for complete system operation.
- 1.5 Operation of the Intercom System
 - .1 To originate a call, a person shall depress a single "call" button.
 - .2 This shall automatically and simultaneously cause the following to occur:
 - .1 Visual and audio signals shall be activated at the remote stations.
 - .2 Visual indication shall be provided at the calling station showing that the call has been placed.
 - .3 Audio & Visual indication shall be provided in the Pharmacy showing that a call has been placed.
 - .4 Necessary circuitry shall be activated to permit a two-way conversation to take place.
 - .3 When the called station is not in a "private" position, it shall now be possible for both parties to engage in a two-way conversation without the need to operate any buttons or controls. At the end of the conversation, either party shall be able to cancel the call.
 - .4 Call cancellation shall be possible by pressing a suitable "Cancel" or "Reset" button, or
 - .5 A called station shall be able to respond to a call by speaking into the built-in speaker microphone

PART 2 - PRODUCTS

- 2.1 Stations
- .1 Stations shall be wall mounted
 - .2 Stations shall incorporate the following features and facilities:
 - .1 Sturdy modern style appearance and colour
 - .2 Solid state circuitry
 - .3 Built-in device to provide tone signal for incoming calls, called station on Privacy, speech channel available.
 - .4 Built-in lights to announce incoming calls or busy exchange.
 - .5 Talk-Listen or Press-To-Talk, Release-To~Listen button.
 - .6 High quality microphone housed behind grille enabling person to answer incoming calls from anywhere within the room.
 - .7 High quality speaker or speakers housed behind grille set to an adequate volume level enabling person called to receive voice message anywhere within the room.
 - .8 Cancel or Release button
 - .9 Privacy button
 - .10 Volume control
 - .11 The exterior Station and the Station in the Decontam Room need to be weather-proof.
- 2.2 Power Supplies
- .1 The operating voltage shall be obtained from a line supply of 100 - 120 volt, 60 Hz and shall permit satisfactory operation of the exchange with line voltage variations of plus and minus 10%.
- 2.3 Wiring
- .1 Provide all wiring, conduits, pull boxes, accessories, required for a complete intercom system as shown on the Drawings and specified herein.
 - .2 No lubricants other than talc shall be used while drawing wires into the conduit. No spliced joints shall be used on wiring.
- 2.4 **Manufacturer / Supplier**
- .1 **The system shall be:**
Aiphone 'JP' Series c/w Video, Intercom & Remote Release Control and be as supplied by: Aatel Communications

PART 3 - EXECUTION

- 3.1 Installation
- .1 Provide a complete intercom system as shown on Drawings and as specified.
 - .1 Wall mounted stations shall be arranged 1350 mm above floor.
 - .2 Install ceiling Speakers/ Microphones flush in the ceiling
 - .3 Wiring to stations shall be installed in conduit in accordance with the recommendations of the equipment supplier. Wiring shall consist of multi-conductor, colour-coded twisted pairs with a PVC outer jacket. Shielded wiring shall be used where recommended by the manufacturer

END OF SECTION

TELEPHONE & DATA RACEWAYS

27 05 28

PART - 1 GENERAL

1.1 SYSTEM DESCRIPTION

- .1 Empty raceways systems shall consist of outlet boxes, cover plates, conduits, pull boxes, fish wires and service poles.
- .2 Empty conduit systems being installed shall be for installation of wiring installed at a later date by communications contractor:
 - .1 Telephone and data communications systems.

1.2 PRE/ POST OCCUPANCY PROVISIONS

- .1 Assuming the Hospital will, as the time for occupancy approaches or even after occupying, resolve that some additional telephone/ data outlets/ monitor/ CCTV/ Security System outlets will be required. **Include, in the Contract, the following additional installations:**
 - **Six (6) typical Data/ VoIP outlets**
 - **one (1) Building Automation System Network Connection outlets**
 - **one (1) WAP Outlet**
 - **one Emergency Telephone (Voice) outlet**
- .2 Each drop with an average of 20m of conduit installed and terminated at the Hub Room will be required. Assume, for bidding purposes, that these can be added at any time during construction including at the end of the construction and in any location as directed on site.

PART - 2 PRODUCTS

2.1 MATERIAL

- .1 Conduits: EMT type, to Section 26 05 33 - Conduits Fastenings and Fittings.
- .2 Junction boxes and pull boxes to Section 26 05 32 - Splitters, Junction and Pull Boxes, Cabinets.
- .3 Outlet boxes, and fittings: to Section 26 05 35 - Outlet Boxes, Conduit Boxes and Fittings.
- .4 Cover plates: to Section 26 27 26 - Wiring Devices.
- .5 Fish wire: polypropylene type

PART - 3 EXECUTION

3.1 INSTALLATION

- .1 Install empty raceway system, including fish wire, outlet boxes, pull boxes, cover plates, conduit, service poles, miscellaneous and positioning material to constitute complete system.
- .2 Verify exact location of outlets to suit furniture layout.
- .3 Fish conduit, clear blockages and outlet and clean out pull boxes at completion of installation. Leave conduit free of water or excess moisture. Install 3 mm (c")

polypropylene pull cord continuously from outlet to outlet, through conduit and fasten at each box.

- .4 Conduit bends shall have a bending radius of not less than ten times conduit diameter. Ream out conduits and identify end with green paint.
- .5 Install additional steel pull boxes in such a manner that, throughout entire system, there shall be not more than two 90 degree or equivalent bends or more than 30 m (100') in each run, so that wire or cables may be pulled in or withdrawn with reasonable ease.
- .6 Minimum space requirements in pull boxes, having one conduit each in opposite ends of box, shall be as follows:

Maximum Size of Conduit in Millimetres (Inches)	Size of Box in Millimetres (Inches)			For each Additional Conduit, Increase Width (Millimetres)Inches)
	Width	Length	Depth	
20 mm (¾")	100 mm (4")	300 mm (12")	75 mm (3")	50 mm (2")
25 mm (1")	100 mm (4")	400 mm (16")	75 mm (3")	50 mm (2")
32 mm (1¼")	150 mm (6")	500 mm (20")	75 mm (3")	75 mm (3")
38 mm (1½")	200 mm (8")	675 mm (27")	100 mm (4")	100 mm (4")
50 mm (2")	200 mm (8")	900 mm (3')	100 mm (4")	125 mm (5")

- .7 Minimum space requirements in pull boxes for 90 degree pulls, shall be as follows:

Maximum Size of Conduit in Millimetres (Inches)	Size of Box in Millimetres (Inches)			For each Additional Conduit, Increase Width Millimetres (Inches)
	Width	Length	Depth	
20 mm (¾")	150 mm (6")	300 mm (12")	100 mm (4")	50 mm (2")
25 mm (1")	200 mm (8")	400 mm (16")	150 mm (6")	50 mm (2")
32 mm (1¼")	250 mm (10")	450 mm (18")	200 mm (8")	75 mm (3")
38 mm (1½")	300 mm (12")	600 mm (24")	250 mm (10")	100 mm (4")
50 mm (2")	350 mm (14")	750 mm (30")	300 mm (12")	125 mm (5")

- .8 Maintain separation of communications conduits to sources of electromagnetic interference as follows:

Item	Minimum Clearance
Fluorescent ballasts	150mm (6")
Conduit and cables used for electrical distribution less than 1kV	300mm (12")
Conduit and cables used for electrical distribution greater than 1kV	1000mm (36")
Motor	1200mm (48")
Transformer	1200mm (48")

- .9 The above tables provides a guideline and at all times the Consultant may advise greater clearances if the currents being carried through these devices are particularly likely to cause interference.
- .10 Interference shall be minimized by ensuring that, wherever possible, communications conductors cross sources of interference at right angles.
- .11 Install cables, conduit and cable tray, etc. along or at right angles to building lines unless impractical to do so. Verify specific cases of deviation in advance with consultant.

END OF SECTION

COMMUNICATIONS CABLING

27 15 00

PART - 1 GENERAL

1.1 GENERAL REQUIREMENTS

- .1 Comply with General Conditions of Contract, Supplementary Conditions and Division 01 - General Requirements.
- .2 Where conflict occurs between Codes, Specification and Drawings, plan and riser, the maximum condition to govern, and the Tender to be based on whichever indicates the greater cost.
- .3 Conform with the requirements of the Electrical Tender Specifications and Drawings.
- .4 **Refer also to Sunnybrook 'Data Centre and Hub Room Access Policy' Appended to this Specification. Refer also to Sunnybrook 'ICN Cable Installation Standards' Appended to this Specification**

1.2 WORK INCLUDED

- .1 Price quotations are to include the furnishing of all materials, equipment, maintenance and training manuals, tools, and the provision of all labor and services necessary or proper for the completion of the work, except as may be otherwise expressly provided in the Contract Documents. The Owner will not be liable for any costs beyond those proposed herein and awarded.
- .2 Work to be done under this Section shall include furnishing of labour, materials, and equipment required for installation, testing and putting into proper operation complete Communications systems as shown, as specified and as otherwise required. Complete systems shall be left ready for continuous and efficient satisfactory operation. Provide equipment, materials, labor, and services not specifically mentioned or shown which may be necessary to complete or perfect all parts of this installation and in compliance with requirements stated or reasonably inferred by the Contract Documents.
- .3 All work shall be performed as per the schedule prepared by the General Contractor. Allow for work to be done after hours and on weekends as dictated by the schedule.
- .4 **Installations in existing Hospital Network Hub Rooms:**
 - .1 **Access to Sunnybrook Hospital Network Rooms is severely restricted and Contractors will not be allowed to access these rooms un-escorted/ un-supervised.**
To complete this installation the following applies:
 - **Contractor must retain the Hospital's Security Department to allow access to and supervise activities of the Contractor while in the Hub Room for any Cable/ Equipment installation in the Hub Room (it is assumed Contractor can install Cabling to a point outside of the Hub Room but can not install the Cable into the Hub Room without Security**

Supervision) and to complete Cable connections and equipment installation (Patch Panels)

- **Arrangements for Security Supervision is to be coordinated directly between Security and the Contractor with the Contractor providing a minimum seven days written request**
- **The Hospital's Security Department will charge the Contractor \$50.00 (fifty dollars) per hour for a minimum four hours at any one time**

.6 AS THE CONTRACTOR IS RESPONSIBLE TO COVER ANY/ ALL COSTS REQUIRED TO RETAIN THE HOSPITAL'S SECURITY GROUP, IT IS STRONGLY RECOMMEND THE CONTRACTOR PROPERLY SCHEDULE THE NEED TO ACCESS HUB ROOMS AND THAT THE TIMES REQUIRING ACCESS BE ACCURATELY INDICATED ON THE PROJECT SCHEDULE

.7 GENERAL:

.1 "CATEGORY 6 CABLING JACKS"

To clarify all Network Type outlets require 'Category 6 Jacks' and 'Category 6 Cabling'. There is no 'Category 5E' jacks/ cabling on this project.

.8 Pre/ Post Occupancy Provisions

.1 Assuming the Hospital will, as the time for occupancy approaches or even after occupying, resolve that some additional telephone/ data outlets/ monitor/ CCTV/ Security System outlets will be required. **Include, in the Contract, the following additional installations:**

- **Six (6) typical Data/ VoIP outlets**
- **one (1) Building Automation System Network Connection outlets**
- **one (1) WAP Outlet**
- **one (1) Emergency Telephone (Voice) outlet**

.2 Each drop with an average of 90m of cables installed and terminated at the Hub Room will be required. Include cable, patch cords, jacks, face-plates, labels, terminations, testing, and documentation for each drop. Assume, for bidding purposes, that these can be added at any time during construction including at the end of the construction and in any location as directed on site. Devices not installed at the construction completion are to be turned over to the Hospital as spare parts for future installation.

1.3 INSTALLATION STANDARDS

.1 The following are typical outlet types used on this project:

- Emergency Telephone (Voice) outlet consisting of a single gang box with one 'RJ-45' voice jack and one 'Cat 3' voice cable in conduit/ wireway system to Telephone backboard
- Wireless Receiver (WAP) outlet consisting of a single gang in-line 'RJ-45' data jack and one 'Cat 6' cable in conduit/ wireway system to Hub Room. Provide a minimum 25'-0" cable coiled in ceiling space to allow flexible location of the receiver.

- typical Data/ VoIP outlet consisting of a single gang box with three 'RJ-45' data jacks (two for "data" and one for "VoIP") and three 'Cat 6' data cables in conduit/ wireway system to Hub Room
 - Data/ VoIP/ Printer outlet consisting of a single gang box with three 'RJ-45' data jacks and three 'Cat 6' data cables in conduit to Hub Room
 - Data/ VoIP/ Printer/ Telephone (could be Fax or Conference Phone) outlet consisting of a single gang box with three 'RJ-45' data jacks, one 'RJ-45' voice jack, three 'Cat 6' data cables in conduit/ wireway system to Hub Room and one 'Cat 3' voice cable in conduit/ wireway system to Telephone backboard
 - CCTV to Network outlet consisting of a single gang box with one 'RJ-45' CCTV jack and one 'Cat 6' data cable in conduit to Hub Room
 - Security System to Network outlet consisting of a single gang box with one 'RJ-45' Security System jack and one 'Cat 6' data cable in conduit to Hub Room
 - Smart Board outlet consisting of a single gang box with one 'RJ-45' data jack and one 'Cat 6' data cable in conduit to Hub Room
 - Alarm outlet consisting of a single gang box with one 'RJ-45' Alarm jack and one 'Cat 6' Alarm cable in conduit to Code White System
- .2 All Data, Monitor, TV, CCTV and Security System outlets shall be PS5+ Gigaflex eight (8) position Cat 6 module.
- .3 All cables shall have "**Category 6**", **white coloured**, eight -24 AWG thermoplastic insulated, solid conductors formed into individually twisted pairs and enclosed in a **CMP (FT-6)** rated thermoplastic jacket and all individual conductors to be insulated with fluorinated ethylene propylene (FEP).
- .4 All drops will be routed through conduit system provided and installed by Division 16 Contractor. If conduits are provide for the entire route of the cable, CMR (FT-4) cable can be used.
- .5 Where cable is run through modular furniture all cables must be protected by spiral wrap from the "service" pole to the furniture race way. The Communication Cabling Contractor is responsible to supply and install spiral wrap.
- .6 All cables will be terminated on flush mount outlets as determined by the type of wall or furniture used.
- .7 All Data/ VoIP Cables must have a orange coloured insert, all Voice Cables must have a blue insert, all TV Cables must have yellow insert, all CCTV to Network Cables and all Security to Network Cables must have white inserts.
- .8 All **Data, CCTV to Network and Security System to Network drops** will terminate on 48 port MDVO modular patch panels completely filled with black EZ MDVO PS5 modular jacks in the telecommunications room as noted on drawings. The number of patch panels will be determined by the total number of data ports that the closet must serve plus 20% space capacity for future use.
- .9 All **Voice drops** will terminate on the BIX blocks. The pigtail cable shall connect voice patch panel with the BIX block on the wall. See Drawings for details.
- .10 All drop locations and quantities to be confirmed prior to the start of the installation.

- .11 Performance of the cables shall comply with the latest draft of ANSI/EIA/TIA-568A Addendum 5 Attenuation and Power Sum Near End Cross Talk (NEXT) parameters for UTP Category 6 cable.
 - .12 For horizontal voice terminations provide spare QCBIX1A4 and QCBIX 1A connectors in any spare or partially filled mount, such that all mounts are completely filled. Use standard BIX single jumper channel layout.
 - .13 The number of patch panels shall be as required for outlets shown on the floor plans plus 20 % spare capacity which shall be provided for the future applications.
 - 14 The communication contractor shall refer to the construction schedule prepared by the General Contractor and include for premium labour costs if required to meet the schedule.
 - .15 Horizontal Data and Monitor cabling will be split and dressed down the back and each side of the Rack, terminating on **Beldon 48 port HD Patch panels**.
 - .16 For horizontal Data terminations, **provide one spare Patch Panel**. For horizontal voice terminations, **provide one spare QCBIX1A4 connector** in any spare or partially filled mount. Use standard BIX single jumper channel layout.
 - .17 The Rack mountable Patch Panels performance shall comply with the latest draft of ANSI/EIA/TIA-568A Attenuation and Power Sum Near End Cross Talk (NEXT) parameters for UTP Category 6 hardware.
 - .18 All Patch Cords shall be factory assembled and not site prepared.
- 1.4 **INSTALLATION REQUIREMENTS, WORKSTATION**
- .1 All Data, Voice, TV, CCTV to Network and Security to Network outlets shall be **Beldon EZ-MDVO RJ45** flush mounted where possible, otherwise a **Beldon** surface mount shall be used unless otherwise indicated on the supplied drawings.
 - .2 The number of patch panels shall be as required for the number of cables shown plus the spare specified.
- 1.5 **INSTALLATION GUIDELINES**
- .1 Codes and Standards
 - .1 All work performed on this project will be installed in accordance with the current edition of the Canadian Electrical Code and all local codes and ordinances, authorities having jurisdiction, and the following standards (including all sub-headings, addenda, and TSBs):
 - ANSI/TIA/EIA-568-B.1, Commercial Building Telecommunications Cabling Standard, Part 1: General Requirements, 2001.
 - ANSI/TIA/EIA-568-B.2, Commercial Building Telecommunications Cabling Standard, Part 2: Balanced Twisted-Pair Cabling Components, 2001.
 - ANSI/TIA/EIA-568-B.3, Optical Fiber Cabling Components Standard, April 2000
 - ANSI/TIA/EIA-569-B, Commercial Building Standards for Telecommunications Pathways and Spaces, 2003.

ANSI/TIA/EIA-606-A, Administration Standard for Commercial Telecommunications Infrastructure, 2002
ANSI J-STD-607-A, Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications, 2002.
CSA C22.1-02, Canadian Electrical Code, Part 1, 2002.
CSA T527, Grounding and Bonding for Telecommunications in Commercial Buildings, 1999.
CAN/CSA T528, Design Guidelines for Administration of Telecommunications Infrastructure in Commercial Buildings, 1997.
CSA T529, Telecommunications Cabling Systems in Commercial Buildings, 2000
CSA T530, Commercial Build Standard for Telecommunications Pathways and Spaces, 1999
Building Industry Consulting Service International (BICSI) TDM Manual latest editions at the time of tender
Manufacturers design guide

- .2 The Contractor's performance of the work shall comply with applicable national, provincial and local laws, rules, and regulations. The Contractor shall give required notices, shall procure necessary governmental licenses and inspections, and shall pay without burden to the Owner, all fees and charges in connection therewith unless specifically provided otherwise. In the event of violation, The Contractor shall pay all fines and penalties, including attorney's fees, and other defense costs and expenses in connection therewith.

1.6 **QUALIFICATION OF SYSTEM**

- .1 General
- .1 Acceptable proposed system will be covered by a two part certification program provided by the single manufacturer and that manufacturer's Reseller (Vendor, Installer or similar designation).
- .2 Manufacturer shall administer a program through the Installer to provide support and service to the purchaser.
- .3 The first part is an assurance program which provides that the certified system will support the applications for which it is designed, during the lifetime of the certified system.
- .4 The second portion of the certification is a 25-year warranty provided by the Manufacturer and the Reseller on all products within the system (jacks, cables, cross-connects, baluns, etc.).
- .5 In the event that the certified system ceases to support the certified applications, whether at the time of cut over, during normal use or when upgrading, the Manufacturer and Reseller shall commit to promptly implement corrective action.
- .6 Documentation proving the cabling system's compliance to the recommendations, as listed in the Codes and Standards section shall be provided by the Reseller prior to the structured cabling system being installed.
- .7 Workmanship and installation methods used shall be equal to or better than that found in the BICSI (Building Industry Consulting Service International) TDM manual and the NeIS document "Installing Commercial Building Telecommunications Cabling".

- .8 Purchaser demands strict adherence to the performance specifications listed in the Codes and Standards section. The manufacturer shall maintain 9001 Quality Control certification for the facilities that manufacturer the product used in this cabling system.

PART - 2 MANUFACTURER

2.1 GENERAL

- .1 Manufacturer refers to the company that manufactures the components and is responsible for the design and installation guidelines used by the Reseller (Installer, Vendor, or similar designation) to complete this cabling system installation.
- .2 The manufacturer along with the Reseller is responsible for the final warranty and certification of the application assurance.
- .3 The Reseller shall show proof of a contractual relationship with the Manufacturer, and shall pass through the Manufacturer's certification to purchaser.
- .4 The cabling manufacturer shall provide an end-to-end cabling solution, including horizontal cables, backbone cables, jacks and connectors, patch panels, termination blocks, patch cords and jumpers. For this project only end-to-end solutions shall be accepted.
- .5 Where no manufacture is specified, provide products from manufactures in compliance with the listed requirements.

2.2 SUBMITTALS

- .1 Pre-construction Submittals
- .2 Submit the following documents for Review prior to construction:
 - .1 A cable labelling schedule (see Administration Section for more information)
 - .2 Cross-connect schedule for approval by the Owner.
 - .3 A list of all staff to be used, including proof of experience of installing structured cabling.
 - .4 Shop drawings:
 - .1 Submit shop drawings, product data, and samples with promptness as not to cause delay in work or in the activities of separate contractors. Submit shop drawings, product data, and samples as a complete set within thirty (30) days of award of contract for Engineer's Review.
 - .2 By submitting shop drawings the Contractor represents that the materials have been carefully reviewed and verified, as well as related quantities, field measurements, and field construction criteria. It also represents that the Contractor has checked, coordinated, and verified that information contained within shop drawings and samples conform to the requirements of the contract documents.

