

Project Manual

Sunnybrook Health Sciences Centre
K Wing – Hematology

Project No. ONBL22-0011

12 November 2024

Issued For Tender & Permit

NORR

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**Sunnybrook Health Sciences Centre
K Wing – Hematology**

The professional seals and signatures below apply to documents, specifications and schedules prepared by the respective architectural and engineering professionals.

Architect



Structural Engineer



Mechanical Engineer



Electrical Engineer



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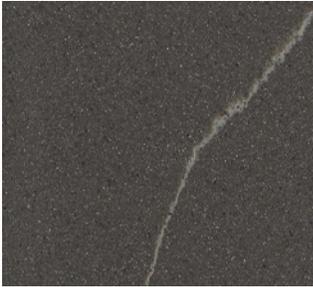
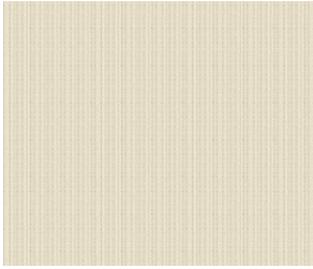
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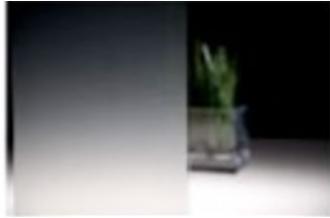
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NOTE: The application / location for the materials indicated is not limited to the list below and is to be used in conjunction with and may be supplemented by, the Specifications, Schedules and Drawings. Refer to Specifications, Schedules and Drawings for full extent of material application and additional material types. Owner/SMH supplied items are to be installed by contractor. And provide necessary blockings to support the installation of those items. Final locations to be confirmed with owner.

CODE	ITEM	DESCRIPTION	LOCATION	IMAGE
DIVISION 05 – METALS				
MET-S1	Stainless Steel	Manufacturer: Excelsior, or equivalent Style: X-L Blend “S”	Millwork Base & Door Hardware	
DIVISION 06 – WOOD, PLASTICS AND COMPOSITES				
PLAM-1	Plastic Laminate Millwork	Manufacturer: Formica or Approved Equivalent Colour: Nut Brown Cherry Texture: Artisan Finish	Millwork Reception Desk	
PLAM-2	Plastic Laminate	Manufacturer: Formica or Approved Equivalent Colour: 8576 Blond Cedar Texture: Pure Grain	Millwork	
PLAM-3	Melamine	Manufacturer: Wonderosa Product: Melamine Colour: W100/W300 White Texture: Matte	Millwork interior	
PWC-1	Hygienic Wall Covering	Manufacturer: Altro or equivalent Product: Altro Whiterock Matte hygienic wall cladding Colour: Pearl-41-FT Height: As noted on drawings	Exam room	

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CODE	ITEM	DESCRIPTION	LOCATION	IMAGE
SSF-1	Solid Surface Countertop	Manufacturer: Wilsonart, or approved equivalent Product: Solid polymer surface Color: Morning Ice 9204CE Thickness: 1/2" thick	Countertops where indicated	
SSF-2	Solid Surface Countertop	Manufacturer: Wilsonart, or equivalent Product: Solid polymer surface Color: Carbone Marmo 9914SS Thickness: 1/2" thick	Reception Desk Countertops	
VWP-1	Wall protection General areas	Manufacturer: Construction Specialties Product: Acrovyn Wall Protection Style: Acrovyn Textile Collection Colour: Cornsilk	General areas	

DIVISION 08 - OPENINGS				
FLM-1	Glass Film	Manufacturer: 3M- Architectural Window Solutions or Equivalent Product: Crystal Dusted White Pattern: 7725E-314	Glazed Folding Partition	

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CODE	ITEM	DESCRIPTION	LOCATION	IMAGE
FLM-2	Glass Film	Translucent window film with custom digital print	Waiting Area Feature Wall	
GL-T	Tempered Glass	Product: Clear Thickness: 13mm Tempered glazing with polished & chamfered edges on all visible edges	Reception Desk Vision Panel	