- .3 The Review of shop drawings, product data, and samples submitted by the Contractor shall not relieve the Contractor of responsibility for deviations from requirements of the contract documents, unless the contractor has specifically informed the Engineer in writing of such deviation at time of submittal, and the Engineer has given written approval of the specific deviation. The Contractor shall continue to be responsible for deviations from requirements of the contract documents not specifically noted by the Contractor in writing, and specifically approved by the Engineer in writing.
- .4 The Engineer's Review of shop drawings, product data, and samples shall not relieve the contractor of responsibility for errors or omissions in such shop drawings, product data, and samples.
- .5 The Engineer's Review of shop drawings, product data, and samples, is for the limited purpose of checking for conformance with information given and design concept expressed in the contract documents. The Engineer's Review of such submittals is not conducted for the purpose of determining accuracy and completeness of other details such as dimensions and quantities, or for substantiating instructions for installation or performance of equipment or systems, all of which remain the responsibility of the contractor as required by the contract documents. The Review shall not constitute approval of safety precautions or of construction means, methods, techniques, sequences, or procedures. The Engineer's Review of a specific item shall not indicate approval of an assembly of which the item is a component.
- .6 Perform no portion of the work requiring submittal and review until the Engineer has Reviewed the respective submittal.
- .7 Submit two (2) copies of each shop drawing for Review. One (1) copy shall be retained by the Engineer. All other copies shall be returned.
- .5 Post-construction Submittals (Maintenance Manuals)
 - .1 The Contractor shall submit within two (2) weeks of the end of construction:
 - .1 Manufacturer's technical documentation on all devices used in cabling system.
 - .2 Manufacturer supplied Application Guidelines for required applications.
 - .3 The Manufacturer's and Contractors Warranty and Certification
 - .4 Complete cable testing documentation in hard and soft copies. Provide licenced versions of any software required for viewing test results.
 - .5 An End User's Manual describing the essential system elements as well as the end user's responsibility for maintaining the integrity of the cabling system over time. This Manual shall include, as a minimum, guidelines for system expansion and modification (moves, additions, changes of service) as well as labelling and record keeping.
 - .6 The project shall not be considered complete until all documents, including the original Manufacturer's Certification, have been delivered to the Owner.

- .7 Within 30 days prior to substantial completion, the Contractor shall submit a draft copy of the proposed contents of each manual to the Consultant for review prior to substantial completion. Within 10 days the Consultant shall provide a review of this document to the Contractor.
- .8 Once the draft copy is approved, the Contractor will supply four (4) copies in suitably labelled, hard back, D-Ring type commercial binders, each complete with an index and tabbed title sheets for each section. Final copies of manuals are to be received by Consultant not less than 7 days prior to substantial completion.

2.3 **AS-BUILT DRAWINGS**

- .1 The Contractor shall keep one complete set of prints at the site office, including all addenda, change orders, site instructions, clarifications and revisions for the purpose of record drawings. As the work on site proceeds, the Contractor shall clearly record in Red Pencil all as-built conditions that deviate from the original contract documents.
- .2 Within two (2) weeks of the Project's completion the Contractor shall submit a complete set of As-Built drawings including cable routing, Telecommunication Rooms layouts, riser diagrams and telecommunications outlets. The layout shall detail locations of all equipment and indicate all wiring pathways, and outlets (including cable ID numbers). This as-built information shall include Addenda, Change Orders, Clarifications, Revisions, and Site Instructions.
- .3 Upon completion the Contractor shall certify, in writing that the as built records are complete and that they accurately indicate all communication services related to the communications infrastructure. This shall include all visible and all invisible items. The information shall also correspond with all identifications applied by the Contractor to cables and termination devices in the buildings.
- .4 The Contractor shall forward a letter of certification to the Consultant for final review and as-built CAD drawings to the Consultant for final review.
- .5 The contractor may obtain copies of the telecommunication contract drawings (Tender Issue) in dwg format from the Consultant on request. A drawings release form needs to be signed by the Contractor prior to releasing the drawings.
- .6 After as-built drawings have been reviewed, print four (4) full size copies of the drawings. Deliver two (2) copies to the Owner and two (2) copies to the Facilities Management (if different from the Owner).

PART - 3 COMMUNICATIONS CONTRACTOR

3.1 PROJECT MANAGER

- .1 Within ten (10) days of the date of acceptance of this Bid, the Contractor shall notify the Consultant of the appointment of a competent Project Manager, experienced in the design and installation of structured cabling systems and in the supervision of similar contract work.

- .2 The Project Manager shall be available during the entire life of the Contract to answer all questions pertaining to the contractual work, and shall be available at the site from the commencement date of equipment delivery to the commissioning completion date.
- .3 The Project Manager shall represent the Contractor and shall have authority to carry out directions given to him as the Contractor's representative.

3.2 **COMMUNICATIONS INSTALLERS**

- .1 The staff selected for the installation of the structured cabling system shall conform to the following:
 - .1 An installer on site that is a current member of BICSI and holds a valid RCDD designation. This installer along with the Project Manager will ultimately be responsible for the construction of this project.
 - .2 The Contractor must also have BICSI Registered Installers and Technicians on staff and assign them to this project. The project shall be staffed at all times by Installers and Technicians who, in the role of lead craftspersons, will be able to provide leadership and technical resources for the remaining craftspersons on the project.
 - .3 Submit to the Consultant within seven days of Contract Award a list of all staff to be used in above installation including proof of experience.
 - .4 ONLY qualified technicians directly employed by the CSV or Reseller shall terminate all cables (at both ends), test and perform cross-connects.
 - .5 Certification in the installation of structured cabling system under the title of CSV, Reseller, Vendor, or other similar status issued by the cabling manufacturer.
 - .6 Provide Manufacturer's Certification Number within two weeks upon award of contract.
 - .7 If, in the opinion of the Owner, the RCDD does not possess adequate qualifications to support the project, the Owner reserves the right to require the Contractor to assign an RCDD who, in the Owner's opinion, possesses the necessary skills and experience required of this project.

PART - 4 INSTALLATION GENERAL REQUIREMENTS

4.1 **GENERAL REQUIREMENTS**

- .1 All voice and data outlets shall be flush mounted where possible; otherwise a surface mount shall be used unless otherwise indicated on the supplied drawings.
- .2 All face plates shall be coloured to match electrical face plates in the area unless otherwise noted.
- .3 Blank inserts are to be placed in to outlet ports not containing communications jacks. The blanks are to be coloured to match the faceplate.

- .4 All four pairs of horizontal cables are to be terminated. ISDN T568A wiring configuration is to be used. The splitting of pairs is strictly prohibited.
- .5 All drop locations and quantities to be confirmed prior to the start of the installation. Allow a variation of 4.5m (15').
- .6 Horizontal cabling will be split and dressed on ply-wood backboards and rack. Distribute cables evenly and neatly in bundles.
- .7 The length of each individual run of horizontal cable from the patch panel on each floor to the telecommunications outlet shall not exceed 90m (295').
- .8 All cables shall be loosely bundled using Velcro cable ties every 150mm (6"). To minimize the effects of alien cross-talk, do not comb-out cables.
- .9 Utilize all indicated and available cable pathways such as conduit, cabletrays, ducts, raceways and furniture system channels except where otherwise noted. Exercise caution when pulling cables in such pathways to avoid damage to any cabling and to ensure that the cable manufacturers' maximum pull-force and minimum bend radii specifications are adhered to.
- .10 All free running cables shall be securely fastened to appropriate cable supports so that cables routed to the under side of the floor tiles with a maximal inter-harness cable sag of 150mm (6"). All cables shall be completely supported by the harness so that the entire mass of the cables and harnesses are self supporting and no weight is transferred to any other existing fixture or structure in the ceiling space. The Contractor shall be responsible for the supply of all materials (such as hangers, harnesses or supports) and labour that may be required to achieve this.
- .11 Route all cables to maintain minimum separations from sources of lighting, power cables, HVAC and electrical equipment as indicated in the Manufacturer's minimum separation schedule or otherwise required. The Contractor shall be responsible for the supply of all materials (such as hangers, harnesses or supports) and labour that may be required to maintain the indicated minimum separations.
- .12 In the Telecommunications Rooms all communications cables shall be neatly bundled, supported and routed to the corresponding termination panel. The Contractor shall be responsible for the supply and installation of any additional cable supports. Velcro tie-wraps on cables should be loose and rotate freely.
- .13 Each run of cable between the termination block and the data outlet shall be continuous without any joints or splices.
- .14 Where the Contractor is required to remove ceiling tiles, such work shall not break or disturb grid or tiles.
- .15 Terminated conductor ends shall be properly trimmed to assure a minimum clearance of 0.250" between the conductors of adjacent modules.
- .16 Ground all Telecommunications equipment, racks and cabletrays using green insulated #6 AWG copper wire to the Telecommunications Ground Bar. All ground wires shall be home-run back to the Telecommunications Ground Bar. Do not daisy chain.

- .17 Completely test out systems and, before they are turned over to Owner, demonstrate them to Owner's representative until such time as he is fully conversant with the operation of the systems.
- .18 Six months after installation has been accepted by Owner, arrange a time convenient to the Owner to do necessary re-aligning, and replace defective components.

4.2 **COMMUNICATIONS HORIZONTAL CABLING**

.1 General

- .1 All horizontal cables will be FT6 rated for plenum environment (CMP).
- .2 All terminations shall be in T568A configuration.
- .3 For all horizontal cables provide 3m of slack at the cabinet end and 1m of cable slack at the workstation end.
- .4 Follow the Manufacturer's guidelines for pulling force. If no guidelines are present the maximum pull-force for 4-pair horizontal twisted-pair cables is 111N (25 lbf).
- .5 Maintain the manufacturer's recommended bend radius at all times. If no guidelines are present ensure the bend radius does not exceed four (4) times the outside cable diameter.
- .6 The communications wiring system shall be an end-to-end solution provided by a single manufacturer.
- .7 Cables will be routed through conduits, cabletray. The Division 26 Contractor will provide the conduits and cabletray where shown.
- .8 Approved manufactures for the end-to-end cabling solution are as follows:

**Standard of Acceptance
Belden/CDT (To match existing facility standard)**

.2 Horizontal Data Cables

- 1. Provide horizontal cables to connect each information outlet to the backbone subsystem on the same floor.
- 2. All horizontal cabling shall be **BELDON Category 6, IBDN for FT-6** environment. All Category 6 cables shall conform to or exceed the EIA/TIA 568 Commercial Building Wiring Standard. Horizontal Cable Section and the EIA/TIA Technical Systems Bulletin 36 for Unshielded Twisted Pair Cables. Other standards supported include IEEE 802.3, 1Base5, 10BASE-T; IEEE 802.5, 4 Mbps, 16Mbps (328 ft [100m], 104 Workstations) and proposed ANSI X3T9.5 TPPMD requirements for UTP at 100 Mbps. In addition, cables shall be capable of supporting evolving high-end applications such as 155 Mbps ATM.
- 3. The 4 pair UTP cable shall be UL Listed type CM. or CMP.

4. All plenum rated Category 6 Unshielded Twisted Pair (UTP) cables shall be composed of 24 AWG solid copper conductors, dual insulated with high density polyethylene (HDPE). The insulated conductors are twisted into pairs and jacketed with Polyvinyl Chloride (PVC) and shall meet or exceed the Electrical Specifications listed below:
 1. Maximum DC resistance 28.6 S/1,000 ft (9.38S/100m)Maximum DC resistance
 2. Unbalance: 5%Mutual Capacitance @1kHz: 14nF/1,000 f
 3. Mutual Capacitance Unbalance (pair to ground): 40OpF/1,000 ft (131.2 pF/100m)
 4. Attenuation (dB/1,000 ft [305m]):@ 0.772 MHz: 5.5@ 1.0 MHz: 6.3@ 4.0 MHz: 13@ 8.0 MHz: 18@ 10.0 MHz: 20@ 16.0 MHz: 25@ 20.0 MHz: 28@ 25.0 MHz: 32@ 31.25 MHz: 36@ 62.5 MHz: 52@ 100 MHz: 67
 5. Characteristic Impedance (S):@ 0.064 MHz: 125 ± 15S@ 0.128 MHz: 115 ± 15S@ 0.256 MHz: 110 ± 15S@ 0.772 MHz: 105 ± 15S@ 1.0-25.0 MHz: 100 ± 15S
 6. Pair to Pair Next (db) at 1,000 ft (305 m):

FREQUENCY	EIA STANDARD	90 TH PERCENTILE
1.0 MHZ	62	68
4.0 MHZ	53	59
8.0 MHZ	48	54
10.0 MHZ	47	53
16.0 MHZ	44	50
20.0 MHZ	42	48
25.0 MHZ	41	47
31.25 MHZ	40	46
62.50 MHZ	35	41
100.0 MHZ	32	38

7. UL Listed
8. CSA Certified
5. The UTP-based cabling system shall be capable of supporting the following applications:
 6. 1.2 Gbps ATM*

7. Gigabit Ethernet (1000BASE-T)
 8. Broadband Video
 9. 25/52/155/622 Mbps ATM
 10. Fast Ethernet (100BASE-TX, 100BASE-T4)
 11. 100VG-AnyLAN
 12. TP-PMD
 13. Ethernet (10BASE-T)
 14. 4/16 Mbps Token-Ring
 15. Baseband Video
 16. ARCnet/ARCnet Plus
 17. IBM System 370/3270
 18. IBM 3x - AS/400
 19. IBM 4700 Financial Communication System
 20. IBM 5080/6090 Graphics System
 21. EIA-232/EIA-422
 22. Voice
- .3 Information Outlet (eight (8) position Category 6 modular jacks at working station. Unless otherwise noted all information outlets shall be:
- 1 Eight (8) position Cat 6 modular type
 - 2 insulation displacement
 - 3 modular
 - 4 universal application/multi vendor supportive
 - 5 accepting most phone and data plugs. Provide corresponding faceplate 4. All Category 6 outlets shall be:
 - 1 The outlet UTP connection module shall be Power Sum rated, with a Power Sum NEXT performance equal to or better than ANSI/TIA/EIA-568 Category 6 pair-to-pair NEXT performance specifications, and shall have a PS5 marking to indicate compliance.
 - 2 The eight-position outlet UTP connection module shall accommodate sixposition modular plug modular cords without damage to either the cord or the module.
 - 3 The outlet UTP connection module shall use a hand-termination installation method, without the need for punch down tools or slip lock pliers.
 - 4 The outlet UTP connection module shall have an optional cover to protect the module when not in use.
 - 5 The outlet UTP connection module and its optional cover shall be available in the following colours: grey, almond, white, black, orange, red, yellow, green, blue, purple, and brown.
 - .6 The outlet UTP connection module shall be designed for use at the Work Area, Telecommunications Closet and/or Equipment Room without modification.
 - .7 The outlet UTP connection module shall only have a single insulation displacement connection block for the termination of wire pairs.
 - .8 The outlet UTP connection module shall be available in both the T568A-ISDN and T568B-ALT wiring configurations.
 - .9 The outlet UTP connection module shall be UL Listed and CSA Certified.

- .10 The outlet UTP connection module shall be made of fire-retardant UL 94V-0 plastic.
- .11 The outlet UTP connection module shall have an insulation displacement connection featuring insulation-slicing, tin-plated clips, forming a gas-tight connection.
- .12 The outlet UTP connection module shall have a maximum Contact Resistance of 1 milliohm per contact.
- .13 The outlet UTP connection module shall have an minimum Insulation Resistance of 100 megaohms between clips.
- .14 The outlet UTP connection module shall have a durability rating of 200 insertions/withdrawals of any combination of 24 and 26 AWG wire.
- .15 The outlet UTP connection module modular jack shall be FCC Part 68, Subpart F compliant.
- .16 The outlet UTP connection module modular jack durability shall be 1500 mating cycles.
- .17 The outlet UTP connection module modular jack contact material shall be nickel with 50 micro-inches gold plated.
- .18 The outlet UTP connection module modular jack maximum Current Rating shall be 1.5 amperes.
- .19 The outlet UTP connection module modular jack Dielectric Strength shall be 1000V RMS at 60 Hz for 1 minute.
- .20 The outlet UTP connection module modular jack minimum Insulation Resistance shall be 500 megaohms.
- .21 Outlet Faceplate:
 - 1. The faceplate housing the outlet UTP connection modules shall provide a symmetrically-centered appearance for the modules.
 - 2. The faceplate housing the outlet UTP connection modules shall have no visible mounting screws.
 - 3. The faceplate housing the outlet UTP connection modules shall be removable without requiring the removal of screws or other fasteners.
 - 4. The faceplate housing the outlet UTP connection modules shall have an outlet wiring diagram stamped on the inside.
 - 5. It shall be possible to inspect and/or reterminate the UTP cable at the outlet through front access at the faceplate.
 - 6. The faceplate housing the outlet UTP connection modules shall have aperture plugs to cover any unused openings in the faceplate.
 - 7. It shall be possible to install the outlet UTP connection modules in wall mounted single and dual-gang electrical boxes, utility poles and modular furniture (cubicle) access points using manufacturer-supplied faceplates and/or adapters, equipped with front, side or angled-entry options for modular cords.
 - 8. The faceplate housing the outlet UTP connection modules shall be available in the following colors: grey, almond, white, and black.
- .22 Outlets shall be wired in an EIA/TIA 568 A configuration.
- .23 Unless otherwise noted on the floor plans, the information outlet shall be surface flush mounted, single or multi jacks as indicated.

- .24 Each work area shall be supplied with a telecommunications outlet/connector (previously called a modular jack) for connection to the horizontal media. All telecommunications outlet/connectors shall be installed in an appropriate faceplate. All telecommunications outlet/connectors shall be complete with faceplate and attached permanently to a fixed structure, such as building walls, utility poles or modular furniture partitions.
- .25 The work area telecommunications outlet/connector must provide maximum flexibility in supporting UTP, fibre, and coax while maintaining performance in order to meet the changing requirements that are likely to occur throughout the life of the system.
- .26 8 Position modular telecommunications outlet/connectors shall accept 8 position modular plugs while providing proper electrical connection and not damaging telecommunications outlet/connector (jack). Manufacturer shall warrant all 8 position modular outlets used in such a manner to be usable for 8 position modular plugs in the future.
- .27 In order to allow normal expansion of service during the life of the cabling system, flush work area telecommunications outlets shall provide sufficient density to support up to a maximum of eight connectors per single gang telecommunications outlet and twelve connectors per double gang telecommunications outlet.

2 PATCH PANELS

- 1. The termination block shall support the appropriate 'Category 6' applications and facilitate cross-connection and inter-connection using cross connect wire. The UTP cross-connect/interconnect system rack mount shall feature built-in wire management to secure cable bundles, control and maintain proper cable bend radius and provide physical protection for terminations..
- 2. Patch panel installations shall contain a retaining trough between every 50 pair termination block.
- 3. The wiring block shall be able to accommodate 24 AWG cable conductors.
- 4. Termination blocks that require rotation after connection of horizontal/vertical wiring will not be allowed.
- 5. The block shall be Underwriter's Laboratories (UL) listed.
- 6. All 'Category 6' Patch Panels shall support 100 Mbps TP-PMD and 155 Mbps ATM and shall meet or exceed the NEXT Values listed as follows: 1.0 MHz: 86@ 4.0 MHz: 74@ 8.0 MHz: 68@ 10.0 MHz: 66@ 16.0 MHz: 62@ 20.0 Mhz: 60@ 25.0 MHz: 58@ 31.25 MHz: 56@ 62.50 MHz: 50@ 100.0 MHz: 46
- 7. Horizontal cabling will be split and dressed down the back and each side of rack 2, terminating on NORDX 48 port HD Patch panels.
- 8. The termination block shall support the appropriate Category 6 applications and facilitate cross-connection and inter-connection using cross connect wire. The UTP cross-connect/interconnect system rack mount shall feature built-in wire management to secure cable bundles, control and maintain proper cable bend radius and provide physical protection for terminations.
- 9. The wiring block shall be able to accommodate 24 AWG cable conductors.
- 10. Termination blocks that require rotation after connection of horizontal/vertical wiring will not be allowed.
- 11. The block shall be Underwriter's Laboratories (UL) listed.

12. Contractor shall supply cross-connect wire and patch cords for cross-connection and inter-connection of termination blocks and fibre optics termination units.
13. One patch cord shall be provided for each workstation outlet, and one for each data port in the telecommunications closet.
14. The type of jumper cables shall depend on EIA/TIA Category 6 applications and the termination block used. i.e. a punch panel, a patch panel termination block.
15. The UTP data patch cord for connecting a computer workstation to its corresponding equipment jack shall be manufactured by NORDX.
16. The UTP data patch cord lengths shall be as follows: 10 ft
17. The Plus series patch cord shall be available in 4 pair version with lengths of 10 feet and shall meet or exceed the following electrical, mechanical and NEXT specifications listed below:
19. The modular plug shall meet the requirements of the latest issue of ANSI/TIA/EIA-568.
 - a. The modular plug shall meet the requirements of the latest issue of ISO/IEC 11801.
 - b. The modular plug shall meet the requirements of the latest issue of FCC Part 68, Subpart 5.
 - c. The modular plug shall meet the requirements of the latest issue of IEC 603-7
 - d. The modular plug shall have a maximum Voltage Rating of 150V AC.
 - e. The modular plug shall have a minimum Dielectric Withstanding Voltage of 1000V RMS at 60 Hz for 1 minute.
 - f. The modular plug minimum insulation resistance shall be 500 megaohms.
 - g. The modular plug maximum contact resistance shall be 10 milliohms.
 - h. The modular plug housing shall be made of UL 94V-0 rated polycarbonate.
 - i. The modular plug contacts shall be made of phosphor bronze.
 - j. The modular plug contacts shall be plated with a minimum of 50 microinches of gold.
 - k. Each modular plug of every modular cord shall be legibly and indelibly stamped with the wiring configuration of the cord (T568A or T568B).
 - l. The modular plug shall be crimped such that the distance between the top of each contact and the bottom of the plug is 0.237 +/- 0.005 inch. The insulated conductor shall be visible from the front of the plug.
 - m. The modular plug shall be UL 94V-0 Flame Rating compliant.
20. Plus Series Modular Cord Assembly:
 - a. The modular cord assembly shall meet or exceed the short link NEXT requirements of 34 dB when tested with enhanced Category 5 connecting hardware.
 - b. The modular cord assembly shall meet the requirements per the latest issue of ANSI/TIA/EIA-568
 - c. The modular cord assembly shall meet the requirements per the latest issue of ISO/IEC 11801

- d. The modular cord assembly shall be UL listed as a Communication Cable Assembly.
 - e. The modular cord assembly shall be CSA Certified as a Communication Cord Set.
 - f. The modular cord assembly shall be capable of withstanding an 11.25 pound pull test. Each of the individual conductors shall be capable of withstanding a 3 pound pull.
 - g. Each conductor in every modular cord assembly shall be capable of withstanding, without breakdown for 1 minute, an AC (RMS) potential of 1000V (1500V DC). Each conductor shall be tested against all other conductors and/or any metal enclosure part of a connector, all electrically connected together and grounded. The test voltage shall be increased from zero at a rate not exceeding 200 V/s until the required value has been attained.
21. The patch cord shall have built-in exclusion features to prevent accidental polarity reversals and split pairs.