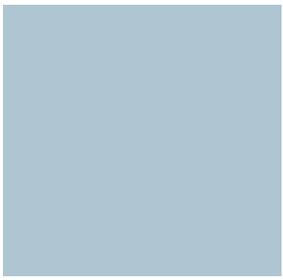
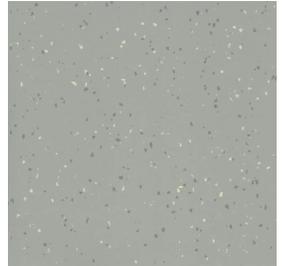
DIVISION 09 – FINISHES				
Ceiling Finishes				
ACT-1	Acoustic Ceiling Tile	Manufacturer: Armstrong Ceilings, or Equivalent Product: Health Zone Optima #3115, Clean Room Ceiling, Fibreglas core Size: 610mm x 1219mm Suspension: Clean room system (Steel or aluminum – Refer to RFS) NRC: 0.95 Durability: Washable, Soil Resistant Surface: Fine, Non-perforated Edge: Square Lay-in Colour: White Moisture Resistant	General areas	

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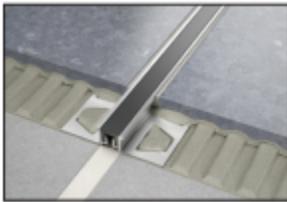
CODE	ITEM	DESCRIPTION	LOCATION	IMAGE
LMC-1	Specialty ceiling system	Manufacturer: Armstrong Ceilings Product: Metalworks Diverge Product code: MWLD-01 Color: Gun Metal Grey (MY)/ Effects Poppy Seed (FXPS)	Reception	
PANEL	Specialty ceiling system	Manufacturer: Armstrong Ceilings, or Equivalent Product: Infusions Lay-in 5922 Size: 24" x 24" x 1/8" thick Edge: Square Lay-in 9/16 or 15/16" Face Profile: 9/16" or 15/16" Colour: Crystalline Focus Fire Performance: Class A	Reception Area	 

Wall finishes				
PT-1	Paint	Manufacturer: Benjamin Moore or Dulux Color: DLX1023-1 Oatmeal	Walls General	
PT-2	Paint	Manufacturer: Benjamin Moore or Dulux Colour: DLX1001-1 Delicate White	Drywall Ceilings	

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CODE	ITEM	DESCRIPTION	LOCATION	IMAGE
PT-3	Paint	Manufacturer: Benjamin Moore or Dulux Color: DLX1154-4 Twinkle	Accent Walls	
PT-4	Paint	Manufacturer: Benjamin Moore or Approved Equivalent Color: Briarwood HC-175	Doors & Frames	
PT-X	Paint	Manufacturer: Color: To match adjacent wall surfaces.		
Floor Finishes				
ICB-1	Integral Flash Cove Base	Refer to RSF-1		
RB-1	Rubber Base	Product is the same as RSF-1		
RSF-1	Resilient Sheet Flooring	Manufacturer: Mondo Contract Flooring Product: Harmoni Premium Rubber Flooring Colour: Nickel HG507 Roll size: 1.9m x 10m Base: ICB-1	General areas	

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CODE	ITEM	DESCRIPTION	LOCATION	IMAGE
RSF-2	Resilient sheet flooring	Manufacturer: Mondo Contract Flooring Product: Harmoni Premium Rubber Flooring Colour: Vellum HG481 Roll size: 1.9m x 10m	Waiting Area & Corridor	
T-1	Transition Strip For transitions at resilient flooring	Manufacturer: Schluter Series: Schluter Schiene Product: E30 Material: Stainless V2A Finish: Stainless steel Length: 2.5 m Height: 3mm (1/8")		
TPS-3	Transition strip for expansion joints TS-1, TS-3, TS-5	Manufacturer: Schluter Series: Schluter DILEX-KSN Product: EKS N 140 HB (Light beige) Material: Stainless steel V2A Finish: Stainless Steel Length: 2.5 m Height: 14 mm (17/32")		
EJC-1	Expansion Joint cover	Manufacturer: Construction Specialties Product: Interior Floor Joint Systems Model: PC-2G Series Width: Refer to existing	Waiting Room	