4.5 COMMUNICATIONS CONNECTING CORDS, DEVICES AND ADAPTERS

- i. Data Patch Cords
 - 1. For each data drop installed provide one (1) patch cord at the patch panel end. Provide quantities as follows:
 - a. 100% Category 6 patch cords (RJ45-RJ45), 1.2m (4') in length
 - 2. For each data drop installed provide one (1) patch cord at the workstation end. Provide quantities as follows:
 - a. 100% Category 6 patch cords (RJ45-RJ45), 2.1m (7') in length
 - 3. All data patch cords shall be installed by the Contractor.
 - 4. All data patch cords shall be RJ45 to RJ45 with booted connector ends.
 - 5. All patch cords shall be FT6 rated.

1.6 IDENTIFICATION FOR COMMUNICATIONS SYSTEMS

.1 General

- .1 The Administration Subsystem links all of the subsystems together. It consists of labelling hardware for providing identification.
- .2 Administration shall be in compliance with the TIA/EIA-606-A standard for Class 2 Administration. Identifiers are required in the following locations:
 - (a) Security Server Room
 - (b) Intrabuilding backbone cable
 - (c) Horizontal link
 - (d) Cabinets
 - (e) Patch panels
 - (f) TMGB
 - (g) TGB
- .3 The Owner may deviate from the TIA/EIA-606-A standard to suit they own particular administration system.

- .4 Submit a complete labelling schedule (as noted in the per-construction submits section) to the Owner for review. Allow for the Owner to make changes.
 - .5 The Contractor shall provide labels at the following locations:
 - (a) At each end of the cable jacket within 6" of where the jacket has been stripped.
 - (b) On the front of each faceplate
 - (c) On the inside of each outlet box
 - (d) On the front of the patch panel or termination block
 - (e) At each end of each patch cord and pigtail cable within 50mm (2") of the connector
 - .6 Labels shall be machine printed with black text on white backing.
 - .7 The minimum height of text shall be 3/16".
 - .8 Use labels produced by the cabling manufacture as recommended for the application.
 - .9 For labels on racks, cabinets, and patch panels supply lamicoid name plates. Colours shall be black text on white backing.
- .2 Numerical Identification
- .1 Label Telecommunication Rooms as follows:
 - (a) FS
 - (b) F = floor the Telecommunications Room is located
 - (c) S = unique identifier for the Telecommunications Room on that floor (A, B, C...)
 - .2 Label all horizontal data links as follows:
 - (a) FS-DXXX
 - (b) FS = the Telecommunications Room identifier for the room the cable is terminated
 - (c) D = Data
 - (d) XXX = unique cable number
 - .3 Label all horizontal voice links as follows:
 - (a) FS-VXXX
 - (b) FS = the Telecommunications Room identifier for the room the cable is terminated
 - (c) V = Voice
 - (d) XXX = unique cable number
- .3 Coloured Identification
- .1 Use the following colours to identify different systems:
 - .2 All horizontal UTP cables shall be coloured blue.
 - .3 All workstation jacks shall be coloured white.
 - .4 All jacks in patch panels shall be coloured black
 - .5 Patch cords shall be coloured as follows:
 - (a) data = white
 - (b) voice = blue

5 COMMISSIONING OF COMMUNICATIONS

5.1 GENERAL

- .1 Provide Commissioning Verification, Inspection and Certification.

- .2 Provide commissioning verification, inspection and certification of all communications cables installed.
- .3 100% of all cables installed must be tested, and certified.

5.2 COPPER CABLE TEST REQUIREMENTS

- .1 Every cabling link in the installation shall be tested in accordance with the field test specifications defined by the Telecommunications Industry Association (TIA) standard ANSI/TIA/EIA-568-B.1.
- .2 The installed twisted pair horizontal links shall be tested from the IDF in the Telecommunications Room to the telecommunication outlet in the work area against the Basic Link performance limits specification as defined in ANSI/TIA/EIA-568-B.1.
- .3 100% of the installed cabling links must be tested and must pass the requirements of the standards mentioned in above specifications. Any failing links must be diagnosed and corrected. The corrective action shall be followed with a new test to prove that the corrected link meets the performance requirements. The final and passing result of the tests for all links shall be provided in the test results documentation in accordance with Section below.
- .4 Trained technicians who have successfully attended an appropriate training program and have obtained a certificate as proof thereof shall execute the tests.
- .5 The test equipment (tester) shall comply with the accuracy requirements for Level III field testers as defined in TIA-568-B.1
- .6 The tester shall be within the calibration period recommended by the vendor in order to achieve the vendor-specified measurement accuracy.
- .7 The tester interface adapters must be of high quality and the cable shall not show excessive twisting or kinking resulting from repetitive coiling and storing of the tester interface adapters.
- .8 The Pass or Fail condition for the link-under-test is determined by the results of the required individual tests. Any Fail or Fail* result yields a Fail for the link-under-test. In order to achieve an overall Pass condition, the results for each individual test parameter must Pass or Pass*.
- .9 A Pass or Fail result for each parameter is determined by comparing the measured values with the specified test limits for that parameter. The test result of a parameter shall be marked with an asterisk (*) when the result is closer to the test limit than the accuracy of the field tester. The field tester manufacturer must provide documentation as an aid to interpret results marked with asterisks.
- .10 A representative of the consultant and end-user shall be invited to witness field testing. The representative shall be notified of the start date of the testing phase 5 business days before testing commences.
- .11 A representative of the consultant and end-user will select a random sample of 5% of the installed links. The representative (or his authorized delegate) shall test these randomly selected links and the results are to be stored in accordance with the prescriptions in Specifications. The results obtained shall be compared to the data provided by the installation contractor. If more than 2% of the sample results differ in terms of the pass/fail determination,

the installation contractor under supervision of the end-user representative shall repeat 100% testing and the cost shall be borne by the installation contractor.

5.3 COPPER CABLE TEST STANDARDS

- .1 Test all horizontal copper cable links to Category 6 standards.
- .2 The test parameters for Category 6 are defined in ANSI/TIA/EIA 568B.1. The test of each link shall contain all of the following parameters as detailed below. In order to pass the link test all measurements (at each frequency in the range from 1 MHz through 250 MHz) must meet or exceed the limit value determined in the above-mentioned Category 6 standard.
- .3 When testing cables the correct NVP value must be entered in to the tester for the particular cable being tested or the test results will be considered void.

5.4 TEST RESULT DOCUMENTATION

- .1 The test results information for each link shall be recorded in the memory of the field tester upon completion of the test.
- .2 The test results records saved by the tester shall be transferred into a Windows™-based database utility that allows for the maintenance, inspection and archiving of these test records. A guarantee must be made that these results are transferred to the PC unaltered, i.e., "as saved in the tester" at the end of each test.
- .3 The test results records saved by the tester shall be transferred into a Windows™-based database utility that allows for the maintenance, inspection and archiving of these test records. A guarantee must be made that these results are transferred to the PC unaltered, i.e., "as saved in the tester" at the end of each test.
- .4 The database for the completed job shall be stored and delivered on CD-ROM including the software tools required to view, inspect, and print any selection of test reports.
- .5 A paper copy of the test results shall be provided that lists all the links that have been tested with the following summary information
- .6 The identification of the link in accordance with the naming convention defined in the overall system documentation.
- .7 For OTDR testing include all ray traces and graphical outputs.
- .8 The date and time the test results were saved in the memory of the tester. Ensure that the correct information has been entered.
- .9 Test results must be received by the Consultant for review within 2 weeks of completion of testing or they will be considered void.

5.5 CLEAN-UP

- .1 General
 - .1 Remove all redundant cables completely-both horizontal and vertical cable
 - .2 All existing cables and communications equipment needs to be removed.

- .3 The Telecommunications Rooms are to be cleaned using canned compress air suitable for cleaning electronic equipment. All equipment shall be cleaned of dust and debris. The floors are to be vacuumed and all garbage removed prior to the owner taking occupancy.
- .4 Do not dust and vacuum until all trades have completed work.

5.6 OCCUPANCY

.1 General

- .1 When the owner is ready to take occupancy the Communications Contractor is to provide an onsite communications technician to assist during the move.
- .2 The communications technician is to have extensive knowledge in the design and construction of the system.
- .3 The communications technician is to assist the owner during the move and answer any questions related to the system.
- .4 If the owner deems the technician unable to provide proper assistance for any reason, another technician will be provided by the contractor immediately with no addition charge to the owner.
- .5 The owner will decide the time and date that the technician is to arrive. The owner must give at least 48 hours notice to the communications contractor before such time.
- .6 The technician is to remain on site for a maximum of 8 hours. These hours may occur during premium time or during weekends. Any additional time must be arranged with the Communications Contractor.

6 EXECUTION

- 1 Data Cable Installation
- 2 Communications cables shall be placed through shafts, conduit, raceways or floor penetration.
- 3 Supply all materials and labour for the installation of the complete Riser Cabling system including all cables and terminations.
- 4 Ensure that proper cable support techniques are utilized for suspending and supporting riser cables as per manufacturer's specifications. Cable ties shall also be used to prevent side to side movement of the cable. The cable ties shall not be installed so as to deform the cable jacket.
- 5 Supply all materials and labour for the installation of the complete Communications Cabling system including all cables and terminations.
- 6 Ensure that proper cable support techniques are utilized for suspending and supporting riser cables as per manufacturer's specifications. "Velcro" cable ties shall also be used to prevent side to side movement of the cable. The cable ties shall not be installed so as to deform the cable jacket.
- 7 Provide, install and terminate the indicated quantities of riser cables in the communications rooms.
- 8 All cables shall be neatly bundled, tie-wrapped and routed together. Secure cable bundles to vertical and horizontal supports and neatly fasten to plywood backboards or termination racks when routing to termination panels.
- 9 Installation shall be suitably tested and demonstrated to the Engineer consistent with standard industry practice.
- 10 Connect equipment is to closet ground bus with #6 AWG green grounding wire.
- 11 Submit shop drawings of all communications equipment, cabling, receptacles and miscellaneous hardware.

- 12 Installation shall conform to the standard, EIA/TIA 568A. The length of each individual run of horizontal cable from the administration subsystem (Communications Closet) on each floor to the information outlet shall not exceed 295 ft (90 m).
- 13 All cables shall be neatly bundled and tie-wrapped. Secure cable bundles to vertical and horizontal supports in Communications rooms to support cable bundles.
- 14 Utilize all indicated and available cable pathways such as conduit, cable trays, ducts, raceways and furniture system channels except where otherwise noted. Exercise caution when pulling cables in such pathways to avoid damage to any cabling and to ensure that the cable manufacturers' maximum pull-force and minimum bend radii specifications are adhered to.
- 15 All free-running cables shall be securely fastened to appropriate cable supports and harnesses a minimum of every 1500mm so that cables are bundled tightly. All cables shall be completely supported by the harness so that the entire mass of the cables and the harnesses is self supporting and no weight is transferred to any other existing fixture or structure in the ceiling space (such as suspended ceiling or light fixtures). The Contractor shall be responsible for the supply of all materials (such as hangers, harnesses or supports) and labour that may be required to achieve this.
- 16 Route all cables to maintain minimum separations from sources of lighting, power cables, HVAC and electrical equipment as indicated in the "NORDX/CDT" minimum separation schedule or otherwise required. The Contractor shall be responsible for the supply of all materials (such as hangers, harnesses or supports) and labour that may be required to maintain the indicated minimum separations.
- 17 In the building Communication Closets all communications cables shall be neatly tie-wrapped, bundled, supported and routed to the corresponding termination panel in the hub rooms or computer room. The Contractor shall be responsible for the supply and installation of any additional cable supports. Tie wraps on Cat 5e cables must be velcro type only (plastic cable ties are not acceptable).
- 18 The communications contractor is to coordinate the installation of the data and voice cables with other contractors and tenants as required for the installation of these cables.
- 19 Inform the Consultant of any cable lengths in excess of 90 m in length prior to installation.
- 20 Each run of cable between the termination block and the data outlet shall be continuous without any joints or splices.
- 21 In suspended ceiling and raised floor areas where systems duct, cable trays or conduit are not available, the Contractor shall bundle station wiring with velcro cable ties at appropriate distances (plastic cable ties are not acceptable for Cat 5e cabling). The cable bundling shall be supported via "J" hooks attached to the existing building structure and framework. Plenum cable will be used in all appropriate areas where cables are not enclosed in metal raceways or concrete encased conduits.
- 22 If the interior of walls are not obstructed, the Contractor shall conceal horizontal distribution wiring internally within the walls. If such obstructions exist, Contractor shall secure approval prior to the use of an alternate method.
- 23 Where the Contractor is required to remove ceiling tiles, such Work shall not break or disturb grid or tiles.
- 24 Contractor shall provide detailed cable run diagrams for cable runs within raised floors detailing exact locations of cable for review and approval after coordination with other contractors and engineer.
- 25 Conduit runs installed by the contractor should not exceed 100 feet or contain more than two 90 degree bends without utilizing appropriately sized pull boxes.
- 26 Dedicated four-pair 24 AWG UTP horizontal distribution cable shall be provided for each application or service planned, present and future. Each of the four cable pairs of each horizontal cable must be terminated on an individual 8 position modular connector at the telecommunications outlet/connector. Pairs within a cable shall not be split and all pairs must be terminated.

- 27 The splitting of pairs within a cable between different jacks is not permitted. Terminating resistors in the case of ISDN applications shall be placed external to the telecommunications outlet/connector.
- 28 Cable shall be provided on reels or in Reelex boxes. Cable shall be marked decrementally from 100 ft to indicate both the length of a run as well as the amount of cable remaining on the reel or within the carton
- 29 The installation of the horizontal cable shall follow the appropriate recommendations covered in the Manufacturer's Design Guide and the appropriate standards documents. This is done in order to ensure adequate protection from Electro-Magnetic Interference (EMI) sources and to ensure that all components and cables are in good condition after installation.
- 30 Copper cables shall be handled, installed, and supported as per the manufacturer's guidelines. During the laying of the cable, installer shall take care not to over stress the cable. After the cable is installed, installer shall make sure that all parts of the cable are supported properly and shall be stress free at both ends and throughout their length.
- 31 Appropriate attention shall be given to the handling of Category 5e copper and optical fibre cables to ensure that bending radius conforms to the manufacturer's requirements. At no time shall the cable's static or dynamic bending radius be exceeded.
- 32 All telecommunications outlet/connectors shall be securely mounted at all work area locations and shall be located so that the cable required to reach the work area equipment will be no more than 3 meters long.
- 33 All optical fibre and copper cables shall be handled, installed, and supported as per the manufacturer's guidelines. During the laying of the cable, installer shall take care not to over stress the cable. After the cable is installed, installer shall make sure that all parts of the cable are supported properly and shall be stress free at both ends and throughout their length.
- 34 Appropriate attention shall be given to the handling of Category 5e copper and optical fibre cables to ensure that bending radius conforms to the manufacturer's requirements. At no time shall the cable's static or dynamic bending radius be exceeded.
- 35 All telecommunications outlet/connectors shall be securely mounted at all work area locations and shall be located so that the cable required to reach the work area equipment will be no more than 3 meters long.
- 36 The total optical attenuation through the cross-connect from any terminated fibre to any other terminated fibre shall not exceed 2.0 dB. Optical fibre splices, fusion or mechanical, shall not exceed a maximum optical attenuation of 0.3 dB when measured in accordance with ANSI/EIA/TIA-455-34.
- 37 Surface mount telecommunications outlets where indicated shall provide up to six telecommunications outlet/connectors.
- 38 A non-impact termination method using either a stuffer cap with pliers or fullcycle terminating tool having both tactile and audible feedback to indicate proper termination shall be used. High impact tools are not permitted.
- 39 Terminated conductor ends shall be properly trimmed to assure a minimum clearance of 0.250 in. between the conductors of adjacent modules.
- 40 Face plates shall be clean in appearance. Mounting hardware shall not be visible on the faceplate. If colour coded modules are employed, colors shall comply with the requirements of CAN/CSA 528.
- 41 The work area telecommunications outlet/connectors shall not be responsible for creating "resonance" on short cable runs as described 'in the Field Testing TSB 67 (Draft 13 section 7.8 Short Links/Channels). This problem is related to return loss and/or the balance of the link and can cause transmission errors.
- 42 Telecommunications outlet/connector shall require (or specifically not allow more than) only one single connection to horizontal cable as per TIA/EIA-568-B.

- 1 Flush mounted face plates shall accommodate modular telecommunications outlet/connectors and be available in four connectors per single gang telecommunications outlet.
- 2 All telecommunications outlets shall be made of high impact plastic.
- 3 The same modular telecommunications outlet/connectors as found in the flush and surface mount telecommunications outlets shall be installable in utility poles and modular furniture using manufacturer face plates or adapters for this purpose. Each telecommunications outlet shall house as many as three telecommunications outlet/connectors.
- 4 The eight position modular UTP telecommunications outlet/connector and its pin assignments shall meet the requirements described in the standard CAN/CSA-T529 as T568A.
- 5 Each telecommunications outlet shall be uniquely labelled. The label shall form an integral part of the faceplate.

4 WARRANTY

- 1 Provide written verification confirming that the testing and inspection has been completed and that all cable runs have passed. Also document that all defects have been identified, corrected, and retested successfully.
- 2 Contractor shall provide a 25 year Extended Product Warranty and System Assurance Warranty for this Structured Cabling System.
 - .1 Provide "NORDX" IBDN certification, certifying that the cabling system is Installed In accordance to manufacturer's Category standards. The certification must include a minimum of 25 years application assurance warranty, which warranties that the installed cabling system is compliant with standard current network applications and emerging technologies such as TPPMD, 100 Mbps Ethernet, Gigabit Ethernet, UTP based ATM and other 100 + Mbps applications.

END OF SECTION

AUDIO VISUAL NURSE CALL SYSTEM

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PART - 1 GENERAL

GENERAL REQUIREMENTS

- .1 Conform to Sections of Division 1 as applicable.
- .2 Conform to Section 26 05 01, Electrical General Requirements.
- .3 The new system components shall be CSA and/or UL approved Standard 1069 Hospital Signaling and Nurse Call Equipment. Transistors, capacitors, integrated circuits, and other components shall not be operated to exceed their rated values. Design systems for 24-hour continuous operation
- .4 Refer also to Sections regarding Code Blue and Code White
- .5 Conform to the "Sunnybrook – Code White, Code Blue & Nurse Call Installation policy" appended to this Specification

WORK INCLUDED

- .1 Work to be done under this Section shall include furnishing of labour, materials, and equipment required for installation, testing and putting into proper operation complete systems as shown as specified and as otherwise required.
 - .1 New single Enhanced Two additional call input jacks Audio Visual Patient Bed Stations
 - .2 4 position corridor dome lights;
 - .3 Staff Terminal Stations and ceiling Speakers for Decontamination Room Patient to Nurse Communication
 - .4 wiring as per system manufacturer's requirements, run in conduit and provision of required ancillary devices; (coordinate supply and installation of wiring with Electrical Contractor
 - .5 integration of system with other nurse call systems of complex, coordinate with Sunnybrook IS to integrate R5 system with existing Connexall alarm management;
 - .6 plexi-covers for stations as indicated on drawings including emergency response buttons;
 - .7 ring tones to match other devices serving same area;
 - .8 nurse call devices to ring at consoles designated by Owner.
 - .9 ancillary devices as required for a complete system;
 - .10 end to end testing and verification of new and old rooms on systems with plant and users as part of verification training time 2-4 hours; preparation of test reports;
 - .11 providing technical assistance to Electrical Contractor with regards to conduit, wiring and component installation requirements.
- .3 Generally, Electrical Contractor is responsible for following:
 - .1 arranging and coordination of system vendor's work to clearly identify responsibilities of system vendor and Electrical Contractor;
 - .2 supervision of system vendor onsite;
 - .3 provision of system conduits and boxes, power feeders, to suit system requirements and as per requirements of Section 26 05 00 and as per system manufacturer's requirements;
 - .4 installing system components, wiring, wiring accessories, and identification and labelling of each wiring run; (coordinate supply and installation of system wiring with system vendor;
 - .5 assist system vendor in onsite system testing, inspection and verification work upon completion of each phase (as applicable);
 - .6 submission of copies of testing and verification reports signed by manufacturer's authorized representative and by Electrical Contractor;

- .7 preparing as-built drawings and other submittals to requirements of Section 26 00 10.
- .4 Upgraded consoles, stations and other products to be 100% compatible to upgraded system and hospital's existing alarm management system (Connexall). Prior to submission of shop drawings, contact Owner's Project Manager and department user representative to confirm exact model and version of products to be supplied.
- .5 The system to be based on provision of a Rauland Borg "Responder 5" voice over IP based audio/visual nurse call system. The system to be a multiplexed solid-state microprocessor based networked system providing two-way full duplex voice communications between any console(s) and patient stations, and staff/duty stations. Provide equipment, accessories and material required for the installation of system. Any material and/or equipment necessary for the proper operation of the system not specified or described herein is to be deemed part of this specification. The equipment described and provided to be the standard product of one manufacturer.
- .6 Components and system as a whole to meet or exceed the minimal standards issued by CSA, EEMAC and ULC. The system to also be compliant with requirements of UL-1069. Each major component to bear the manufacturer's name, catalogue number, place of manufacture and CSA/ULC label.
- .7 The system to be UL 1069 listed as a Nurse Communications Network. The system to be capable of interconnecting with the hospital's LAN (Local Area Network). This connection to be minimal and utilize only one Ethernet 100 Mbps (or optionally 1 Gb) connection to accomplish all ADT, hospital information, reporting software and information exchange. The HL-7 standard to be confirmed with Owner to be utilized for receipt of patient information from the ADT system, as required by Owner.
- .8 The system head end equipment and software to also be capable of handling an additional minimum 20% future expansion. Include for sufficient cabinet/panel/rack spaces, sufficient power supplies, and sufficient space for future zone/device connection modules and include in system software programming to easily accommodate future expansion requirements.
- .9 System sequence of operation to be confirmed with and approved by Owner prior to start of work.
- .10 Existing system stations and components being disconnected and not re-located for use on this project, to be properly decommissioned, packaged, identified with label and turned over to Owner.

2 PRODUCTS

2.1 STAFF TERMINAL STATIONS

- .1 Dynamic device which supports various workflows and two-way communication between staff members and Patient Room ceiling Speakers.
- .2 Full-duplex audio communication.
- .3 Wall-mounted.
- .4 Complete with Emergency Call Button where indicated
- .5 Functionality:
 - .1 Place or answer calls with other nurse call devices;
 - .2 Place Emergency (Staff Assist) calls where indicated.
 - .3 Announce other calls on the Nurse Call System.

2.3 DUTY STATIONS

- .1 Dynamic device which supports alarms on the local Nurse Call.
- .2 Full-duplex audio communication.
- .3 Wall-mounted (over the Patient Room door where indicated)
- .4 Functionality:
 - .1 Display/ Alarm calls from the respective Nurse Call in-room Devices.

2.4 SINGLE PATIENT STATION

The single patient bedside station shall contain all the necessary electrical components to support all stations within the room, including the Lavatory Stations, the Code Blue Stations, the Code White Stations, the Staff Emergency Stations, manual or automatic presence stations, and four-section corridor lights

Stations shall include:

- Two additional call input jacks
- jack for Pillow Speaker and for other ancillary devices

2.5 LAVATORY EMERGENCY STATIONS

The lavatory emergency station shall provide audio and visual communication with the Patient. The Station shall include a pull cord version, equipped with a built-in Speaker/ Microphone, a CANCEL button and call assurance LED, all mounted on a two-gang, non-conductive chassis.

2.6 CORRIDOR LIGHTS

Multi section corridor lights, suitable for wall or ceiling mounting, shall be provided outside the entrance to each patient room and all staff/duty rooms, clearly visible from all directions.

The chassis, similar in design and material to the patient station, shall accommodate four long-life, colour-coded lamps, separated by snap-in metal barriers to meet the functional requirements of each room.

PART 3 - EXECUTION

3.1 INSTALLATION

- .1 Provide a complete extension to the existing audio-visual nurse call system as shown on the drawings and specified herein. Install equipment in accordance with manufacturer's instructions
- .2 Interconnect equipment.
- .3 Provide specified various nurse call systems components in areas as shown and as required. Programme system on servers/terminals/nurse consoles, as required. Obtain Owner's approval of room nomenclature prior to start of programming. Customize software to suit Owner's specific applications. Program sequence of operation and user information as required. Include for system manufacturers authorized representative to program systems. Programme exact programming requirements as confirmed with Consultant and/or Owner in writing prior to start of Work. Utilize manufacturer's recommended configuration chart during installation and record respective device names, serial number, room name and number and comments, as outlined on sheets. Submits sheets with test reports.
- .4 Locate head end equipment, terminal cabinets, racks, patch panels, UPS, and central computer terminal in locations as shown and/as directed by Consultant. Locate equipment in electrical or telecom closets or as noted. Provide terminal cabinets/panels as required, and locate in electrical or telecom closets as approved by Consultant. Do not locate in ceiling spaces or public/patient areas, corridors, stairways or offices. Ventilate areas as required for proper equipment performance. Confirm cabling standards with system manufacturer and perform installation to suit standards. Clearly label each cable run and port. Install devices in strict accordance with system manufacturer's instructions and recommendations.
- .5 Provide power receptacles, feeders, data jack/drop as required to accommodate for installation of new head-end equipment. Exact locations to be confirmed with Consultant prior to roughing-in. Coordinate work of all trades.
- .6 Provide dedicated conduit feeder(s) into the equipment cabinets and UPS units. Generally, required sizing of breakers, feeders and conduits to be as noted on drawings, but in absence of directions, size distribution to local governing electrical code requirements to
- .7 Provide stations and install into locations. Install components at the mounting heights as

- noted on drawings, on architectural elevations and as required and confirmed with Consultant. Generally, wall mount devices onto recessed boxes. Provide suitable conduits and backboxes to accommodate device installations. Confirm back box requirements with system vendor prior to roughing-in.
- .8 Generally, install new dome lights in locations as shown but reviewed with Consultant prior to roughing-in. Connect patient room smoke detectors to new dome lights and remote communicators, as applicable. Coordinate work with fire alarm system technicians of fire alarm system vendor. Install zone lights to ceilings on recessed boxes in locations
 - .9 Generally, install emergency call stations of pull cord type in locations as shown. Silicone seal between the wall and the device to prevent water from entering the device for all devices located in wet locations including but not limited to showers.
 - .10 Provide system wiring. Wiring to be copper conductor, colour coded, and in accordance with the system manufacturer's recommendations and instructions. Connect equipment in accordance with the system manufacturer's certified wiring diagrams and instructions and under direct supervision of the manufacturer. Provide and arrange for authorized system manufacturer's representative to make final equipment connections. Run conductors in conduit or where identified on drawings, in cable tray.
 - .11 Perform system integration connections to various systems as required. Include costs for systems service vendors to perform required integration and programming requirements.
 - .12 Ground and bond system as required by local governing electrical code and authority and system manufacturer.
 - .13 When work is complete, arrange for attendance at the site of the system manufacturer's authorized representative to make final equipment connections and provide testing and verification requirements.
 - .14 Provide signed documented test report verifying that system components have been tested successfully and that the system is in proper working order. Testing and verification of system to be witnessed by the Consultant and Owner at times approved by Consultant.

3.3 SYSTEM TRAINING, INSTRUCTIONS AND TRAINING UNIT

- .1 Provide to Owner's designated staff, onsite training sessions to Owner's designated personnel on the operation and maintenance procedures with regards to the system. Each session may be held on different days and locations, at Owner's discretion. Exact times and dates to be coordinated with and approved by Owner.

END OF SECTION

CODE WHITE SYSTEM

27 52 23

PART - 1 GENERAL

1.1 GENERAL REQUIREMENTS

- .1 Conform to Sections of Division 1 as applicable.
- .2 Conform to Section 26 05 01, Electrical General Requirements.
- .3 The system shall be CSA and/or UL approved Standard 1069 Hospital Signaling and Nurse Call Equipment.
- .4 Transistors, capacitors, integrated circuits, and other components shall not be operated to exceed their rated values. Design systems for 24-hour continuous operation.
- .5 **Conform to the “Sunnybrook – Code White, Code Blue & Nurse Call Installation policy” appended to this Specification**

1.2 CODE WHITE SYSTEM

1.3 WORK INCLUDED

- .1 Work to be done under this Section shall include furnishing of labour, materials, and equipment required for installation of Code White System as shown as specified and as otherwise required.
- .2 System will include the following:
 - .1 Supply and installation of control equipment including auxiliary power supplies.
 - .2 Supply and installation of all system equipment and devices (both Pushbuttons and Wireless Receivers as shown).
 - .3 Supply and installation of all wiring required for complete system operation.
 - .4 All required system programming, testing and verification.
 - .5 Complete layout, wiring and installation diagrams for overall system design.
 - .6 Complete instruction to Owner on system operation.
 - .7 Technical data on each product, including finishes.
 - .8 Factory prepared operation and service manual for each system, operation details, schematics, wiring diagrams, colour coding, terminal numbers, and component values for printed circuit boards.

1.4 SYSTEM VERIFICATION

- .1 Test and demonstrate the operation of the complete system to the Owner. This shall include, but not be limited to:
 - .1 detailed test and demonstration of each operable device
 - .2 detailed test and demonstration of overall system operation
 - .3 interfacing of various components.

- .2 On completion of the installation the manufacturer/supplier shall supply a certificate, together with detailed inspection record sheets showing location of each device and certifying the test results per unit, confirming that the system is installed and operates in accordance with Specification.

PART - 2 PRODUCTS

2.1 GENERAL

- .1 The Specifications for this system are a description of the various components with the minimum requirements of the operational sequence, facilities and features required.

2.2 CODE WHITE (PERSONAL ALERT PANIC ALARM) SYSTEM

- .1 Provide, as indicated on the plans, a wireless Code White (Personal Alert Panic Alarm) System complete with a fixed location Code White Button. The System shall be integrated to the existing Hospital Central Code White System. Buttons shall be located where indicated on the drawings and provide adequate coverage insuring system operation anywhere within each room.
- .2 The system shall permit staff , when activating the Code White Button, signal emergency call placement causing the following to occur;
 - .1 annunciate on the local annunciator,
 - .2 simultaneously signal the main security office via a new remote console installed within the security office.
 - .3 **Simultaneously send a signal to the Unit entry doors to release the magnetic locks (permitting Security un-restricted entry). Locks shall remain un-locked until the Code White is reset**
- .3 The system shall include all necessary hardware and software permitting the future integration to the facilities in house pocket paging system enabling Code White calls to be dispatched to security personnel remotely via alpha-numeric pocket pager.
- .4 Discreet annunciation shall be provided by the Code White system at the local annunciator via a touch screen master console, and at the Security Office defining the call type and pinpointing location by room number where the call originated.
- .5 **Manufacturers**
 - .1 **The manufacturer for this system to be manufactured/ supplied by:**
 - **For Pushbuttons: Rauland, and as supplied by Aatel Communications.**

PART - 3 EXECUTION

3.1 INSTALLATION

- .1 Provide a complete Code White System as shown and as specified.
- .2 Install Code White Buttons as indicated on Drawings with suitable backboxes.
- .3 Wiring to be of a type recommended by manufacturer, to be colour-coded, and to be installed in conduit.
- .4 Provide interface wiring from Code White System to the existing Central Code White System via the Hospital Network.

.5 Test complete installation.

END OF SECTION

CARDIAC ARREST SYSTEM

27 52 24

PART - 1 GENERAL

1.1 GENERAL REQUIREMENTS

Conform to Sections of Division 1 as applicable.

Conform to Section 26 01 01, Electrical General Requirements.

The system shall be CSA and/or UL approved Standard 1069 Hospital Signaling and Nurse Call Equipment.

- .4 Conform to the "Sunnybrook – Code White, Code Blue & Nurse Call Installation policy" appended to this Specification

1.2 SHOP DRAWINGS AND PRODUCT DATA

Submit shop drawings and product data in accordance with Section 26 05 01 Electrical General Requirements.

Include: Details for devices.

1.3 WORK INCLUDED

Work to be done under this Section shall include furnishing of labour, materials, and equipment required for installation, testing and putting into proper operation complete systems as shown as specified and as otherwise required.

Equipment design considerations for future expansion when indicated.

Materials list and backbox schedule (including unique backboxes).

Factory prepared operation and service manual for each system, operation details, schematics, wiring diagrams, colour coding, terminal numbers, and component values for printed circuit boards.

1.4 OPERATION AND MAINTENANCE DATA

Provide operation and maintenance data for incorporation into manual specified in Section 26 05 01 Electrical General Requirements.

1.5 MAINTENANCE MATERIALS

Provide maintenance materials as required and as specified in Section 26 05 01 Electrical General Requirements.

1.6 OPERATING AND MAINTENANCE INSTRUCTIONS

Provide operating and maintenance instructions as specified in Section 26 05 01 Electrical General Requirements.

1.7 SYSTEM VERIFICATION

Test and demonstrate the operation of the complete system to the Owner. This shall include, but not be limited to:

detailed test and demonstration of each operable device

detailed test and demonstration of overall system operation
interfacing of various components.

On completion of the installation the manufacturer/supplier shall supply a certificate, together with detailed inspection record sheets showing location of each device and certifying the test results per unit, confirming that the system is installed and operates in accordance with Specification.

1.8 **OPERATION**

If any Cardiac Arrest station is operated by Code Blue Button, the following events to take place simultaneously and continuously until reset:

- a call placed light to appear at the station originating the call, identifying blue.
 - a dome light to become illuminated and flash steadily at the ceiling over the door to the room where the call originated
 - a light to flash steadily in the annunciator at the associated nurses' stations and a signal to sound at two (2) second intervals
 - a pilot light to be illuminated in an annunciator to identify the general area at the communications Centre and a signal to sound at two (2) second intervals
- Simultaneously send a signal to the Unit entry doors to release the magnetic locks (permitting un-restricted entry). Locks shall remain un-locked until the Code Blue is reset**

To reset the call, the switch which originated the call to be returned to its original position. It to not be possible to cancel the call from any other location.

PART - 2 PRODUCTS

2.1 **GENERAL**

The Specifications for this system are a description of the various components with the minimum requirements of the operational sequence, facilities and features required.

2.2 **CALL PLACEMENT STATIONS**

Each station to include the following:

- backbox of required dimension
- call placed switch
- call placed light
- reset feature

2.3 **DOMelight**

Dome light to be single gang with trim and to feature blue plastic or alternatively clear plastic with blue lamp.

If combined with nurse call system, dome light to be two-gang with barriered sections.

2.4 **MANUFACTURER/ SUPPLIER:**

System shall be as manufactured by Rauland (Responder 5) and as supplied by Aatel Communications

PART - 3 EXECUTION

3.1 **INSTALLATION**

Provide a complete Cardiac Arrest (Code Blue) System as shown and as specified.

Install call placed stations at elevations indicated on Drawings with suitable backboxes and plaster rings.

Install dome lights on ceiling at door to room originating call.

Wiring to be of a type recommended by manufacturer, to be colour-coded, and to be installed in conduit.

Test complete installation.

END OF SECTION

CLOCK SYSTEM

27 53 13

PART - 1 GENERAL

1.1 GENERAL REQUIREMENTS

- .1 Conform to Section 26 01 01, Electrical General Requirements.
- .2 Conform to Section 26 05 01, Electrical Basic Materials and Methods.
- .3 Conform to Section 27 15 00, Communications Cabling.

1.2 REFERENCES

- .1 Industry Canada specifications RSS 119 Issue 6.
- .2 Bluetooth wireless technology standard 4.1.

1.3 WORK INCLUDED

- .1 Work to be done under this Section includes furnishing of labour, materials, software and equipment required for installation, testing and putting into proper operation complete systems as shown as specified and as otherwise required.
- .2 Furnish and install all system devices, accessories, and materials in accordance with these specifications and drawings to provide a complete and operating Wireless Clock System using the Primex OneVue platform. The model designations are that of Primex.
- .3 System to include the system devices below:
 - .1 **Digital Clocks**

1.4 SYSTEM DESCRIPTION

- .1 General Specifications
 - .1 System to provide synchronized time by way of system devices and a cloud-based system software hosted by the Manufacturer that allows Owner to manage and monitor system devices.
 - .2 System shall consist of system Clocks enabled with IP Ethernet/PoE technology.
 - .3 System shall provide synchronized time by way of system devices connected to IP Ethernet/PoE network
 - .4 System shall not require the installation of any onsite system hardware or software, with the exception of the specified system devices.
 - .5 Clocks shall be capable of automatically adjusting for Daylight Saving Time.
 - .6 Clocks shall be fully portable, capable of being relocated at any time.
 - .7 Clocks shall receive UTC time from a Network Time Protocol (NTP) time source; allow up to three NTP time sources for failover purposes.
 - .8 Clocks shall operate with a free-running accuracy of .45 seconds per day, and will continue to operate in the absence of receiving the UTC time from an NTP time source.

- .2 System devices with Ethernet network communication
 - .1 Network Communication Protocols: Hypertext Transfer Protocol Secure (HTTPS) | IP Addressing: Dynamic Host Configuration Protocol (DHCP), static IP addressing | Data Packet Size: typically less than 5 kilobytes (kB).
 - .2 Network setting data is stored locally in devices shall be encrypted and access to locally stored setting data can be controlled by a system admin user.
 - .3 Manufacturer to provide stand-alone configuration software to locally configure a device to meet Owner security policies if network setting data cannot be stored in third-party software or to troubleshoot device network connectivity issues.
- 1.5 **SHOP DRAWINGS AND PRODUCT DATA**
 - .1 Submit samples and cut sheets of clocks for review and selection of the desired types and styles. Samples to be equivalent to the specified types and styles.
 - .2 Provide one additional set of reviewed drawings, shipped with the equipment, for start up and maintenance use.
 - .3 Include with the shop drawings;
 - .1 description of system operation,
 - .2 riser diagrams.
- 1.6 **OPERATION AND MAINTENANCE DATA**
 - .1 Include detailed instructions to permit effective operation and maintenance of the equipment.
 - .2 Technical data to be included;
 - .1 Setup and operation instructions,
 - .2 Cut sheets with specification for each component used in the system,
 - .3 List of spare parts included with the system,
 - .4 Illustrated parts lists with part catalogue numbers,
 - .5 "as built" layout, wiring and installation diagrams.
- PART - 2 PRODUCTS**
 - 2.1 **SYNCHRONOUS CLOCK SYSTEM**
 - .1 General
 - .1 The system and equipment is specified as described in this section.
 - .2 All bids to be based on the equipment as specified herein. **The model designations are that of Primex.**
 - .2 System Software:
 - .1 Basis of Design Software Product: Primex OneVue
 - .2 System Software Platform: Cloud-based software platform that resides on Amazon Web Services (AWS) and is accessed via the internet.
 - .3 System stores and monitors system devices operating conditions.

- .4 All system device and system settings are managed within the system software.
- .3 Digital Clocks:
 - .1 **The clock LED display must include a 12- or 24-hour time display, a PM indicator light, and an alternating time and date display option.**
 - .2 Clock to be capable of automatically adjusting for Daylight Saving Time.
 - .3 Power over Ethernet (PoE) models shall have an IEEE 802.3af compliant power supply built into the clock assembly.
 - .4 Clock shall have a power outage memory backup and maintain the correct time up in its memory for a minimum of 1 hour without power.
 - .5 Clock shall be viewable from 150 ft. (45.7 m).
 - .6 Clock shall have highly visible 7-segment LED digits.
 - .7 Clock shall have display dimmer options, including 100%, 75%, 50%, and 25%.
 - .8 Clock enclosure shall be ABS plastic and junction box shall be UL listed (UL 50E 1st Ed; listing number E469550).
 - .9 SUPPLY MODELS - Digital Clocks
 - Surface Mount 2.5" Digits
 - Number of Digits: 6 Digit
 - .10 Digit Color: Green
 - .11 Bracket: 4" Slope Bracket,
- .4 System Verification
 - .1 Test and demonstrate the operation of the complete system to the Owner, including:
 - a) **test and demonstration of overall system operation,**
 - b) **test and demonstration of each operable device,**
 - .2 On completion of the installation, manufacturer/supplier to supply documentation including:
 - a) **record sheets showing the location of each device,**
 - b) **record sheets showing the test results for each device,**
 - c) **a certificate confirming that the system is installed and operates in accordance with the Specifications and the Manufacturer's recommendations.**

Standard of Acceptance

Primex OneVue

Supplied by:

Troy Life & Fire Safety Ltd.

Luch Condarcuri

Fire Systems Sales Representative

T: 905 672 5348 ext 303

C: 647 331 0093

luch.condarcuri@troylfs.com

PART - 3 EXECUTION

3.1 EXAMINATION

- .1 Examine conditions with the Installer present for compliance with requirements and other conditions affecting the performance of the system and system devices.
- .2 Do not proceed until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- .1 General: Install system devices in accordance with applicable codes.
- .2 Install system devices in accordance with Manufacturer written instructions.
- .3 Provide all system equipment necessary for a complete and operable system.
- .4 Comply with requirements of Division 27 Sections "Common Work Results for Communications" and "Communications Horizontal Cabling."
- .5 Inspection: Make observations to verify that system devices and components are properly labeled.
- .6 Prior to final acceptance, inspect each system device and component, adjust as required, and replace parts that are found defective.
- .7 At the completion of system device installation and prior to final acceptance, turn on the equipment; ensure that all equipment is operating properly and that the system software and all system devices and components are functioning.
- .8 Commissioning General: Provide system commissioning in accordance with Manufacturer written recommendations. Perform operational testing to verify compliance with requirements. Adjust as required.
- .9 Services shall include a specified level of commissioning services.
- .10 Remote commissioning service: system deployment training, including system setup, device configuration, and system functionality by way of a web conference.
- .11 Onsite commissioning service: system training, system setup, validation of device configuration and system functionality, verification of device network connections, and device installation training.
- .12 Onsite installation and commissioning service: system training, configuration, validation of device configuration, training on system functionality, verification of device network connections, and device installation.
- .13 **CLEANING**
 - .1 Prior to final acceptance, clean exposed surfaces of devices, using cleaning methods recommended by Manufacturer.
 - .2 Perform cleanup as work progresses and leave the work area clean at the end of each day.
- .14 **DEMONSTRATION**
 - .1 Initial Demonstration: provide a demonstration to identified OWNER facility staff that is responsible to maintain the system.

- .2 Demonstrate maintenance procedures for system devices.
 - .3 Demonstrate the system features, including monitoring and management of system devices.
- .15 **PROTECTION**
 - .1 Protect finished installation until the final project acceptance.
 - .2 Repair damage to adjacent materials caused by the system installation.
- 3.3 **CLOCKS:**
 - .1 Do not install clocks until painting and other finish work in each room is complete.
 - .2 Locate clocks 450 mm (18 in) below finished ceiling unless indicated otherwise.
 - .3 Provide a deep recessed receptacle at each clock.
 - .4 Provide new batteries in battery powered clocks.
 - .5 Set clocks to correct time, time zone, Standard/Daylight Savings Time and date.
 - .6 Adjust the display brightness of each digital and combination clock to suit both daytime and nighttime illumination levels, to the satisfaction of the Owner.
 - .7 Prior to final acceptance, clean exposed surfaces of clocks, using cleaning methods recommended by clock manufacturer.
- 3.4 **WIRING**
 - .1 Provide wiring as required for a complete, fully operating system.
 - .2 Provide wiring in accordance with the recommendations of the clock system manufacturer.
 - .3 Install wiring in conduit.
- 3.5 **TESTING**
 - .1 Conduct complete testing of the system to verify:
 - .1 operation during loss of power,
 - .2 operation on generator power,
 - .3 ability to correct secondary clocks,
 - .4 ability to restore correct time following loss and restoration of power,
 - .5 Daylight Saving Time adjustment,
 - .6 time zone adjustment.
 - .2 Submit a written report, identifying the results of the above tests and certifying that the system has been installed correctly and is functioning correctly.
 - .3 Assist the manufacturer in conducting the manufacturer's verification of the system. Submit a written report, prepared by the system manufacturer, identifying the verification results and certifying that the system has been installed in accordance with the manufacturer's recommendations.

3.6 **TRAINING**

- .1 Provide the Owner's staff with complete training in the operation and maintenance of the system and it's components. Allow for two separate (repeat) sessions so that all of the Owner's facility personnel can attend.

END OF SECTION

**3RD PARTY FIRE ALARM VERIFICATION
28 08 15**

PART - 1 GENERAL

1.1 GENERAL REQUIREMENTS

- .1 Conform to Sections of Division 1 as applicable.
- .2 Conform to Section 26 05 01, Electrical General Requirements.