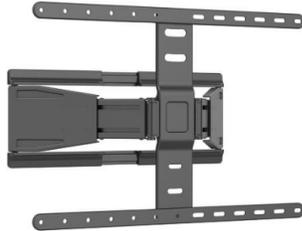
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CODE	ITEM	DESCRIPTION	LOCATION	IMAGE
GLP-1	Plastic Panels	Manufacturer: 3Form Product: Tonic Guage: 12.7 mm (1/2")	Reception Desk	
DIVISION 10 – SPECIALTIES, WASHROOM ACCESSORIES				
BNH	Bench	Manufacturer: Hadrian Product Standard Benches Seat: 32mm thick 241mm wide 1,220mm long	Locker room	
B-RLG-1	Bumper Guard B-RLG-1	Manufacturer: Construction Specialties, or Equivalent Product: Acrovyn SCR-64M Profile: 2032mm (8") high x 32mm (1-1/4") offset; Mount: Surface mounted continuous aluminum retainer Finish: PVC-free Acrovyn in showgrain texture Color: TBD		
CH-1	Coat Hook	Manufacturer: Frost, or equivalent Product: Steel safety coat hook Product code: 1150 Finish: 18 gauge stainless steel, type 304 brushed finish		 3D view 1150

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CODE	ITEM	DESCRIPTION	LOCATION	IMAGE
CG-1	Corner Guard	Manufacturer: Construction Specialties Inc. Product: CO Series: CO-8 Style: 4.8mm nose radius guard Radius: 90 degrees Size: 75mm x 75mm, Gauge: 16. 304 Stainless steel alloy Height: Finish: Satin #4 Stainless Steel, radius edge	Patient rooms	
CG-2	Corner Guard 135 Degree	Manufacturer: Construction Specialties Inc. Product: CO Series: CO-8M Style: 4.8mm nose radius guard Radius: 135 degrees Size: 75mm x 75mm, 16 gauge, 304 Stainless steel alloy Height: 1981mm (6'-6") Finish: Satin #4 Stainless Steel, radius edge	Patient room	
CG-3	Corner Guard U-Shaped	Manufacturer: Construction Specialties, or Equivalent Product: CO Series: Custom design Style: 4.8mm nose radius guard Height: 1981mm (6'-6") Type: Hugs two corners at once Finish: #4 Satin finish radius edge	Patient room	
CRL-1	Chair Rail	Manufacturer: Acrovyn 4000, or Equivalent Product: SCR-80M Wall offset: 349mm (1-3/8") Profile: 203mm (8") Mount: Aluminum Retainer Finish: Acrovyn in shadowgrain texture Color: TBD	Waiting Area	

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CODE	ITEM	DESCRIPTION	LOCATION	IMAGE
FS-1	Folding screen 7 panels	Manufacturer: Silentia Art Panels Product: Wall Mounted Folding Screen Height: 1.85m Color: Ocean	Patient Room	
FS-1	Folding screen 9 panels	Manufacturer: Silentia Art Panels Product: Wall Mounted Folding Screen Height: 1.85m Color: Ocean	Patient Room	
MGP	Moveable glass partition	Manufacturer: Modernfold Product: Acousti Clear Paired Panel System Top Supported – Manually Operated G330 Suspension System STC 51 6 Panels	Staff Room	
SG-1	Splash Guard	Manufacturer: Hadrian Product: Metal Urinal Screens Wall Mounted Stainless Steel standard series Width: 610mm (24") Height: 1,524mm (60") 305mm (12") AFF	Patient Room	
TVMB-1	TV Mounting Bracket	Manufacturer: Prime Cables or equivalent Product: Ultra Slim Full Motion TV mount Model Number: Cab-LPA79-464 Size: Fits most 43" – 90" TV Use this for Smart Suite Need another one for smaller TV- 24-32"		