1.2 WORK INCLUDED

- .1 The Division 26 contractor shall retain and pay for the services of an Independent 3rd Party Fire Alarm Verification Specialist Firm to provide Fire Alarm and Emergency Voice and Communications System Inspection and Verification services in accordance with the details specified herein. This does not eliminate the requirement for the Fire Alarm System manufacturer to perform testing and verification as part of their scope of work as indicated in Section 28 31 19 - Addressable Fire Alarm System.
- .2 The Division 26 Contractor shall include in the Bid Amount the cost for the services of tradesmen to handle equipment, make temporary connections, operate equipment and make repairs and adjustments and assist the verification organization's on-site specialists during the on-site inspection, testing, and verification phase of the work.
- .3 The Bidders for Division 26 work shall advise all fire alarm equipment suppliers bidding for the equipment supply for this project prior to Bid close of the requirement for comprehensive 3rd party verification and ensure the services and associated costs on the part of the fire alarm equipment supplier are included in the suppliers' quotations for the project and in the Division 26 bid amount.
- .4 The Owner Fire Prevention Coordinator will also be involved to witness Verification. Contractor to co-ordinate with Owner.

1.3 GENERAL SCOPE

- .1 Witness and provide 3rd party verification of the Fire Alarm, Emergency Voice Communication System, and submit completed typed copies of inspection record sheets as described herein. Ensure that the complete system is left fully functioning.
- .2 Provide adequate qualified technicians to witness the complete system verification being performed under the Div 16 contract in accordance with the Division 26 contractor's schedule. Provide any necessary equipment, test apparatus, ladders and scaffolding as required.
- .3 The Fire Alarm & Emergency Voice Communication System supplier will undertake testing and verification of their system in accordance with applicable standards and the Authorities Having Jurisdiction over the project.

1.4 VERIFICATION REPORTS

- .1 Submit verification reports in accordance with Section 26 05 01 Electrical General Requirements.

1.5 **ACCEPTABLE AGENCIES FOR INDEPENDENT 3RD PARTY WITNESS OF TESTING
AND VERIFICATION.**

- .1 The firm selected for the independent 3rd party witnessing of the testing and verification of the Fire Alarm, Emergency Voice Communication System shall be suitably recognized by the Professional Engineers of Ontario. Completed copies of reports shall be submitted directly to the Consultant as well as part of the requirements for shop drawings/data books
- .2 The independent agency shall act as an independent witness on behalf of the Owner of the complete testing and verification of the fire alarm system.

Standard of Acceptance

- ° Insta Tech (416 565-6762)

PART - 2 SCOPE OF WORK

2.1 **GENERAL**

- .1 System verification shall be in accordance with the current CAN/ULC-S537" Standard for the Verification of Fire Alarm System". On completion of the verification, the witnessing agency shall submit directly to the Owner one signed certificate together with detailed inspection record sheets outlining location of each system, item, device and certification of the test results per unit. The certificate must clearly confirm that the system is installed, supervised and operates in accordance with the Project Specification and applicable Codes and Regulations.

2.2 **SYSTEM VERIFICATION**

- .1 Make a detailed inspection of all components installed for the Fire Alarm, Emergency Voice Communication System to ensure the following:
 - .1 The completed installation is in accordance with:
 - (a) Project Specification and Drawings
 - (b) ULC requirements
 - (c) Manufacturer's recommendations and guidelines
 - .2 Wiring has been inspected at each device and that wire type, gauge and colour coding are in accordance with the Project Specification.
 - .3 Each manual pullstation, thermal detector, smoke detector, sprinkler flow switch, sprinkler supervisory switch and signalling device are in compliance with the ULC Standards, and that the installation details are in accordance with CAN/ULC-S524.
 - (a) each and every device has been inspected for apparent damage which may interfere with its operation
 - (b) every device has been tested for alarm situation and trouble initiation and circuit polarity
 - (c) the emergency firefighter's telephones have been tested and that two-way voice communication is clear and audible, and that indications at Communication Centre and applicable local control panels are correct.
 - (d) adjacent EVAC speakers have been connected to alternate circuits and that speakers are properly zoned.

- (e) each zone has been tested for remote bypass "Activation" and "Restoration" from the fire alarm video terminal in the power plant.
- .4 The most remote device on each circuit receives operating power. Also confirm that replaceable over-current protection devices are inspected for proper rating. Where new devices (i.e. door holders, magnetic locks, fan shutdown relay, EVAC speakers) are added to the circuit, ammeter load readings are taken and recorded for that circuit.
- .5 Non-damaging tests shall be applied to all the new smoke detector(s) and rate of rise heat detector(s) to activate an alarm in the Communication Centre. In the event that new smoke detectors, heat detectors or pullstations are added to an existing zone, apply simulated test to one randomly-picked existing device in the same zone. Verify printout of the alarm on the Video terminal printer.
- .6 Each alarm and trouble initiating device properly activates the Fire Alarm System such that the Communication Centre and all Annunciator Panels indicate the Zone(s) and the building from which the alarm or trouble originated. The zone description shall match the assigned zoning schedule.

PART - 3 EXECUTION

3.1 REPORTS

- .1 Prepare and submit the following reports. Simultaneously submit one copy directly to the engineer and a further 6 copies to the contractor to be processed as a shop drawing:
 - .1 Site Verification Report for each area requiring partial occupancy within 5 working days of completion of site test.
 - .2 Site verification report(s) reflecting each significant phase of system completion.
- .2 Complete and submit in binder form 6 copies of detailed inspection sheets including Appendix "C", Items "C1", "C2", "C3", "C4", "C5", "C6" and "C7" of the CAN/ULC-S537-97 Standard. In lieu of the ULC Appendix "C", the Verification Agent's own Standard forms, together with the completed Fire Alarm and Voice communication System Verification Report Summary will be accepted if in a comparable format. Information must be clearly defined and legible.
- .3 Completed reports shall also be included as part of the project maintenance manuals / data books.

END OF SECTION

SECURITY CCTV SYSTEM

28 23 01

PART - 1 GENERAL

1.1 GENERAL REQUIREMENTS

- .1 Conform to Sections of Division 1.
- .2 Conform to Electrical General Requirements

1.2 WORK INCLUDED

- .1 **The Hospital currently have, and it is the Scope of this Project to expand the existing, Central CCTV System Network and Network Video Recording/ Monitoring System. The expansion involved in this project are as follows:**

- **'Cat 6' Cabling from new Cameras and Monitors to Security System "Hub" terminated in 'Cat 6' Jacks at both ends**
- **Cat 6 Patch Cables, as required**
- **Installation must implement latest Avigilon Platform and must include integration of the new Cameras/ Monitors into the existing System. It is imperative that the new CCTV Cameras be integrated into the now fully functional Avigilon CCTV NVAR "Cluster" installed in the existing Security Server Room CB-11**

Work to be done under this Section shall include furnishing of labour, materials, and equipment required for installation, testing and putting into proper operation complete CCTV systems as shown, as specified and as otherwise required. Electrical Contractor shall ensure complete systems shall be left ready for continuous and efficient satisfactory operation.

Details of Typical Camera Network Cabling, Network Racks, Patch Panels (Cat 6 and Fibre), UPS System, Patch Cables, etc. shall be as specified in Section 28 15 00.

- .2 The system, including all components and appurtenances, shall be configured and installed to yield a mean time between failure (MTBF) of at least 10,000 hours, and shall be calculated based on the configuration specified.
- .3 Provide equipment, wiring and other materials for a complete and operational closed circuit television (CCTV) system. The system shall be modular and expandable as herein specified or as the Owner may direct up to full system capacity.
- .4 The system shall consist of state-of-the-art, IP Based programmable dome cameras, various lens sizes, mounts, housings, associated controls.
- .5 Provide low voltage power supplies where required.
- .6 Provide line extending equipment for long distance cabling in Network Based applications.
- .7 Provide suitable low voltage power and connect signal wiring to suit manufacturers' recommendations.
- .8 Provide and test for proper operation, a colour low light level security CCTV system to include focus, resolution and signal level.

- .9 The CCTV system is intended to give clear views of both the site and any one individual, such that the security department can use the video for recognition purposes. The lens shall be chosen by the contractor, in order to achieve the proper result.

1.3 **SYSTEM SUPPLIER**

- .1 The entire CCTV System shall be fully compatible with connection, monitoring and recording via the Avigilon™ Server Hardware and Storage Expansions Model 10.0TB-HD-NVR2 supplied, installed and commissioned by a certified experienced Security Contractor acting as a Sub Contractor to this Division. The approved Security Sub Contractor shall be:

OHM Security LTD
Attn: Andrew Browne
Phone: 905-299-8255
Email: andrew.browne@ohmsecurity.com

1.4 **CCTV INTEGRATION REQUIREMENTS**

- .1 The CCTV Contractor shall be included as part of this project and will be certified in the solution provided as per this specification.
- .2 Provide SDK for CCTV video management system that will enable access control events to cause the change in the recording frame rate of the associated CCTV views. The system shall automatically select and present ready for operator review of the recording of the associated CCTV views for a pre-selected time window prior to the event and after the event.
- .3 The selected and alarm events on the system shall cause immediate security staff notification. On the CCTV system they shall initiate change in the recording frame rate of the associated CCTV views and the security system shall automatically select and present ready for operator review of the recording of the associated CCTV views for a pre-selected time window prior to the event and after the event.
- .4 The video surveillance System shall be interfaced to the Access Control system such that selected Physical Access Control events shall cause the associated video surveillance camera(s) view(s) to be called up on a specified monitor at specified operator station(s). Access Control system is Keyscan.
- .5 The Video Management System shall integrate with Networked Digital Video Recording system.
- .6 This contractor will be responsible to work with the Sunnybrook Project Manager to deliver the required solution. This will include working with Sunnybrook IT Department, to implement and onboard the solution on to the Security VLAN Network.
- .7 The successful proponent will be required to attend all project meetings along with any conference call and/or meetings with Sunnybrook IT department to facilitate the solution through the onboarding process. This contractor shall produce and distribute minutes of meetings.
- .8 This will include but not limited to providing system requirements any antivirus and firewall port exceptions. They will also be required to populate and complete all Sunnybrook Forms and Sunnybrook collaboration sheets to complete the above denoted tasks.
- .9 The Contractor shall attend meetings with an Owner representative and key staff to identify the specifics of the system programming and integration into Sunnybrook's Security VLAN Network.

- .10 The Contractor shall be responsible to record all decisions and parameters discussed during these meetings. The Contractor shall submit in a document all configurations, parameters and receive approval for all programming parameters prior to implementation.

- .11 The Contractor shall ensure that the operation of the system matches and meets the programming requirements determined in the pre-installation meetings.

1.5 **QUALITY ASSURANCE**

- .1 The entire closed circuit television system shall be designed in accordance with and conform to the requirements of:

- .1 Canadian Standards Association (CSA)
- .2 Ontario Hydro Safety Code
- .3 Underwriters' Laboratories Canada (ULC)
- .4 Provincial and Local Bylaws and Regulations

1.6 **SHOP DRAWINGS**

- .1 Submit complete sets of shop drawings following an award of order. Shop drawings shall include copies of dimensional drawings completely describing installation that will be performed with relation to the space available for installation.

- .2 Part of the shop drawings submittals shall be a Functional Design Manual and Technical Data Package.

- .1 The functional design manual shall identify the operational requirements for the system and explain the theory of operation, design philosophy, and specific functions.
- .2 A description of hardware and software functions, interfaces, and requirements shall be included for all system operating modes.
- .3 The Contractor shall prepare Technical Data Package with test procedures and reports for the performance verification test and the endurance test.
- .4 The contractor shall provide a report detailing the results of the field test and a video tape as specified in paragraph Contractor's Field Testing." The final performance verification and endurance test report shall be delivered after completion of the tests.

1.7 **MANUFACTURERS' DATA**

- .1 Submit data in the form of catalogue cuts or special data sheets as prepared by the manufacturer.

1.8 **OPERATION AND MAINTENANCE MANUALS**

- .1 Submit copies of parts, lists and preventive maintenance requirements for systems to be installed.
- .2 A draft copy of the operation and maintenance manuals shall be delivered to the Owner's prior to beginning the performance verification test for use during site testing.

- .3 The maintenance manual shall describe maintenance for all equipment including inspection, periodic preventive maintenance, fault diagnosis, and repair or replacement of defective components.

1.9 **OPERATOR'S MANUAL**

- .1 The operator's manual shall explain all procedures and instructions for operation of the system:
 - .1 Cameras equipment
 - .2 Use of the software
 - .3 Operator commands
 - .4 System start-up and shut-down procedures
 - .5 Recovery and restart procedures
 - .6 Hardware Manual
- .2 A manual shall describe all equipment furnished, including:
 - .1 General hardware description and specifications.
 - .2 Installation and checkout procedures.
 - .3 Equipment electrical schematics and layout drawings
 - .4 System schematics and wiring lists
 - .5 System setup procedures
 - .6 Manufacturer's repair parts list indicating sources of supply
 - .7 Interface definition

1.10 **DEVIATIONS**

- .1 The approval of shop drawings by the Consultant shall not relieve the installer from responsibility for deviation from drawings or the specifications unless he has called attention in writing to such deviations at the time of submission and has obtained the approval of the Consultant thereon. When such deviations are called to the Consultants attention, and no mention is made of extra cost, it will be assumed that any proposed change will be made at no extra cost to the Owner.

1.11 **SUBSTITUTIONS**

- .1 The intent of these Specifications is to establish the quality of the materials and/or workmanship desired for this project. Substitutions shall be in conformance with the requirements as indicated.

1.12 **CCTV SYSTEM TECHNICAL DATA PACKAGE**

- .1 The data package shall include the following:
 - .1 System block diagram
 - .2 Security center CCTV equipment installation, interconnection with equipment, block diagrams and wiring diagrams

- .3 Camera wiring and installation drawings.
- .4 Surge protection device installation.
- .5 Final copies of each of the manufacturer's commercial manuals arranged as specified bound in hardback, loose-leaf binders, shall be delivered to the Owner's within 30 days after completing the endurance test.
- .6 The draft copy used during site testing shall be updated prior to final delivery of the manuals. Each manual's contents shall be identified on the cover.
- .7 The manual shall include names, addresses, and telephone numbers of each subcontractor installing equipment and systems, and nearest service representatives for each item of equipment for each system.
- .8 The manuals shall have a table of contents and tab sheets.
- .9 Tab sheets shall be placed at the beginning of each chapter or section and at the beginning of each appendix.
- .10 The final copies delivered after completion of the endurance test shall include all modifications made during installation, checkout, and acceptance.
- .11 The number of copies of each manual to be delivered shall be as specified.

1.13 **WARRANTY, MAINTENANCE, TESTING AND CERTIFICATION**

- .1 Warranty servicing shall be provided for a one (1) year period commencing at system acceptance. This service shall include:
 - .1 Maintenance service as required during or after regular working hours during warranty period
 - .2 Replacing defective parts and components as required.
 - .3 Servicing by factory trained and employed service representatives of the equipment manufacturer.
 - .4 Maintenance of system programming.
- .2 Servicing and maintenance of the CCTV system shall be performed by qualified technicians in regular employment.

1.14 **OPERATION**

- .1 Performance of scheduled adjustments and repair shall verify operation of the CCTV system as demonstrated by the applicable portions of the performance verification test.

1.15 **SYSTEM MODIFICATIONS**

- .1 The Contractor shall make any recommendations for system modification in writing to the Owner's.
- .2 No system modifications, including operating parameters and control settings, shall be made without prior approval of the Owner's.
- .3 Any modifications made to the systems shall be incorporated into the operations and maintenance manuals, and other documentation affected.

1.16 **PRODUCT INSTALLATION AND HANDLING**

- .1 Before and during installation care must be exercised to prevent damage to the sensitive parts and components of the system and be responsible for the storage and handling of all components until acceptance of the completed installation.

1.17 **DEFINITIONS**

- .1 Bridging: Connecting two electrical circuits in parallel.
- .2 Brightness: The attribute of visual perception in accordance with which an area appears to emit more or less light.
- .3 Burned-in Image: An image which persists in a fixed position in the output signal of a camera after the camera has been turned to a different scene.
- .4 CCTV: Abbreviation for closed circuit television.
- .5 Contrast: the range of difference between light and dark values in a picture.
- .6 Depth of Field: The in-focus range of a lens or optical system.
- .7 ESS-Electronic Security System
- .8 Environment-Resistant: General term meaning capable of operating in extremes of temperature, humidity, vibration and dust.
- .9 Footcandle: The illuminance at a surface, all points of which are at a distance of one foot from a uniform source of one candela.
- .10 Iris: An adjustable aperture built into a camera lens to control the amount of light passing through the lens.
- .11 Monitor: a Device for viewing TV connected directly to the camera output.
- .12 Pan and Tilt: The capability which allows a camera to be moved in both the azimuth (pan) and in the vertical (tilt) plane.
- .13 Scanning: Moving the electron beam of an image pickup tube diagonally across the target or screen area of a tube.
- .14 Sensitivity: A factor expressing the incident illumination on a scene required to produce a specified picture signal at the output terminals of a television camera.
- .15 SIT (Silicon Intensifier Target): Trade names for a TV image pickup tube of the direct read out type designed for low light applications.
- .16 CCD: A solid state cameras, charged coupled devices.
- .17 Zoom: To enlarge or reduce the size of a televised image.

1.18 **REQUIREMENTS**

- .1 The CCTV system shall consist of IP Based Type colour format cameras, lens, housings, mounts, controls, cable interface equipment any necessary auxiliary devices for a complete operating system.
- .2 The closed circuit television system shall be synchronized to eliminate vertical roll and jitter when cameras are being switched.

- .3 The signal input level from all cameras to the CCTV switcher system shall be minimum 1 volt peak to peak with equalization (flat) to 5 MHz.
- .4 System shall be provided to prevent ground loop interference.
- .5 Drawings and Specifications: Exact locations of all items shall be determined by reference to the general plans and measurements of the building and shall be subject to the approval of the Consultant.
- .6 The Consultant reserves the right to make any reasonable change in the location of any part of this work without additional cost to the Owner.
- .7 Should any change be deemed necessary by the installer to the proposed contract drawings, the shop drawings, descriptions and the reason for the proposed changes shall be submitted for approval.

PART - 2 PRODUCTS

2.1 GENERAL

- .1 All system hardware components shall be produced by manufacturers regularly engaged in the production of CCTV equipment.
- .2 Units of the same type of equipment shall be products of a single manufacturer.
- .3 All material and equipment shall be new and currently in production.
- .4 Each major component of equipment shall have the manufacturer's name address, and the model and serial number in a conspicuous place.

2.2 COLOUR CAMERAS

- .1 Camera shall transmit images over over 100BASE-TX using advanced H. 264 or MPEG 4 compression technology to achieve the lowest network bandwidth and most efficient image storage. Where required, the data will be converted from PoE+ to fibre. The camera shall be a High-resolution with 2.6-6 mm variable focal auto iris lens mounted in a high impact vandal resistant housing.
- .2 **Acceptable Camera Manufacturer (must be compatible with the Avigilon System)**
 - .1 **Avigilon**
 - .3 Signal-to-noise ratio shall not be less than 50 dB unweighted.
 - .4 The camera shall exhibit no geometric distortion.
 - .5 The lenses shall be integral to the camera block and feature vari-focal length and auto iris
 - .6 The camera shall operate from 10 to 50 degrees C without auxiliary heating or cooling, and with no change in picture quality or resolution.
 - .7 The camera shall operate on 60 Hz AC power, and shall be capable of operating at a voltage of 120 or 24 Volts.
 - .8 The camera shall have a solid state imaging array, and the picture produced by the camera shall be free of blemishes as defined by EIA 330.
 - .9 The camera shall provide not less than 480 lines of horizontal resolution, and resolution shall not vary over the life of the camera.

- .10 The imager shall have at least 768 horizontal x 494 vertical active picture elements.
- .11 Sensitivity
 - .1 The camera shall be a high-resolution color 1/4" CCD type with 480 lines of resolution and light sensitivity at F1.4 of 3.0 lux at 50 IRE and 0.4 lux at 20 IRE
- .12 Camera Synchronization
 - .1 The camera shall also have the capability of synchronization by line-locking to the AC power line frequency at the zero crossing point, and shall provide not less than plus or minus 90 degrees of vertical phase adjustment.
- .13 Connectors
 - .1 Cameras with lenses having auto iris, manual iris, or zoom and focus functions shall be supplied with connectors and wiring as needed to operate the lens functions.
 - .2 Video signal output connector shall be a BNC.
 - .3 Cameras with integral fiber optic video transmitters shall have straight-tip bayonet type fiber optic video output connectors.
 - .4 Connector shall be provided for external sync input.
- .14 Automatic Circuits
 - .1 The camera shall have circuitry for through the lens (TTL) white balancing, fixed white balancing, and automatic gain control.

2.3 **CAMERA HOUSINGS AND MOUNTS**

- .1 Provide adequate camera housing and mounts to accommodate adequate protection and installations of CCTV cameras:
 - .1 The camera and lens shall be enclosed in a tamper resistant housing as specified below.
 - .2 Any ancillary housing mounting hardware needed to install the housing at the camera location shall be provided as part of the housing.
 - .3 The camera and lens contained in a camera housing shall be installed on a camera support using manufacturer recommended procedures.
 - .4 Any ancillary mounting hardware needed to install the support and to install the camera on the support shall be provided as part of the support.

2.4 **GROUND ISOLATION TRANSFORMER**

- .1 Provide necessary ground isolation transformers and other components to prevent ground loop interference.
- .2 Ground Loop Corrector
 - .1 The ground loop corrector shall eliminate the measured ground loop Interference (common mode voltage) in wireline or coaxial video transmission lines.
 - .2 The ground loop corrector shall pass the full transmitted video bandwidth with no signal attenuation or loss.

- .3 Clamping ground loop correctors shall be capable of rejecting at least an 8 volt peak-to-peak 60 Hz common mode signal.
- .4 Ground isolation transformers shall be capable of rejecting at least a 10 volt peak-to-peak 60 Hz common mode signal.
- .5 Ground isolation amplifiers shall be capable of rejecting at least a 30 volt peak-to-peak 60 Hz common mode signal.
- .6 Differential ground loop correctors shall be capable of rejecting at least a 100 volt peak-to-peak 60 Hz common mode signal.

- .3 All wire and cable components shall be able to withstand the environment the wire or cable is installed in for a minimum of 20 years.
- .4 Twisted pair low voltage control wiring to be used above ground or as direct burial cable shall be provided as described in Section 16792. Plenum or riser cables shall be IEEE C2 CL2P certified.

2.5 **DIGITAL DATA INTERCONNECTION WIRING**

- .1 Interconnecting cables carrying digital data between equipment located at the security center or at a secondary control/monitoring site shall be not less than 20 AWG and shall be stranded copper wire for each conductor.
- .2 The cable or each individual conductor within the cable shall have a shield that provides 100 percent coverage.
- .3 Cables with a single overall shield shall have a tinned copper shield drain wire.
- .4 Plenum or riser cables shall be IEEE C2 CL2P certified.

2.6 **CAMERA POWER SUPPLIES**

- .1 Provide camera power supplies as required. Camera power supplies to be CSA approved or to have special Hydro approval. Power supplies to have 24VAC output/120VAC input, individually fused outputs, and a cabinet with suitable lock.
- .2 Representative units to be #ALTV2416-ULX Video Camera Power Supply for 16 cameras and #ALTV248-UL Video Camera Power Supply for up to 8 cameras.

2.7 **“POWER OVER INTERNET” NETWORK SWITCH**

- .1 Provide “Power over Internet” Network Switches, Rack mountable type as required for the System Network connections. Switches shall have adequate power capacity for the ultimate number of connected devices, shall be IEEE.802.3af compliant with adequate 10/100 PoE Ports as required plus minimum 4 spares.
- .2 **Network Switches and associated Service requirements to be purchased from:**
TELUS Enterprise Solutions
Contact: Michele K House, Sales Specialist
(416)-999-6109
michele.house@telus.com

Switches shall be 1u and be as manufactured by CISCO as follows:

CATALYST 9300 48-PORT POE+ NETWORK ESSENTIALS	C9300-48P-E
SOLN SUPP 8X5XNBD CATALYST 9300 48-PORT POE+ NETWORK ESSE	CON-SSSNT-C93004PE
C9300 NETWORK ESSENTIALS 48-PORT LICENSE	C9300-NW-E-48
NORTH AMERICA AC TYPE A POWER CABLE	CAB-TA-NA
50CM TYPE 1 STACKING CABLE	STACK-T1-50CM
CATALYST 3750XSTACK POWER CABLE 30 CM	CAB-SPWR-30CM
C9300 DNA ESSENTIALS 48- PORT TERM LICENSES	C9300-DNA-E-48
C9300 DNA ESSENTIALS 48- PORT 3 YEAR TERM LICENSE	C9300-DNA-E-48-3Y
715W AC CONFIG 1 POWER SUPPLY	PWR-C1-715WAC
Catalyst 9300 8 x 10GE Network Module	C9300-NM-8X
NO SECONDARY POWER SUPPLY SELECTED	C9300-SPS-NONE
UA POWER SUPPLY BLANK	PWR-C1-BLANK
CAT9300 UNIVERSAL IMAGE	S9300UK9-166

.3 Service to be provided by Telus

Service Description	Service Code	Minimum Hours
Site: Main Site		
System: CCTV System		
Stand-alone rtr/sw or First switch in a stack (static routes, RIP, no QOS)	NENG	4.00

Stand-alone rtr/sw or First switch in a stack (static routes, RIP, no QOS)	NICD	2.00
Technical Project Management REG	NIMPMR	1.00
Stand-alone rtr/sw or First switch in a stack (static routes, RIP, no QOS)	NISOL	1.00

2.8 **UPS SYSTEM**

- .1 Security System Network UPS Systems should be 3kVA, 120 volt Nominal, Eaton #SPX-3000RT-2U complete with Network-MS Monitoring xx and #EHBPL-3000R-PDUIU 'Hot Swap Bypass' component (See also attached cut sheet)

PART - 3 EXECUTION

3.1 **INSTALLATION**

- .1 Provide CCTV system as shown on Drawings and as specified.
- .2 The Contractor shall install all system components including Owner's furnished equipment, and appurtenances in accordance with the manufacturer's instructions, IEEE C2 and as shown, and shall furnish all necessary connectors, terminators, interconnections, services, and adjustments required for a complete and operable system.
- .3 Raceways shall be furnished and installed as specified in Electrical General Requirements, Cabletroughs, Wire & Cables 1-1000 Volts, and Splitters, Junction and Pull Boxes, Cabinets.
- .4 DTM shall not be pulled into conduits or placed in raceways, compartments, outlet boxes, junction boxes, or similar fittings with other building wiring.
- .5 All other electrical work shall be as specified in the above sections including grounding to preclude ground loops, noise, and surges from adversely affecting system operation.
- .6 Provide wiring as required.
- .7 Provide power and signal at cameras as required.
- .8 Install all equipment in accordance with manufacturers' instructions.
- .9 Provide necessary mounting accessories.
- .10 Mount cameras in enclosures on ceilings as per Drawings. Provide suitable power and signal wiring to suit a manufacturer. Selected enclosure must be suitable for each camera location.
- .11 Test each camera output on monitors in the presence of the Consultant to finalize the selection of lenses for cameras.

- .12 Test each system component and feature to prove the system performance and response under normal conditions.
- .13 Test each system component and feature to prove the system performance and response under normal conditions.
- .14 Provide all system wiring in conduits.
- .15 All video cables to be adequately shielded and are not to be run with power cables in same conduits.
- .16 Provide necessary corrective circuitry to accommodate location of CCTV cabling in close proximity to high voltage cabling.
- .17 Install security equipment in the main security office as shown and as specified and install, connect and test all components for a complete operating system.
- .18 Connect all CCTV cameras and control equipment in the building to the same phase in all lighting and receptacle panels.

3.2 **CAMERAS**

- .1 Install:
 - .1 the cameras with the proper focal length lens as indicated for each zone;
 - .2 connect power and signal lines to the camera;
 - .3 set cameras with fixed iris lenses to the proper f-stop to give full video level;
 - .4 aim camera to give field of view as needed to cover the alarm zone;
 - .5 synchronize all cameras so the picture does not roll on the monitor when cameras are selected.
- .2 Dome cameras shall have all preset positions defined and installed.
- .3 Calibrate and test all equipment, verify operation, place the integrated system in service, and test the integrated system.
- .4 Deliver a report describing results of functional tests, diagnostics, and calibrations including written certification to the Owner's that the installed complete system has been calibrated, tested, and is ready to begin performance verification testing.
- .5 The report shall also include a copy of the approved performance verification test procedure.
- .6 Note any objects in the field of view that might produce highlights that could cause camera blinding.
- .7 Note any objects in the field of view or anomalies in the terrain which may cause blind spots.
- .8 Note if a camera cannot be aimed to cover the zone and exclude the rising or setting sun from the picture.
- .9 Note night assessment capabilities and whether lights or vehicle headlights cause blooming or picture degradation.

- .10 If any of the above conditions or other conditions exist that cause picture degradation or interfere with the camera field of view, inform the project manager.
- .11 Provide the Owner's with the digital media record as part of the documentation of the system and shall submit a letter certifying that the CCTV system is ready for performance verification testing.

3.3 **TESTING**

- .1 The field testing shall as a minimum include:
 - .1 Verification that the video transmission system and any signal or control cabling have been installed, tested, and approved as specified.
 - .2 All software functions shall be exercised.
 - .3 Verification that all video sources and video outputs provide a full bandwidth signal that complies with EIA 170 at all video inputs.
 - .4 Verification that all video signals are terminated properly.
 - .5 Verification that all cameras are aimed and focused properly.
 - .6 The Contractor shall conduct a walk test of the area covered by each camera to verify the field of view.
 - .7 When dome camera mounts are used in the system, verify that all preset positions are correct and that the dome also operates correctly in a manual control mode.
 - .8 Deliver a report describing results of functional tests, diagnostics, and calibrations including written certification to the Owner's that the installed complete system has been calibrated, tested, and is ready to begin performance verification testing.
 - .9 The report shall also include a copy of the approved performance verification test procedure.

END OF SECTION

ACCESS CONTROL SYSTEM

28 23 10

PART - 1 GENERAL

1.1 GENERAL REQUIREMENTS

- .1 Conform to Sections of Division 1 as applicable.
- .2 Conform to Electrical General Requirements.
- .3 Materials and equipment described in each Section of the Specification are designed to establish standards of construction and workmanship.
 - .1 Where manufacturers or manufacturers products are identified in lists with phrase "Standard of Acceptance", these are manufacturers and/or products which meet standards with regard to performance, quality of material and workmanship
 - .2 Manufacturers and or products used are to be chosen from these lists.
 - .3 Where the Specification states "to match existing Hospital Standards" it is mandatory that the existing Standard be maintained and that the product must be as manufactured the identified manufacturer and must be the product identified. Quality Assurance.

1.2 WORK INCLUDED

- .1 The Access Control, Security Systems involved in this project are as follows:
 - Key-Scan System serving the Hospital Campus
- .2 Work to be done under this Section shall include furnishing of labour, materials, and equipment required for installation, testing and putting into proper operation complete Access Control, Security Systems as shown, as specified and as otherwise required. Complete systems shall be left ready for continuous and efficient satisfactory operation.
- .3 Provide equipment, wiring and other materials for a complete and operational Access Control, Security System. The system shall be modular and expandable as herein specified or as the Owner may direct up to full system capacity.
- .4 The system shall consist of state-of-the-art controls.
- .5 Provide low voltage power supplies where required.
- .6 Provide all required mounting hardware and brackets.
- .7 Provide suitable low voltage power and connect signal wiring to suit manufacturers' recommendations.
- .8 Provide and test for proper operation.

1.3 “KEY-SCAN” ACCESS CONTROL, SECURITY SYSTEM SUPPLIER

- .1 The “Key-Scan” Access Control, Security System, to serve the new areas, shall be supplied, installed and commissioned by the following approved Security Contractor acting as a Sub Contractor to this Division. The approved Security Sub Contractor shall be:

OHM Security LTD
Attn: Andrew Browne
Phone: 905-299-8255
Email: andrew.browne@ohmsecurity.com

1.4 QUALITY ASSURANCE

- .1 The Access Control, Security Systems shall be designed in accordance with and conform to the requirements of:

- .1 Canadian Standards Association (CSA)
.2 Electrical Safety Code

1.5 SUBMITTALS: SUBMITTALS SHALL BE OF ADEQUATE DEPTH TO DEFINE FULLY THE SYSTEM OFFERED.

- .1 Shop Drawings: Submit complete sets of shop drawings following award of order. Shop drawings shall include copies of dimensional drawings completely describing installation that will be performed with relation to the space available for installation.
- .2 Manufacturer's Data: Submit data in the form of catalogue cuts or special data sheets as prepared by the manufacturer.
- .3 Maintenance Data: Submit copies of parts, lists and preventive maintenance requirements for systems to be installed.
- .4 Training Data: Submit copies of the proposed employee training plan and documentation for the system.

1.6 PRODUCT INSTALLATION AND HANDLING

- .1 Before and during installation care must be exercised to prevent damage to the sensitive parts and components of the system and be responsible for the storage and handling of all components until acceptance of the completed installation.

1.7 WARRANTY:

- .1 Systems shall include a standard warranty on parts and warranty on labour. Any required system repairs which occur between the date of acceptance by the owners and the one year anniversary shall be provided without cost.
- .2 The supplier shall maintain a service department, necessary spare parts, after hours telephone answering services and call dispatching services required to implement the service standard stated below as part of this contract.

1.8 1.8 SYSTEM VERIFICATION

- .1 Test and demonstrate the operation of the complete system to the Owner. This shall include, but not be limited to:
- a) detailed test and demonstration of each operable device

- b) detailed test and demonstration of overall system operation
- c) interfacing of various components.

- .2 On completion of the installation the manufacturer/supplier shall supply, to the Consultant and Commissioning Agent, a certificate, together with detailed inspection record sheets showing location of each device and certifying the test results per unit, confirming that the system is installed and operates in accordance with Specification.

1.9 **SCOPE, "KEY-SCAN" SYSTEM**

- .1 The "Key-Scan" Access Control, Security System installation required for this installation incorporates:
 - .1 Card Readers to control entry to doors indicated
 - .2 Electric Strikes and Power Supplies
 - .3 Request to Exit Devices
 - .4 Magnetic locks including Magnetic Lock Permits
 - .5 Door alarm contacts for connection to Central Security System
 - .6 local power supplies as required
 - .7 Wire, conduit and connections to card reader, door alarms, electric strike, magnetic locks on doors and power supplies to controlled doors.
 - .8 Connection to Hospital Network System for connection to Central Security System
 - .9 Integration between the Security System and the CCTV System.
 - .10 For doors equipped with a Wandering Patient Detector, integration between the Security System and the Wandering Patient System

1.10 **THE ACCESS CONTROL SYSTEMS SHALL BE USED TO PROVIDE:**

- .1 Access control to the protected doors
- .2 Whenever a card is read by a card reader/ key-reader, the reader shall check for valid entry in the following manner:
 - .1 The card must be authorized.
 - .2 The priority/access level must match that of the card reader
 - .3 The time must fall within the access schedule for the card reader
- .3 The information from the card reader shall include provision for transmission the Central Security Computer which shall (activate or deactivate by operator's command) display related information such as card number, employee name, department, reader number, time and date on the card access CRT display terminal. Alarm messages and transactions from assignable readers shall be displayed on the card access CRT display terminal and a hard copy printout initiated on the appropriate printer.
- .4 If the card is valid, the electric locking devices shall be bypassed for a preset time. The preset bypass time will vary for each access controlled door which will be determined on site.
- .5 Exit through card access doors shall be by free-exit through motion sensor.
- .6 If the door is held open longer than the preset time, the door monitoring switch shall initiate an alarm to the Security Computer

- .7 All invalid or unauthorized access attempts or alarm conditions shall initiate an alarm to the future Security Computer.
- .8 All information shall be stored in disk form with the ability to retrieve information on a day, time, card number, employee name or reader number when requested by operator's command.

PART - 2 PRODUCTS

2.1 DOOR MONITORING:

- .1 All doors as indicated on the Drawings shall be monitored
- .2 Each door shall be capable of being monitored in one of three modes:
 - .1 Free access
 - .2 Secure
 - .3 Schedule controlled free access
- .3 Selected (manual override) doors in the building to be manually controlled from the security office. Activation of associated code on the security terminal keyboard will release locking devices and by pass monitor switch.
- .4 Activation of the fire alarm system or power failure shall cause the electro-magnetic locks on exit doors to release. Provide the necessary interconnection with the fire alarm system for system operation.
- .5 The release shall be of the failsafe type ensuring unlocking of doors for any malfunction of the security system or if the fire alarm system alarms. The arrangement shall be on the approval of the local authorities having jurisdiction

2.2 "KEY-SCAN" INTELLIGENT PROXIMITY CARD READERS INCLUDING:

- .1 Fully compatible with cards produced by the Hospital's "IdentiCam" photo card system.
- .2 LCD back-lighted with EL lamp
- .3 Each door shall be considered a separate security alarm point or zone.
- .4 System shall include dry contacts for remote alarms.

2.3 SECURITY SYSTEM COMPUTER SOFTWARE:

- .1 System must be compatible with existing photo imaging system "Identicam".
- .2 Software must have ability to be integrated with the CCTV System.
- .3 Computerized software shall monitor new doors or zones.
- .4 The security system shall up-date/ provide any required automatic display of colour floor plan maps of the building (showing area in alarm) on the graphic CRT display terminal screen.
- .5 An alarm condition shall be displayed on the graphics by a colour code change and the flashing of the standard symbol used to highlight the location of the device which initiated an alarm and identifying the current status of the device.

- .6 Each time a map is displayed, the system shall determine and display the status of the monitored points represented in the map. The system shall be provided with all software and hardware required for an operator to create and maintain maps.
- .7 The colour graphics display shall identify input circuit conditions such as circuit secure, circuit in alarm, circuit in trouble and circuit manually shunted (ie. difference colour codes). Create maps, with necessary active points including building or area outlines, symbols, stairs, elevators, corridors for areas in which security devices are shown. Mapping data base to be programmed by cursor or other approved method and have the capability of printing maps. Include all menus, charts, and symbols required for total system outline and hardware required to produce the graphics to the Consultant's approval.

2.4 **TAMPER OPERATION:**

- .1 Tamper switches shall be provided on all control and equipment cabinets such as card reader controllers. Tamper switches shall include provision for future connection to Security System.

2.5 **SUBMITTALS AND INSTRUCTION:**

- .1 The following data shall be forwarded upon award of Contract:
 - .1 cable schematic showing card reader controllers, alarm terminals, card readers, power supply locations and all other devices and associated wiring and power
 - .2 Technical specification data sheets of each system component and device.
- .2 Provide complete system documentation at acceptance time, as specified herein.

2.6 **READER CONTROLLERS:**

- .1 Controllers to be solid state microprocessor based and shall support and communicate with card readers employing a LCD display. The unit shall grant or deny access while including independent reporting system activity back to the CPU for report generation or alarm initiation.
- .2 Provide battery backup for unit.
- .3 Provide tamper switch alarmed to security console.
- .4 The controller shall be capable of operating, connecting and communicating with proximity type readers

2.7 **REMOTE ALARM TERMINALS:**

- .1 Provide wall mounted remote data terminals to be microprocessor based housing circuit modules capable of monitoring and connecting to alarm inputs of zones (ie. door monitor, switches, etc.) as required, power supply unit and standby battery.
- .2 The terminal shall have LED indicators for AC power, alarm and trouble. The unit shall contain automatic self-checking program for processor and memory with self-diagnostics.
- .3 Each remote terminal shall be loaded to 85% of its capacity with the field zone/point circuits. The remaining 15% capacity of circuit modules shall be used for future connections.
- .4 Remote terminals shall have a key locked cabinet with tamper switch alarm to the security terminal if located outside of terminal cabinets.
- .5 Unit to be fed from the nearest emergency power source at 120 V.A.C.

2.8 POWER SUPPLIES:

- .1 Provide all necessary power supplies, 24 volt AC and/or DC including transformer and/or rectifiers required for operation of the system. 120 volt AC power circuits will be connected from the nearest emergency power panel.
- .2 Provide battery back-up to prevent loss of memory and loss of power. UPS system shall be retained for a power outage for a minimum of two (2) hours.
- .3 Power supplies shall be in a separate enclosure, secured with a key lock.

2.9 SYSTEM DEVICES:

- .1 "Key-Scan" Card Readers
 - .1 Provide flush mounted card readers. The card reader shall detect the code information on the card and shall include provision to transmit the information to the "Key-Scan" Central Security System.
 - .2 Card reader shall include an "EL" indicator lamp.
 - .3 The response time shall be within .5 seconds. The reader shall be mounted to any non-metal surface.
 - .4 Power to the reader and data cables shall be connected to the associated card reader controller.
 - .5 The reader shall be vandal-proof, dirt-proof, weatherproof and shock-resistant.
 - .6 Provide a backbox for mounting of card reader.

2.10 CONNECTION TO ELECTRIC DOOR HARDWARE:

- .1 For doors with electric strikes, electric magnetic locks or electric locking devices provide all connections to electric door hardware at a voltage to suit hardware for proper operation.
- .2 Provide transformers and rectifiers for the necessary power supplies (24 volts AC or DC) and sized as required to suit hardware equipment supplied.
- .3 Coordinate with all suppliers of other equipment connected to security system.
- .4 Conduit and wiring will be provided by the Electrical Contractor as specified by the security (card access) system manufacturer.
- .5 The Security System Installer shall provide all door hardware (electric strikes, door monitoring contacts, motion exit device, power supplies etc.) that are to be installed on existing doors.

2.11 DOOR MONITORING SWITCHES:

- .1 Door monitoring switches (ie. magnetic contacts) shall be provided.
- .2 Provide the necessary points, wiring, conduits, boxes, and connections to the door monitoring switches for proper operation. Coordinate connections and installation with the door hardware contractor.

2.12 SECURITY INTERFACING

- .1 Interface the Security System to the CCTV/ Wandering Patient Systems.

- .2 Security System will receive a dry contact signal from either system to activate the alarm.

2.13 MISCELLANEOUS REQUIREMENTS

- .1 Include in the Contract the cost of a qualified technician to test and verify the system and correct all wiring and installation faults. Test and demonstrate the operation of the system to the Owner. This shall include, but not be limited to a detailed test and demonstration of each operable device and a detailed test and demonstration of overall system operation.
- .2 On completion of the installation the manufacturer/supplier shall supply a certificate, together with detailed inspection record sheets showing location of each device and certifying the test results per unit, confirming that the system is installed and operates in accordance with Specification.
- .3 Provide all back boxes and plates, all wire and cable, complete with terminations if necessary and multi-prong female fittings for the complete installation of the intercom stations in the locations shown.

PART - 3 EXECUTION

- .1 Provide "Key-Scan" Access Control, Security Systems as shown on Drawings and as specified.
- .2 Install all equipment in accordance with the manufacturer's instructions.
- .3 Readers shall be installed at least 6" away from metal surfaces.
- .4 Readers to be mounted at 47" above finished floor.
- .5 The manufacturer/supplier it to assist the Contractor in the installation and provide technical expertise required. Make final connections.
- .6 Adjust system components as necessary to ensure complete system operation.

3.2 WIRING

- .1 All wiring to be installed in conduit.
- .2 All wiring to be in accordance with manufacturer's recommendations.
- .3 All card access cables to be adequately shielded and are not to be run with power cables in same conduit.

3.3 SECURITY SYSTEM - WARRANTY, MAINTENANCE, TESTING AND CERTIFICATION

- .1 Provide Warranty and Training as specified.
- .2 Test all components of the system for proper operation as indicated in Specification.
- .3 Acceptance procedures shall be in accordance with General Requirements and the following:
 - .1 Written certification shall be provided, on completion of a thoroughly tested installation, that the system has been pre-tested and is ready for acceptance testing. Written certification shall consist of a check list of operating features has been pre-tested and is functioning satisfactorily.

END OF SECTION

FIRE ALARM SYSTEM

28 31 13

PART - 1 GENERAL

1.1 GENERAL

- .1 Conform with the requirements of Section 26 05 01 Basic Electrical Requirements

1.2 PROGRAMMING CHANGES

- .1 Include in the Bid Price for all programming changes required for the duration of the project and as required to obtain final acceptance by the Fire and Building Departments.
- .2 Include in the Bid Price for all costs associated with Up-dating the existing Fire Alarm System Computer Floor Plan Graphics as required by the changes created by this renovation.
- .3 Provide audibility testing of sound levels in each and every room and ensure Code required minimum levels are maintained. Adjust speaker transformer "taps" to ensure minimum/maximum sound levels are maintained. Provide, in the final Verification Report, an indication of the exact sound pressure levels in each room.
- .4 Care shall be taken when placing detectors to ensure that they are not in the direct air stream of a supply air diffuser. However, the preferred location of a smoke detector within any one bay would be in the air stream of a return air diffuser. Ensure smoke detectors are a minimum of 5'-0" from any supply air diffuser.