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CODE	ITEM	DESCRIPTION	LOCATION	IMAGE
WB	Whiteboard	Manufacturer: Calyx by Claridge Product: Calyx Glass Wall Mounted Markerboard Size: 4' x 6' Landscape Orientation Color: Calm White	Staff Room	
LKR	Lockers (Z type lockers)	Manufacturer: Bradley Product: Lenoxocker Product type: Lenox 'Z' locker – solid plastic Size: 12"w x 21"deep x 72" high Color: Charcoal Gray – S215 Accessories: Sloped top, Shelf, Coat hook	Locker Room	
TVCM	TV Ceiling Mount	Manufacturer: Peerless Product: Smartmount Ceiling Mount with ceiling plate & tilt box for up to 90" Displays Model Number: PLCM-1CP		
DIVISION 12 – FURNISHINGS				
RS-1	Roller shades	Manufacturer: Lutron or Approved Equivalent Product: Manual Roller Shades LHSS-150/160 Shade Fabric: E Screen-Theia / White Pearl, 1.7 Openness Hem Type: Architectural Wrap		
RS-2	Roller shades w blackout	Manufacturer: Lutron or Approved Equivalent Product: Manual Roller Blackout Shade Shade Fabric: E Screen-Theia / White Pearl, Hem Type: Architectural Wrap		

End of Section

1.01 MANDATORY INSTRUCTIONS TO BIDDERS

Submission Instructions for Suppliers

Please follow these instructions to submit via our Public Portal.

1. Prepare your submission materials:

Requested Information

Name	Type
Submission	File Type: Any (.csv, .pdf, .xls, .xlsx, .ppt, .pptx, .bmp, .gif, .jpeg, .jpg, .jpe, .png, .tiff, .tif, .txt, .text, .rtf, .doc, .docx, .dot, .dotx, .word, .dwg, .dwf, .dxf, .mp3, .wav, .avi, .mov, .mp4, .mpeg, .wmv, .zip)

Requested Documents:

Please note the type and number of files allowed. The maximum upload file size is 100 MB.
Please do not embed any documents within your uploaded files, as they will not be accessible or evaluated.

2. Upload your submission at:

<https://medbuy.bonfirehub.ca/opportunities/private/bdf4a3e41981a9a92ea3b97a54a1dc20>

Your submission must be uploaded prior to the Closing Time, **December 10, 2024, at 2:00 PM (EST)**. We strongly recommend that you give yourself sufficient time and **at least ONE (1) hour** before Closing Time to begin the uploading process and to finalize your submission.

To supplement uploaded Bid Security and Agreement to Bond documents uploaded to the Bonfire portal, original hard copy documents of the Bid Security and Agreement to bond must be received by the Tendering Call Authority upon request, within 48 hours of the request.

Important Notes:

Each item of Requested Information is instantly sealed and will only be visible after the Closing Time.

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

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

Minimum system requirements: Internet Explorer 8/9/10+, Google Chrome, or Mozilla Firefox. Javascript must be enabled.

Need Help?

Sunnybrook Health Sciences Centre uses a Bonfire portal for accepting and evaluating proposals digitally. Please contact Bonfire at Support@GoBonfire.com for technical questions related to your submission. You can also visit their help forum at <https://bonfirehub.zendesk.com/hc>

1 BIDS

1.1 Intent

The intent of this Bid call is to solicit and receive a formal Bid for the K3C Hematology Renovation Project for Sunnybrook Health Sciences Centre (the "Owner")

Only Prequalified General Contractors may submit bid submissions on this Tender. The Prequalified General Contractors, from Sunnybrook RFSQ No.2733127893 are as follows:

- Maystar General Contractors Inc.
- REA Construction Ltd.
- Dineen Construction Corporation
- BDA Inc.
- Compass Construction Resources Ltd.
- Harbridge & Cross Limited
- Chart Construction Management Inc.
- MJ Dixon Construction Limited
- Elite Construction Management Inc.
- Pomerleau
- Diligent Construction Inc.