1.3 RELATED WORK

- .1 Sprinkler systems: Section 21 13 13 Wet Pipe Sprinkler Systems
- .2 Wiring: Section 26 05 19 Wires & Cables 0-1000 Volts
- .3 Conduits: Section 26 05 33 Conduits Fastenings and Fittings
- .4 Access Control System: Section 28 23 10 Access Control System

1.4 REFERENCES - CURRENT EDITION OF

- .1 CAN/ULC-S524 Installation of Fire Alarm Systems
- .2 ULC-S525 Audible Signal Appliances
- .3 CAN/ULC-S527 Control Units
- .4 CAN/ULC-S528 Manual Pull Stations
- .5 CAN/ULC-S529 Smoke Detectors
- .6 CAN/ULC-S530 Heat Actuated Fire Detectors
- .7 CAN/ULC-S536 Inspection and Testing of Fire Alarm Systems
- .8 CAN/ULC-S537 Verification of Fire Alarm Systems
- .9 CAN/ULC-S548 Alarm Initiating and Supervisory Devices for Water Type Extinguishing Systems

.10 CAN/ULC–S533 Egress Door Securing and Releasing Devices

.11 CAN/ULC–S542 Speakers for Fire Alarm Systems

.12 CAN/ULC-S526 Visual Signal Appliances

1.5 **REQUIREMENTS REGULATORY AGENCIES**

.1 System

Ontario Building Code

.2 System components: listed by ULC and CSA and complying with applicable provisions of Ontario Building Code, and meeting requirements of local authority having jurisdiction.

1.6 **SHOP DRAWINGS**

.1 Submit shop drawings in accordance with Section 26 05 01- Electrical General Requirements.

.2 Include:

Details for devices.

Details and performance specifications for control, annunciation and peripherals with item by item cross reference to specification for compliance.

Battery capacity calculation.

.3 The Contractor in co-operation with the supplier of the system shall prepare a detailed riser diagram of the complete system showing all major components, devices and necessary interconnecting wiring.

Diagram is to indicate wiring quantities, sizes and colour code and to indicate conduit sizes.

Riser Diagram is to be produced on AutoCad and is to be submitted as a Shop Drawing.

Riser Diagram is to be revised 'As-Built' at the completion of the project and submitted with Maintenance Manuals (submit both a copy of the Drawing and an AutoCad disc).

1.7 **OPERATION AND MAINTENANCE DATA**

.1 Provide operation and maintenance data for fire alarm system for incorporation into manual specified in Section 26 05 01 - Electrical General Requirements.

.2 Include:

Instructions for complete fire alarm system to permit effective operation and maintenance.

Technical data - illustrated parts lists with parts catalogue numbers.

Copy of approved shop drawings with corrections completed and marks removed except review stamps.

Copy of verification certificate, verification report and warranty certificates such as for fire alarm system, batteries, ancillary devices, and other similar items, including battery suppliers date coding for batteries.

1.8 **MAINTENANCE MATERIALS**

.1 Provide maintenance materials in accordance with Section 26 05 01 - Electrical General Requirements.

1.9 **TRAINING**

.1 Provide on-site lectures and demonstration by fire alarm equipment manufacturer to train operational personnel in use and maintenance of fire alarm system.

1.10 WORK INCLUDED:

- .1 Work to be done under this Section shall include furnishing of labour, materials, and equipment required for installation, testing and putting into proper operation complete Fire Alarm System as shown, as specified and as otherwise required. Complete systems shall be left ready for continuous and efficient satisfactory operation.
- .2 Supply and install an expansion to the existing complete and operating two stage, zoned, fully supervised Fire Alarm System as shown, as specified and as otherwise required.

1.11 DESCRIPTION OF SYSTEM

- .1 There exists a two stage, zoned complete and operating Fire Alarm System as supplied by Chubb Edwards. Scope of this renovation requires:
Any expansion, modifications to the existing System to incorporate the revised/ added functions shown on the Drawings including:
 - .1 adding new detection, alarm sounding devices, strobe lights
 - .2 adding new Sprinkler and Pre-Action Sprinkler System alarm and supervisory Zones in the renovated as shown on the DrawingsProvide new Trouble signal devices, Power supply facilities, Manual alarm stations, Automatic alarm initiating devices, connection to sprinkler system flow devices, connection to supervised valves (trouble signal only), Door release for doors with hold-open devices or magnetic locks, Audible signal devices, End-of-line devices, Visual alarm signal devices, Ancillary devices, Door release for doors with hold-open devices or magnetic locks, Fan shutdown,
- .2 Additional Requirements
Necessary circuitry for operation of supervised valves and loss of power alarms for sprinkler system and auxiliary booster or special service pumps.
Smoke detectors shall be Photoelectric/thermal combination with contact to drive the over the door dome light.

1.12 SYSTEM OPERATION

- .1 It is the intent to maintain the operation of the existing Fire Alarm System

PART - 2 PRODUCTS

2.1 INPUT (ALARM INITIATING) CIRCUITS

- .1 Provide alarm receiving circuits for alarm initiating devices such as manual pull stations, smoke detectors, heat detectors, and water flow switches as indicated on schedules.
- .2 Alarm receiving circuits shall be wired in a Class B, 2 wire configuration.
- .3 All alarm receiving circuits shall be supervised for open, short or ground fault conditions by the use of an end of line resistor.

2.2 OUTPUT ALARM CIRCUITS

- .1 Provide alarm output circuits for polarized audible signals such as speakers, horns and visual indicators as indicated.
- .2 Provide necessary amplifiers and tone generator modules for electronic audible alarm devices as required.
- .3 Alarm output circuits shall be wired in a class B, 2 wire configuration.

- .4 All alarm output circuits shall be supervised for open, short or ground fault conditions by the use of an end of line resistor.

2.3 **AUXILIARY CIRCUITS**

- .1 Provide contacts for fan shut-down as indicated. They shall be of normally closed type. Fan bypass switches shall be provided for each group of fans as indicated and coordinated on site.
- .2 Provide contacts for pressurization system fans. They shall be arranged to start up the fans and shall be of normally closed type. By-pass switch shall be provided as indicated.
- .3 Provide contacts for magnetic door locks and holders. They shall be arranged to release the doors upon actuation of fire alarm system. By-pass switches shall be provided to prevent doors from being released during test of fire alarm system.
- .4 Provide contacts for smoke vents as indicated. They shall be of the normally closed type and shall release all smoke dampers upon actuation of fire alarm system. By-pass switches shall be provided indicated.
- .5 Provide auxiliary contacts with 120 V AC/24 V DC, 2.5 A @ 0.5 power factor rating.

2.4 **VOICE COMMUNICATION CIRCUITS**

- .1 Provide communication circuits for the 5th & 7th Floors as required
- .2 All communication circuits shall be supervised for open, short or ground fault conditions.
- .3 Amplifiers shall be solid state type compatible with the existing System
- .4 Provide for interconnection to operate the system as specified.

2.5 **POWER SUPPLY**

- .1 Provide an internal integrated power supplies, including surge suppression and circuitry for the System operation as required.

2.6 **MANUAL FIRE ALARM STATIONS**

- .1 Manual pull stations shall be metal construction, open circuit, pull lever type and finished in red enamel. They shall be mounted in a 101 mm (4 in) square recessed box with plaster ring in finished areas and surface mounted in unfinished areas.
- .2 Manual stations shall be suitable for insertion of an evacuation key.
- .3 Each pull station shall be provided with an additional auxiliary contact(s) to allow direct connection to future magnetic locks {and for two stage operation}.

2.7 **AUTOMATIC FIRE ALARM DETECTORS (HEAT DETECTORS)**

- .1 Automatic detectors shall be of the following types:
57.2°C (135°F), fixed temperature and -9.4°C (15°F) per minute, rate of rise
93.3°C (200°F), fixed temperature only
- .2 Detectors shall have suitable mounting plates with finish ring.

2.8 **END OF LINE RESISTORS**

- .1 Where Class B wiring is specified or permitted, the end of line resistors shall be located in outlet box with stainless steel cover plate.

2.9 PHOTOELECTRIC SMOKE DETECTORS

- .1 Photoelectric smoke detectors shall operate on the photoelectric (light scattering) principle of operation and be activated by visible or invisible products of combustion. Detectors shall be constructed of solid state components with the infrared light source for the photoelectric sensor emitted from a semiconductor diode.
- .2 Detectors shall be ULC listed.
- .3 Incorporate an LED or lamp latched circuit to indicate the signal operation of the unit.
- .4 Smoke detectors shall operate on 24 volts DC and be protected against electrical transients and electromagnetic interference.
- .5 Detectors shall be equipped with NO/NC contacts to operate ancillary devices where applicable.
- .6 Detectors shall be equipped with a fine mesh bug screen to prevent contamination of the detection chamber by insects.
- .7 The detector shall be a plug-in/twist lock unit which may be removed from its base with a special installation tool without disconnecting detector wiring
- .8 The detector shall filter out false alarms caused by intermittent aerosols or cigarette/pipe tobacco smoke
- .9 Recessed smoke detector shall be complete with necessary shroud and flush mounting hardware.
- .10 Protect automatic smoke detectors during construction with a dust-bag, which shall be removed at the time of verification.

2.10 PERIPHERAL ALARM INITIATING DEVICES

- .1 Local control panels, interfaced with other equipment such as pre-action systems, kitchen hood extinguishing systems, or other Control panels, shall be a single zone capable of operating on 120 volt AC, 60 Hz and shall be complete with two isolated Form 'C' contacts and capability to initiate a fire alarm signal.
- .2 Manufacturer shall examine drawings and specifications prior to award of contract to ensure that detectors, control panels and miscellaneous devices being supplied will provide a satisfactory working installation.

2.11 ALARM SIGNAL APPLIANCES

- .1 Remote smoke detector alarm lamps shall be mounted in a single gang switch box with a brushed stainless steel cover, screw type terminals and electrically connected to heat or smoke detectors that require remote annunciation. Use only high intensity (200 med) LED lamps.
- .2 Alarm strobe lamps shall be ULC listed and operate on 24 V DC. The strobe shall be able to flash at a rate of one flash per second in alarm mode. The words "FIRE" shall appear on the strobe lens. Strobes shall comply with ADA requirements.

2.12 FIRE ALARM SPEAKERS

- .1 Speakers shall be complete with acoustically treated enclosure, line matching transformer, 203 mm (8 in) diameter, ULC approved permanent magnet type speaker and complete with flat white baked enamel square baffle.

- .2 Speakers shall be flush mounted unless otherwise noted.
- .3 Speakers shall produce a minimum gap flux density of 9500 gauss, have a voice coil impedance of 8 ohms, power rating of 20 watts, RMS according to EIA Standard RS-426A, a uniform frequency range from 80 - 13,000 Hz with minimum axial sensitivity of 94 dB at 4 feet with one watt input. The speakers shall have characteristics to produce a wide dispersion bandwidth in a hemispherical pattern in both horizontal and vertical plane.
- .4 Speakers shall have line matching transformers with 1/4 W, 1/2 W, 1 W and 2 W taps, initially set at 1 W. Verify suitability of sound levels in each area and adjust tap to suit.
- .5 Speaker baffles shall be held in place with approved fasteners.
- .6 Unit shall be complete with hook-up terminals with screw-type connection.
- .7 Speaker enclosures in exterior areas shall be suitable for surface mounting. Speaker enclosures elsewhere shall be suitable for outdoor location.

2.13 **RISER DIAGRAM**

- .1 The contractor in co-operation with the supplier shall prepare a riser diagram showing all major system components and inter-connecting wiring requirements. Riser to be submitted as a shop drawing.

2.14 **WIRING**

- .1 Wiring shall be as recommended by fire alarm system manufacturer.
- .2 Wiring for speaker circuits shall be twisted pair shielded sized as recommended by the manufacturer and it shall be installed in conduit.
- .3 Wiring within the floor area from detection device to device shall be as recommended by manufacturer, and installed in EMT conduit.
- .4 Provide line isolators where wiring crosses a different fire alarm zone.

2.15 **MATERIALS**

- .1 Fire alarm systems and components shall be:

Standard of Acceptance
◦ **Chubb Edwards**

PART - 3 EXECUTION

3.1 **INSTALLATION**

- .1 Installation of the Fire Alarm system components shall be in accordance with latest edition and all amendments of CAN/ULC-S524-M91 Standard for the Installation of Fire Alarm Systems.
- .2 The system shall be installed and wired by persons qualified and licenced to perform the installation of fire alarm systems.
- .3 Wire alarm initiating, alarm output, auxiliary output and signal devices to local SCP's as indicated in the schedules.
- .4 Wire alarm initiating circuits. Connect detectors and manual stations. Properly arrange and connect circuit wiring to their respective circuits as shown on the drawings.

- .5 Provide a separate class A addressable Loop for each zone as indicated on the drawings, complete with line isolators where the loop enter the zone.
- .6 Connect the pull stations, smoke detectors, flow switches, valves, zone alarm modules etc. to the addressable loops.
- .7 Install wiring for the alarm signal, alarm initiating and speaker circuits in separate raceways.
- .8 Wire signal circuits alternatively such that no two adjacent signal devices are on the same circuit.
- .9 Arrange wiring to the speakers such that no two adjacent speakers are connected to the same circuit.
- .10 Speakers shall be surface mounted in outdoor spaces.
- .11 Equip all raceways with a separate ground conductor.
- .12 Test each automatic detector to ensure correct wiring and zoning by setting off its rate of rise component and sounding the signals or by ringing it out. Test each smoke detector, sprinkler system and standpipe system valves to ensure correct wiring.

3.2 **WIRING**

- .1 Install wiring in conduit using wire size and type in accordance with manufacturer's recommendations.
- .2 Connect automatic detectors, smoke detectors and manual stations between red and black conductors at each outlet. Cut red and black conductors at each outlet and connect to terminal screws provided, red to red and black to black.
- .3 Install wiring between fire alarm and each diesel-generator control panel to show "running" and "trouble" indications.
- .4 Arrange wiring between existing and new fire alarm control system to achieve operation as specified.
- .5 Entire installation shall be done under supervision of manufacturer. Upon completion of installation, check entire system to approval and correct any malfunction immediately.

3.3 **SYSTEM VERIFICATION**

- .1 The fire alarm system shall be verified in accordance to ULC CAN 4-S537 Standard For the Verification Of Fire Alarm Systems.
- .2 The manufacturer of the fire alarm and voice communication system shall make a complete inspection of all components installed for system, such as manual stations, speakers, smoke detectors, annunciators, sprinkler and standpipe valves to ensure the following:

That the system is complete in accordance with Specifications.

That the system is connected in accordance with Manufacturer's recommendations.

That the regulations concerning the supervision of components have been adhered to

That all equipment as part of the system is inspected for visible damage or tampering

That adjacent speakers have been connected to alternate circuits.

That the control functions have been tested for proper supervision, operation and annunciation of fan shutdown and all speaker control circuits

That all speakers are properly zoned.

That all valves are properly connected and displayed correctly on each annunciator.

- That any subsequent changes necessary to conform to the above will be carried out with technical advice supplied by the Manufacturer.
- That all thermal detectors, smoke detectors, manual pull stations and all sprinkler system and standpipe system valves have been operated and are in good working order.
- That all annunciators correctly pin-point the origin of any fire alarm.
- That actual test gas concentrations of sufficient density, have been applied to each new smoke detector to cause the detector to be set off and that the sensitivity of each smoke detector has been set. On completion of test, a letter shall be forwarded stating that tests have been completed and that system is operating correctly.
- All tests required by Local Authorities have been carried out and all existing zones have been verified.
- .3 Verification records shall be maintained with the following minimum requirements:
- verification records shall list each device and show the date on which each device was verified and the initials of the person who verified it.
- verification records shall show the date on which all devices were verified.
- verification records shall show the date of all deficiencies encountered in the control equipment, wiring and field devices.
- verification records shall show the date when deficiencies were corrected and re-verified
- .4 Provide any necessary equipment, test apparatus, ladders and scaffolding as required.
- .5 Adjust system and components as required to ensure complete system operation.
- .6 Only after the testing and verification task is completed, and all deficiencies rectified, notify the Engineers and representatives of the Fire Department and demonstrate the proper functioning of the system

END OF SECTION



ICN Cabling Standards

Information & Telecommunication Services

Revised : January 11, 2017

General Overview

Sunnybrook has an extensive Ethernet network extending throughout four campuses:

1. Sunnybrook (SB) – 2075 Bayview Ave. (north of Eglinton)
2. Holland Centre (HC) – 43 Wellesley St. (east of Yonge)
3. St. John Rehab (SJR) - 285 Cummer Avenue (west of Bayview)
4. CNIB - 1929 Bayview Ave. (north of Eglinton)

There are approximately 74 wiring closets cabled with Cat5/5e/6/6a UTP cables across the four campuses, with the majority of 61 at Sunnybrook campus.

The implementation of an Intelligent Campus Network (ICN) began in 1995 at the SB campus. This involved moving from a token-ring to an ethernet wide facility and included the implementation of new hub rooms, backbone fibre and horizontal UTP cabling installed to Nordx/CDT IBDN certification. Backbone fibre type will be type OM4 MMF or SMF where required. Standard horizontal UTP will be Category 6 with any new construction or large area renovation project.

Majority of the hub rooms have their own dedicated pathway which serves those floors assigned to that specific room. The pathway may be either zone and distribution conduit or a J-hook design.

The telephone infrastructure (Cat3) consists of a riser closet or terminal located in every wing on every floor of our buildings. The majority of our terminals follow the industry BIX standard. Some of our terminals are in shared locations with the ICN network hub rooms.

Scope of Work for Data Cabling

The extent of the MAC work includes but is not limited to the following:

1. Place data cabling in existing horizontal pathway from the offices requiring MAC work to their associated ICN hub room.
2. Terminate both the patch panel or the BIX block and the workstation ends of each cable drop as specified in the EIA/TIA T568A wiring standard.
3. Label both the workstation faceplate and the hub room patch panel as per ICN labeling standards provided by Sunnybrook.

4. Provide a 7 ft stranded patch cord (for the hub room end) and a 10 ft. solid station cord (for the user end) for each new drop.
5. Patch each new data drop into an available switch port in the hub room and document port info. If no available switch port, I.S. is to be notified immediately.
6. Test each cable drop to EIA/TIA TSB67 Category 6/6a standards with a Microtest "PentaScanner" LAN tester or equivalent.
7. Install wire raceway or ceiling access panels if required.

Scope of Work for Voice Cabling

The extent of the MAC work includes but is not limited to the following:

1. Place Voice cabling in existing horizontal pathway from the offices requiring MAC work to their associated terminal.
2. Terminate the BIX block and the jack ends of each cable drop as specified by the BIX wiring standard.
3. Label both the phone jack faceplate and the terminal BIX block (with the next available cable number) as per labeling standards provided by Sunnybrook.
4. Tone each cable drop to BIX to confirm connectivity.
5. Install wire raceway or ceiling access panels if required.

Installation Requirements

Data Cable

- Cable shall be Belden/CDT IBDN Flex Category 6 or 6a, FT4 or FT6 where required, 4 pair UTP.
- Cables shall not exceed the EIA/TIA T568A wiring standard of maximum 90 meters in length. Every effort has been made to centrally locate the hub rooms to facilitate the length limitations. Any drop that may exceed the 90 meter limit will require I.S. approval.

Voice Cable

- Cable shall be Belden/CDT IBDN Category 3, FT4 or FT6 where required, 4 pair UTP.
- Cables shall not exceed distance to nearest telephone terminal.

Data Jacks

- Data jacks shall be Belden/CDT MDVO, 8p8w, orange for Category 6 and turquoise for Category 6a.

Voice Jacks

- Voice jacks shall be Belden/CDT MDVO, 8p8w, white for digital phone/FAX, or yellow for emergency phones.

Patch Panels and Horizontal Wire Management

- Belden/CDT 48 Port MDVO and CableTalk 2M Managers (**Empty MDVO panels and wire managers installed as a part of the hub room setup**).

Wall Plates / Surface Boxes

- Belden/CDT MDVO 4-port faceplate (white) with surface box where required (**use alternate port of existing plate where temporary ethernet cables are terminated**). Faceplates and surface boxes shall be mounted using screws.

Wire Raceway

- Panduit, Wiremold or equivalent. Large enough to accommodate 4 – Cat6 or Cat6a UTP cables and white in colour.
- Use existing raceway where possible.

Ceiling Access Panels (approved by I.S.)

- In rooms without T-bar ceilings where distribution conduit has been installed (floors H2, H3, H4 only), the conduit stubs into the room above the solid ceiling. A permanent access panel (18" x 18") shall be strategically installed near the conduit stub to allow for the cable installation to the room.

Patch cords

- 1 Belden/CDT stranded Cat6 (for Cat6 cabling) or Cat6a (for Cat6a cabling) 7 feet wired T568A modular cord for each hub room connection.
- 1 Belden/CDT solid Cat6 (for Cat6 cabling) or Cat6a (for Cat6a cabling) 10 feet wired T568A modular cord for each workstation connection.
- Patch cords for Cat6 shall be orange and for Cat6a shall be light green.

Labels

- All labels shall be mechanically printed permanent self adhesive (**no hand written labels will be accepted**). See the last page for labeling standards.

Testing

- Cable testing shall be to EIA/TIA TSB67 standards and include the following information:
 - a. Cable Identification (Workstation Room # / Hub Room # / Port #)
 - b. Cat6 or Cat6a test parameter results
 - c. Hub Port Identification (Hub I.D. # / Port #)
 - d. Project ID and description, date of installation, company etc.
- All test results shall be submitted to Sunnybrook Information Services Department in an electronic file.

Pathway

An ICN cabling pathway has been installed throughout the SB campus to allow for isolation and management of ICN cable drops.

Most wings have been fitted with a pathway consisting of CaddyCat J-hooks from Erico Industries. The pathway generally follows both sides of each corridor on their respective floors. In areas where ceiling congestion did not allow for j-hook installation, EMT conduit has been installed in sections with gaps to allow for cabling to enter rooms where required.

All cabling in T Wing (OCC – Odette Cancer Centre) should be dropped through the wall. The OCC is a modern building with drywall walls and drop ceiling. All cable drops in the OCC to be set as inside wall drops only (where circumstances allow).