Only Prequalified Mechanical Subcontractors from Sunnybrook RFSQ No.2733127893 can be named as subcontractors on this project:

- Black & McDonald Ltd.
- Kelson Mechanical Inc.
- English and Mould Mechanical Systems Ltd.
- Pipe All Plumbing & Heating Limited
- VR Mechanical Services Inc.
- Plan Group Inc.
- Nutemp Mechanical Systems Ltd.
- Canadian Tech Air Systems Inc.

Only Prequalified Electrical Subcontractors from Sunnybrook RFSQ No.2733127893 can be named as subcontractors on this project:

- Black & McDonald Ltd.
- Ontario Electrical Construction Company Limited
- Danik Electrical Construction Company Limited
- Plan Group Inc.
- RPG Electric
- Ainsworth Inc.
- Guild Electric Limited
- Modern Niagara Toronto Inc.

.1 A mandatory formal briefing meeting and site tour will be held at the date and time and location as stipulated in Invitation to Bidders. All Prequalified General Contractors, along with Prequalified Electrical/Mechanical Subcontractors wishing to bid must attend the Mandatory Formal Briefing Meeting and Site Tour. The Formal Briefing and Site Tour is on November 19, 2024, at 10:00 AM (EST). Bidders must RSVP before November 18, 2024, 4:00 PM (EST) stating the name of the attendee (only 1 attendee per contractor) via email to the Bid Administrator MHenry@mohawkmedbuy.ca. Bidders should arrive at least 10 minutes before the meeting time. All Bidders must sign the attendance register prior to commencing the site tour/visit.

.2 Submission requirements: Submission must be in accordance with the K3C Hematology Renovation Project, Drawings and Specifications included with these Submission Documents for:

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

And will be received

Prior to 02:00:00 o'clock p.m local time, on December 10, 2024.
Bids will NOT be opened publicly.

.3 Submission must consist of:

.1 Completed Stipulated Price Bid Form

(a) Note 1:

- Bid Form must be filled out in its entirety; failure to do so may result in disqualification.
- Inconsistencies between dollar amounts in numerical form and in written form may result in disqualification

.2 Bid Security

.3 Agreement to Bond

.4 Proposed Construction Schedule

.5 Hazmat Acknowledgement Form

.6 COVID 19 Acknowledgement Form

- .4 Submissions must be submitted on the Bid Form provided, filled out and signed by an authorized signing officer from the Bidder's organization and sealed. Bids must be submitted on one copy of the Bid Form provided. **All instructions to Bidders for Bid Submission in this document are Mandatory. Any instructions not followed will result in Bid Disqualification.**
- .5 Bid form must be completed without delineation, alteration or erasures and there is to be no recapitulation of the work to be done.
- .6 Bids must be for a Stipulated Sum without escalation clauses or other qualifications. Bids will be evaluated on the base bid only. Alternative prices will not be considered in determining the lowest compliant Bidder.
- .7 Prices must exclude: Harmonized Sales Tax where indicated.
- .8 Oral, telephoned, or fax bids, or bids submitted by any other means will not be accepted nor acknowledged. Bids will only be accepted via the Sunnybrook Bonfire Portal described on page 1. Paragraph 1.1.2 states time up to which Bids will be received. This time may be extended by public notice or by written Addendum. Bids not submitted by the submission deadlines stipulated in Paragraph 1.1.2 will be rejected.
- .9 Bidders are reminded that they must base their bids on the manufacturers, installers, materials, equipment and products specified. Bids that are submitted based on alternatives not called for will not be acceptable and will be cause for disqualification.
- .10 Submissions will not be opened until the Owner is in receipt of the submissions.

1.2 DESCRIPTION OF WORKS

Sunnybrook Hospital now plans to relocate the Complex Malignant Hematology (CMH) Outpatient Unit currently located in C606 to the K-Wing Veterans Centre, Level 3 Central Pod, consolidating the program within a single location. This move aims to enhance operational efficiency and improve the patient care experience.

Transforming the Existing Dayroom to an Administrative area (Reception, Waiting Area, Offices, Staff Rooms & Private Meeting Room) & two existing patient rooms to a Clinical area with 7 Transfusion Bays, Exam Room, and Nursing stations.

All areas will have new finishes Walls, Ceilings and Floors, Mech. & Elect equipment and replace existing light fixtures in the Existing Corridor (outside of these areas).

Approximate Area of Renovation on Level 3 Central Pod of K-Wing is 406.75m² (4378.00sqf).

1.3 CONTRACTORS/ SUB-CONTRACTORS

- .1 Bidders must submit on the Supplementary Bid Form, identified list of sub-contractors and corresponding costs to whom it is proposed to sublet any part of the work.
- .2 Bidder must name only one Subcontractor for each trade Section.
- .3 Should Bidder be awarded the Contract, parties named, including Bidder's own forces must be used to perform the work for which they are named and must not be changed without the Owner's written consent.
- .4 The term "Own Forces", or other such phrase, will not be acceptable where such work will knowingly not be provided by Bidder's own forces. Such flagrant use may be cause for disqualification of bid.
- .5 Immediately after notice of Contract award, the successful Bidder must notify it's named Subcontractors that they have been named.
- .6 The list of sub-contractors set forth must not to be altered or changed except as may be agreed by the Owner and the Engineer prior to the signing of the Contract. Contractor has fully investigated and informed itself as to the qualifications of their named Subcontractors. Contractor fully understands that each named Subcontractor can meet and will provide all of their work as per Bid Documents. Where it is found that a named Subcontractor cannot or will not provide its work as per Bid Documents, the Contractor will be obligated to retain a qualified Subcontractor who will provide the work as per Bid Documents. All costs, including cost differences between Subcontractor's prices, required to change the named Subcontractor to a qualified Subcontractor will be at Contractor's own expense and the Owner will not entertain any requests for any additional monies

2 QUESTIONS DURING BIDDING

2.1 Document review

- .1 Bidders finding discrepancies, ambiguities, or omissions in the Drawings or Specifications are to immediately notify solely the Tender Calling Authority who will issue written instructions to all Bidders in the form of posted written Addenda.

2.2 Questions arising during the bidding period must be solely directed to:

Bidding Network Sourcing tool: <https://www.biddingo.com/>

- .2 Bidders seeking information with regard to the organization of documents and clarification and interpretation of information on drawings or in specification may contact only through Biddingo.
- .3 Questions including questions with regard to quantities, quality, or acceptable manufacturers of materials and equipment or questions with regard to interpretation of the documents will not be discussed or answered by telephone and must be directed to Biddingo. All the questions will be answered by published, posted written Addenda.
- .4 **Questions are due no later than November 26, 2024.**
- .5 Bidders must not contact the Owner, its employees, or its agents, including the Engineering Consultant, except via the Tender Calling Authority in regard to this tender.
- .6 Under no circumstances must the Bidder rely upon any information or instructions from the Owner, its employees, or its agents, including the Consultant, unless the information or instructions are provided in writing by the Tender Calling Authority; and
- .7 The Owner, its employees and/or its agents, including the Consultant, will not be responsible for any information or instructions provided to the Bidder, with the exception of information or instructions provided in writing by the Tender Calling Authority.

3 ADDENDA

- .1 During bidding period Bidders may be advised by Addenda of additions, deletions, or alterations to the Specifications and Drawings. The information contained in the Addenda is to supersede and amend the Drawings, Specifications and Schedules. These revisions to the work are to be allowed for in the Bid and the Addenda are to become part of the Contract Documents.
- .2 Bidders to state in the space provided on the Bid Form the numbers of the Addenda received and included for in the preparation of the Bid.