Since each hub room will typically service 3 floors, vertical access to adjacent floors has been done using vertical conduits from the ceiling space of one floor to the ceiling space of the other.

Where a cable or cables leave the pathway to enter a room, a conduit sleeve (3/4" for 1 - 2 cables or 1" for 3 - 6 cables) must be installed to access the room and properly fire stopped after the cabling has been installed.

Several wings or partial wings have had a network of zone and distribution conduit installed for ICN cabling. From the hub room, 2" EMT conduit has been install to a pull box in each predetermined zone. From each pull box there has been installed a 1" EMT pipe to rooms in that specific zone deemed as requiring an ethernet connection. Cabling shall be installed through the proper zone and distribution conduit to each room.

Conduit fill ratios have been considered and should be met. If an exception exists, Information Services is to be notified for consultation.

Conditions

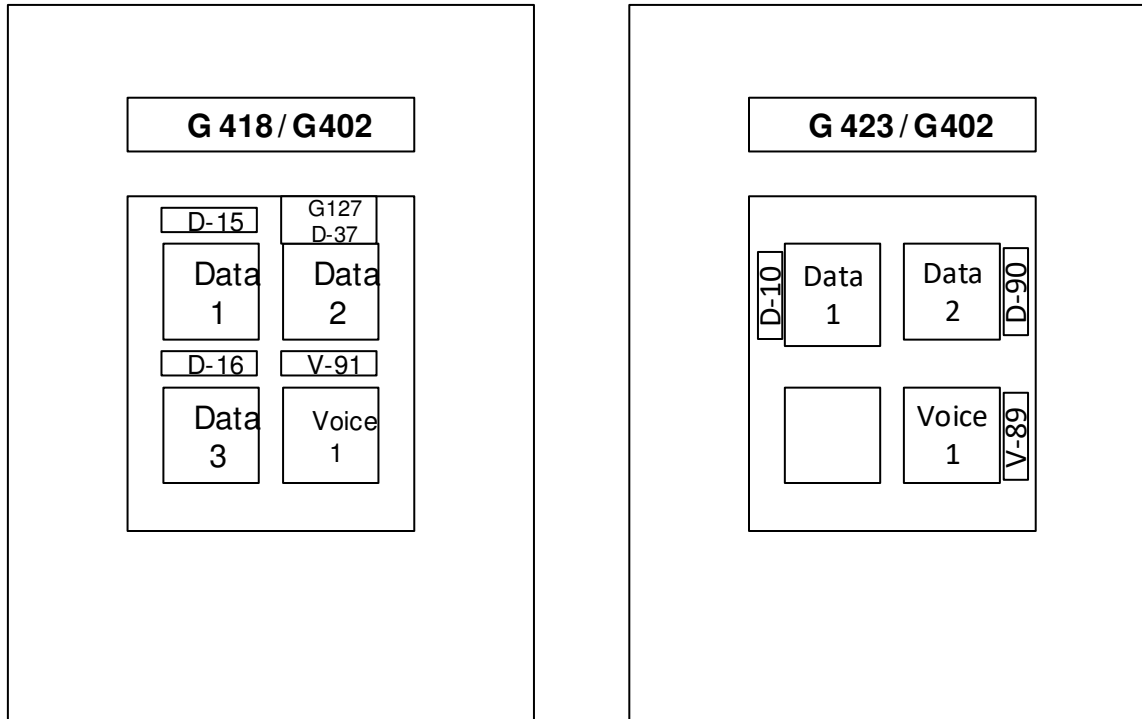
1. No ceiling space shall be accessed without a valid Ceiling Access Permit (CAP) received from the Occupational Health and Safety Coordinator and properly displayed.

2. Most of the work can be done during normal business hours with the understanding that corridor traffic flow must not be compromised.
3. Access to all locked doors will be through Fire and Security Services. Be prepared to wait at times for access to any given room. All doors **MUST** be locked upon completion of work.
4. All individuals working on the cabling projects must have valid picture I. D. provided by the Fire and Security Department of Sunnybrook.
5. MAC work should be completed within 10 business days from the day of assignment or as scheduled (Projects).
6. Most projects/installations (marked as matrix III and IV) will require medical contamination control due to sensitive areas in the hospital. The cabling vendor should own professional construction equipment/material such as mobile cubicles equipped with hepa vacuum cleaner, asbestos masks and plastic sheets for manual tenting.
7. All persons to be employed as Cable Installers at Sunnybrook are required to attend a minimum ½ day Asbestos Awareness Training Session by an outside consultant. Acceptable training programs are offered by Pinchin Environmental, T. Harris Environmental, Jacques Whitford Environmental, and some labour unions. Certificates of training must be copied and given to the Occupational health and Safety Coordinator at Sunnybrook. The accepted contractor must also meet with the Safety Coordinator to review their work and sensitive asbestos areas prior to starting work. The contractor needs to be aware that they must report unsafe conditions to Occupational Health and Safety Coordinator.
8. All persons to be employed as Cable Installers at Sunnybrook are required to attend awareness session provided by Infection Prevention & Control, hosted on-site at Sunnybrook.

Appendix A: Cable Labeling Standard

The following is the cable labeling standards used at Sunnybrook, for horizontal Cat6/6a UTP cables.

Station End Location



Station end wall plates

The Sunnybrook cable labeling standards requires that the label(s) at the station end wall plate identify the 'station end room number', 'hub room number', and 'device patch panel port number' of where the cable terminates to. The station end wall plate labels comprise of a top label and one or more side labels. If only a port number is listed then it is assumed that the hub room is read from the top label. Otherwise the hub room must be listed in addition to the port number.

Top label G418 / G402

- where: - G418 is current station end room location where this wall plate is
 - G402 is the ICN Hub Room that the cable(s) runs to

Side Labels D-15 D-16 G127 V-91 D- 37

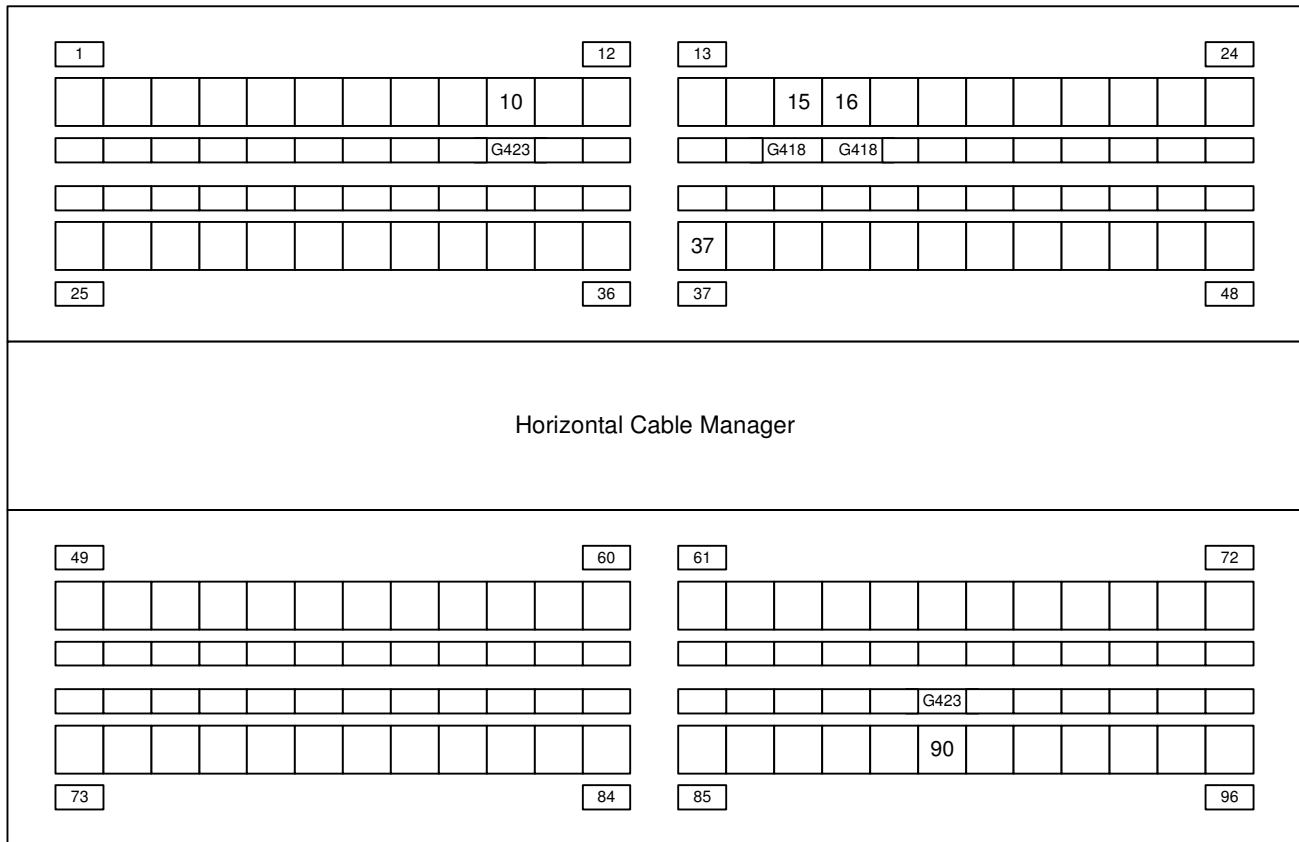
- where - 'D-15' is data cable terminating on patch panel port 15 in hub room G402
 - 'D-16' is data cable terminating on patch panel port 16 in hub room G402
 - 'G127 D-37' is data cable terminating on patch panel port 37 in hub room G127
 (exception cable to a different hub room)

- V-91 is voice cable terminating on BIX panel port 91 in nearest Bell voice closet

Note: if only a number is provided then it is assumed to be a data cable.

Equipment End Location – ICN Hub Room

Each hub room will have data cables terminated on a patch panel. All patch panel ports will be consecutively numbered such that all ports will be uniquely identified regardless if there are several panels on several network racks. The end ports will be labeled at top/bottom consecutively starting from 1 to nnn as illustrated in the following diagram. The centre labels will indicate the device room number where the cable comes from



Equipment end Patch Panels - ICN Hub Room G402

Data Centre and Hub Room Access Policy

Sunnybrook Health Sciences Centre		Policy No:	ICS-025
Title	Data Centre and Hub Room Access Policy	Original: (mm/dd/yyyy)	06/11/2012
Category	Information and Communication Services	Reviewed: (mm/dd/yyyy)	06/11/2012
Sub-Category	Network & Security	Revised: (mm/dd/yyyy)	10/05/2012
Issued By:	IT Operations Committee		
Approved By:	Sam Marafioti		

The Sunnybrook Intranet document is considered the most current.
Please ensure that you have reviewed all linked documents and other referenced materials within this page.

Data Centre and Hub Room Access Policy

Policy

It is Sunnybrook's policy to permit only authorized access to data centre and hub rooms in accordance with Sunnybrook Information Services security policies and procedures in order to ensure the integrity and availability of services dependent on these mission critical resources.

Definitions

Agent means any authorized Sunnybrook person accessing a data centre or hub room.

Visitor means any authorized non-Sunnybrook person seeking access to a data centre or hub room.

Purpose

This policy outlines Information Services standards for access to and maintenance of all Sunnybrook data centres and hub rooms ("facilities"). The policy is intended to enable secure access to facilities and to ensure that these facilities are maintained and operated in a safe, clean and effective manner in order to provide continuous service for dependent systems and infrastructure. All persons accessing data centres or hub rooms must abide by this policy. Failure to comply may result in loss of facility access privileges and/or removal

of equipment.

Applicability

This policy applies to:

- All authorized Information Services administrators and their authorized agents who maintain equipment owned and operated by Information Services in a data centre or hub room; and
- Any other Sunnybrook person who owns or maintains equipment housed in or accessed via any Sunnybrook data centre or hub room.
- Any Visitor for any purpose whatsoever.

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Procedures

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1 - Authorized Data Centre and Hub Room Activities

Hub rooms are intended to be single purpose rooms for accommodating Information Services network systems (network cabling and equipment), servers and storage systems and may include associated cables, monitors, power, air conditioning units, temperature monitoring units, humidity monitoring, tape drives, backup media, etc.

In addition, other Sunnybrook authorized corporate systems or infrastructure services may be housed within or accessible through a data centre or hub room, including patient monitor network systems, Medical Imaging PACS network equipment, Research network equipment, etc. Other rooms may have been built as multipurpose rooms which have other corporate systems installed such as fire alarm panels, Coax video systems, etc.

Note: installation of any non-IS owned or operated system or service in a data centre or hub room must receive prior written approval from Sunnybrook’s CIO.

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2 – Administrator Responsibilities:

It is the responsibility of each Information Services system administrator to ensure that all data centres and hub rooms and all associated equipment therein are maintained and operated in a safe and effective manner, including the performance of on-going maintenance and monitoring for any unusual conditions, e.g. overheating, flooding, etc.. All non-normal operating conditions must be reported to the Manager of Information Technology at the

earliest opportunity.

- All data centres and hub rooms must be kept in a safe, clean and professional manner at all times. All waste must be immediately disposed of by the respective Administrators and the waste deposited into proper containers.
- All entrances to data centres and hub rooms must kept clear as per fire/security regulations.
- All non-normal operating conditions must be reported to the Manager of Information Technology at the earliest opportunity.
- Staff failing to adhere to this policy will be reported to Director of Information Technology who will take applicable disciplinary action where required.

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3 – Access

Access to a Sunnybrook data centre or hub room by any person requires

- 1) authorization from Information Services; and
- 2) either an IS escort or a personally issued KeyScan-enabled Sunnybrook ID badge.

- KeyScan-enabled access does not require an Information Services escort. Those persons accessing a data centre or hub room who have not been issued a KeyScan-enabled card must be escorted.
- Escort, where required, must be provided by either an authorized Sunnybrook Information Services or Security Services representative.
- KeyScan-enabled card access will generally be provided to authorized Sunnybrook staff (agents) and 3rd parties (visitors) requiring routine, non-escorted access on an individual, case-by-case basis.
- Individuals must only use a personally issued KeyScan-enabled card and all individuals must either scan in or be escorted to enter a room (all tailgating is strictly prohibited).
- Access (whether by escort or KeyScan) will be logged and routinely audited by information Services.

Sunnybrook Information Services Purposes

Sunnybrook agents (IS and non-IS departmental server admins) requiring temporary or permanent access to data centres and hub rooms must send a request to the IS Network team and receive written authorization prior to access.

Temporary access to these rooms will be granted on a short-term basis for 3rd

party vendors or other visitors performing work on behalf of Information Services (e.g. for software or hardware installation or maintenance).

Sunnybrook Non-Information Services Purposes

Access to data centres and hub rooms for non-IS purposes must be authorized by the Director of Information Technology or designate. Temporary access to these rooms will be granted on a short-term basis for 3rd party vendors (visitors) requiring access to service or install non-IS systems in the room (e.g. renovations to the room, service or installation of air conditioning, etc.), including but not limited to:

- Installation or service of any non-IS systems such as Patient Monitor, PACS or Research, fire alarm panels, security system panels, electrical service panels, coax TV systems, etc.
- For construction work near or in these rooms requiring access, including installation of conduit or cables that will pass through the rooms; etc.
- Access by other non-IS Sunnybrook project managers, maintenance and service personnel or their agents (e.g. for Facilities Planning or Maintenance personnel, vendors or contractors) who may require access to these rooms to implement projects, install systems or maintain and service essential systems such as on an ongoing basis or in emergencies.

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4 - Security:

Authorized Access Only

Access to data centres and hub rooms is absolutely restricted to authorized individuals as documented in this policy and as identified by the Manager, Information Technology in the IS Network Team Data Centre and Hub Room Access access control list.

- All data centres and hub rooms must be kept locked at all times.
- Access to data centres and hub rooms will be logged and audited by the Manager, Information technology
- All persons requesting access will be required to supply identifying information (name, company name or department, room number and phone number/local) and the purpose for entry before being granted access.
- Access is permitted for those activities required for the indicated purpose and under no circumstances shall other activities occur for any other purpose without written approval of the Manager, Information Technology.

- Security badges must be worn at all times.

Visitors

- All Visitors must be escorted at all times by an authorized SB Information Services staff or member of Sunnybrook’s Security staff unless they have been issued a KeyScan-enabled Sunnybrook ID badge (see Appendix 1).
- Authorized Visitors who may require continuous access for greater than 5 days may be provided with a temporary Visitors’ badge enabling KeyScan access at their cost or at the cost of their sponsor at the discretion of the Manager, Information Technology.
- Visitors are not permitted to have possession of any data centre or hub room access lock key other than an authorized KeyScan-enabled Sunnybrook ID badge which has been assigned to them personally.

Enforcement:

- Any person found to have violated this policy may be subject to disciplinary action, up to and including termination of employment and/or legal action at the sole discretion of Sunnybrook Health Sciences Centre.

Contact Information:

George Lee	x4219	page 7308
David Chong	x7232	page 8101
Myles Leicester	x4377	page 8137
Wilfred Yan	x85322	page 5416
IS Help Desk	x4159	
Fire and Security	x4589	

Appendix 1

Requesting Access to ICN Data Centres and Hub Rooms

The following procedures must be used for requesting access to any Sunnybrook data centres or hub room.

Requesting access during business hours:

- 1) Users requiring access to data centres or hub rooms must email the IS Network team for access. The IS Helpdesk can also be called and will, in turn, email and page the ICN Network team. Users are to identify themselves and indicate the reason they require access to this room as well as date and time required.
- 2) The IS Network team will review the request and access may require further management approval without prior notice.

- 3) The IS Network team may personally provide access to the room or submit a request to Sunnybrook Security Services to authorize access.
- 4) The IS Network team will log all access, including identity of user, data centre or hub room number, date, start and stop times and reason for access.

Requesting access after business hours:

- 1) Users requiring access to hub room must call the Security office (ext. 4589) to request access. Users must identify themselves and indicate the reason they require access.
- 2) Security will only provide access to persons appearing on a list of pre-approved personnel provided by the IS Network team or based on prior written permission of a member of the IS network Team or the manager, Information Technology.
 - a) If a person is authorized for entry, Security will open the door to permit user access to the room.
 - b) If user is not authorized for entry then Security will deny access and advise the user to contact IS the following day.
 - i) If the user cannot wait then Security may contact the IS Helpdesk for assistance in contacting an authorized IS representative.
 - ii) If Security contacts the IS Helpdesk, the Helpdesk personnel will assess the request and, if necessary, email and page the ICN Network Team for directions.
- 5) Security will log all access, including the identity of user, data centre or hub room number, date, start and stop times and purpose for access.

Requesting KeyScan Access

Note: Some rooms are equipped with KeyScan access. Visitors may be assigned KeyScan-enabled Sunnybrook ID badge as noted above, however only escorted Visitor access can be granted to rooms without KeyScan pads.

The following procedure is used for requesting KeyScan access to data centres:

1. User submits request by email to IS Helpdesk or IS Network team. Name, department, phone number and pager number of person(s) requiring access, data centre(s) to be accessed and reason for access must be provided. Pre-approved requests may be provided by IS management on behalf of the user.
2. All requests will be forwarded to IS Network team. If the request is questionable then it will be forwarded to IS management for approval. (e.g. to install non-IS systems or allow departmental servers to be installed in the ICN data centres).

3. If a request is approved and accepted then the IS Network team will forward an e-mail to Security to authorize access via KeyScan.

Note: Security will not accept requests directly from users and will only accept requests from the IS Network team.

If short term temporary access is requested then the IS Network team will specify the number of days for which access has been granted.

4. Security will create a KeyScan-enabled Sunnybrook ID badge for the approved access and confirm back to ICN Network team and/or directly to the user(s) requiring access. Vendors requiring a temporary ID badge can pick it by visiting the Security office (CG03) only after providing proper identification. Prior email notification of access approval must be received by Security from the IS Network team.

No person may use a KeyScan-enabled Sunnybrook ID badge which has not been assigned to them personally to access a data centre or hub room.

5. If temporary access was issued, at the completion of the access period, IS Network team will issue a follow-up email to Security to remove access.
6. If IS Network team is informed of a user leaving the hospital who no longer requires access to a room, IS will issue an email to Security to remove any KeyScan access which may have been previously assigned to that individual.
7. The IS Network team will maintain a spreadsheet of users that have been granted Keyscan access. Date of request and room accesses granted as well as the date of request or access code removal will be recorded.

POLICY & PROCEDURES

RE: Code White, Code Blue, and Nurse Call Buttons

Corporate Planning & Development



Date: September 20, 2019
Issued by: S. Marafioti

Policy: Code White, Code Blue, and Nurse Call Buttons Installation Policy for Renovation and/or New Construction Projects

Procedure for the installation of Code White, Code Blue, and Nurse Call buttons/pull cords in renovation and/or new construction projects

1. During the Design Development phase, the Corporate Planning & Development (CPD) Project Manager (PM) must notify the user group/area stakeholders, representatives from the Occupational Health & Safety, Security, Risk Management, Biomedical Engineering, and Emergency Preparedness departments of any installations and/or replacements of existing Code White, Code Blue, and/or Nurse Call buttons required throughout the hospital.
2. The CPD PM must make note that all new and renovated areas should be considered for security enhancements during the Design Development phase. The potential enhancements are to be further discussed with Security prior to obtaining their approval.
3. The CPD PM must receive approval from all aforementioned stakeholders on the location(s) and specification of the button(s) before proceeding with the install.
4. When installing the **Code White** button, the following pre-determined specifications must be met:
 - a. The Code White button must be a WHITE button with BLACK lettering
 - b. The text must read, "CODE WHITE"
 - c. A name plate noting the function of the button must be placed above the button's location
 - d. A cover plate for the button is to be considered in consultation with the Patient Care Manager of the unit and/or with the aforementioned stakeholders
 - e. After installation, the Code White button will be handed over to the Security department
5. When installing the **Code Blue** button, the following pre-determined specifications must be met:
 - a. The Code Blue button must be a BLUE button with WHITE lettering
 - b. The text must read, "CODE BLUE"
 - c. A name plate noting the function of the button must be placed above the button's location
 - d. A cover plate must be placed on all buttons unless indicated by the Patient Care Manager of the unit and/or the aforementioned stakeholders
 - e. After installation, the Code Blue button will be handed over to the Biomed department
6. When installing the **Nurse Call** button/pull cord, the following pre-determined specifications must be met:
 - a. The CPD PM must receive approval from all aforementioned stakeholders
 - b. After installation, the Nurse Call button/pull cord will be handed over to the Biomed department