4 EXAMINATION OF SITE

4.1 MANDATORY FORMAL BRIEFING MEETING AND SITE TOUR

- .1 A mandatory formal briefing meeting and site tour will be held at date and time and location as stipulated in the Invitation to Bidders. **This site tour is a Mandatory Requirement for all Prequalified General Contractors and for Prequalified Mechanical and Electrical Contractors wishing to bid as subcontractors.**

Date/Time/Location:

- **November 19, 2024, at 10:00 AM EST**
- **RSVP to email: MHenry@mohawkmedbuy.ca**
- **Location: Sunnybrook Health Sciences Centre, Bayview Campus**
- **2075 Bayview Avenue, Toronto, ON M3N 3M5**

- **Meet at: K Wing Center, Ground Floor Lobby**

- .2 Purpose of meeting is to review full extent of the Project, conduct an inspection of existing premises and to discuss any questions regarding this Project.
- .3 One representative(s) from each Bidding Contractor must attend. The minutes of this pre-Bid meeting listing attendees may be issued as an Addendum.
- .4 It is mandatory that General Contractors and Mechanical and Electrical Sub-contractors attend the meeting. All other interested Bidders/sub-trades are also invited to attend. Bids will be accepted only from Bidders (General, Mechanical, Electrical contractors) that attended the mandatory site tour. Bids from Bidders (General, Mechanical, Electrical contractors) who did not participate in the site tour will be disqualified.
- .5 Bidders must visit and examine the site and the existing building and satisfy themselves as to the conditions of the site, the means of access to same and the nature and quantity of work required.
- .6 Also ascertain the extent, nature and location of concealed services which may have to be protected, removed or relocated.
- .7 Information shown on the Drawings is furnished in good faith by the Consultant, but in no way relieve Bidders of the responsibility for ascertaining to their own satisfaction, the nature of conditions at the site. No claims for extra costs for failure to determine any/ all existing conditions will be entertained.
- .8 Take note of the nature of existing surfaces and include for temporary work necessary to maintain Owner's use of the premises, the roads, and the pathways during the progress of the Contract.
- .9 In addition to paragraph 4.1, Bidders must visit the Place of the Work as required to become fully conversant with conditions which will be met in performing the Work of the Contract.
- .10 Claims for extra payment and extensions to Contract Time will not be considered in respect to conditions which could have been ascertained by an inspection of the Place of the Work prior to close of bids.

5 IDENTIFIED PRICES

None

6 SEPARATE PRICES

None

7. ALTERNATE PRICES

None

8. SUBMISSION

- .1 Submission of Bids to constitute proof of the Bidder's inclusion in the proposal for the work to complete the Contract in every respect and provisions for conditions and limitations, particularly with respect to access facilities, working conditions, existing conditions, storage space, codes, laws, ordinances, and regulations, whether mentioned in the Bid Documents or not.

- .2 Arrangements have been provided for the Bidder to obtain clarification with regard to discrepancies, ambiguities, or omissions in the Bid Documents and to visit and review the conditions at the site and therefore the submission of a Bid will be construed as a waiver of any claims for extra compensation on account of un-anticipated work caused by existing conditions or un-expected interpretation of the Bid Documents.

- .3 The Bidder acknowledges and agrees that nothing contained herein, no act done or expense incurred in the preparation of the Bid, no trade or industry custom or practice and no representation or assurance that may have been given to the Bidder by the Owner or Consultant, must in any manner legally bind the Owner to accept this Bid, the lowest Tender or any Tender submitted. The Bidder acknowledges and agrees that the Owner must have complete and unrestricted liberty in this regard and may reject or accept any Bid in whatever manner, at whatever Bid Price and on whatever terms and for whatever reason as the Owner, in their sole discretion, considers to be in their best interest, all without liability or obligation of any kind to any Bidder.

- .4 The Owner must not be held responsible for any liability, cost, expense loss of damage incurred, sustained or suffered by any Bidder prior to, subsequent to, or by any reason of delay in the acceptance or non-acceptance of this Bid save as provided in the Contract. Bids are subject to a formal Contract being prepared and executed.

- .5 No Bid must be submitted or accepted from any persons or corporations which has any claim or legal proceeding against the Owner with respect to any previous Contract. No Subcontractor that has any claim or legal proceeding against the Owner must be named as a Subcontractor of the Bidder.

- .6 In the event that two or more Bidders submit compliant Bids that contain identical Bid pricing, each bidder will be notified of the tie and will have the opportunity to submit a new bid in the proper form within twenty-four hours of being notified

9. RESERVED RIGHTS OF THE OWNER

- .1 Bids not received as per the Submission Instructions will be disqualified and will not be accepted by the Owner.

- .2 In addition to disqualification in the event of non-compliance with any of the Mandatory Requirements, the Owner reserves the right, in the Owner's sole discretion, to reject or disqualify any bid that does not, in Owner's reasonable discretion, comply with any other instruction, requirement, term or condition set out herein; or otherwise any non-responsive, and conditional Bids or Bids that are improperly prepared, that are unsigned, improperly signed or sealed, conditional, illegible, obscure, contain arithmetical errors, erasures, alterations, or irregularities of any kind.

- .3 The Owner reserves the right to disqualify the Bid of any Bidder who experiences a material change in circumstances after submission of its Bid, including where the Bidder's staffing is materially different from that specified in its pre-qualification documentation.
- .4 Bids received from any other Bidder that has any claim, legal proceeding, or other Construction Project issues, with the Owner or that names a Subcontractor that has any claim, legal proceeding or other Project issues with the Owner, with respect to any previous contract or tender may be rejected at the sole discretion of the Owner.
- .5 Presentation of evidence of collusion, intent to defraud, or illegal practices on the part of a Bidder, will cause its bid to be declared non-compliant and disqualified whether opened or not.
- .6 The Owner reserves the right, in Owner's sole discretion, to cancel this tender at any time without awarding a Contract to any Bidder.
- .7 The owner reserves the right to disregard all non-confirming, non-responsive and conditional bids.
- .8 The Owner reserves the right to negotiate Contract terms with the lowest compliant Bidder or Bidders, or should the Owner not receives any satisfactory or compliant bids, to negotiate a Contract in accordance with paragraph 12.4 (below).
- .9 Discrepancies between words and figures will be resolved in favour of words. Discrepancies between the indicated sum of any column of figures and correct sum thereof will be resolved in favour of the correct sum.
- .10 The Owner reserves the right to request a Bidder to provide clarification regarding any aspect of its Bid, and/or to submit supplementary written information in relation to such request; and to incorporate a Bidder's response to any such request for clarification into the Bidder's Bid, provided that any such clarification must only permit the provision of additional detail but may not contradict or amend a material term of the Bid. The Submission of a Bid does not obligate the Owner to accept any Bid or to proceed further with the Project. The Owner may, in its sole discretion, elect not to proceed with the Project, in whole or in part, and the Owner may elect not to accept any bid that, in Owner's reasonable discretion, does not comply with any instruction, requirement, term or condition herein; and Owner reserves the right, in Owner's sole discretion, to cancel this Bid at any time without awarding a Contract to any Bidder.
- .11 Alternatively, should the Owner not receive any satisfactory Bids, it may, in its sole and absolute discretion, revise the Instructions to Bidders, issue Post-Bid Addenda for re-pricing, or negotiate a Contract for the whole or any part of the Project with any of the Bidders.
- .12 A Bidder's Bid shall be null and void and disqualified
 - .1 Upon the institution by or against the Bidder of insolvency, receivership or bankruptcy proceedings or any other such proceedings;
 - .2 Upon the Bidder making an assignment for the benefit of creditors; or
 - .3 Upon the Bidder's dissolution or ceasing to do business
- .13 The Owner reserves the right not to accept the Bidder's proposed Schedule and reserves the right to clarify or negotiate the Schedule with the successful Bidder.

10 WITHDRAWAL AND ACCEPTANCE OF BIDS

- .1 A bid may be withdrawn at any time prior to the time and date fixed for receiving bids, but only on a request in writing, signed by the Bidder or his agent-in-fact.

- .2** Withdrawn bids may be resubmitted provided the resubmitted bid is received at the office previously indicated prior to the time and date fixed for receiving bids.

A bid may not be withdrawn at or after the time and date fixed for receiving bids and must be irrevocable and remain open to acceptance by the Owner:

- (1) until some other party has entered into a Contract with the Owner for performance of the Work, or
 - (2) until 120 days after the time and date fixed for delivering bids, whichever occurs first (the "Bid Acceptance Period").
- .3** The 120 day period referred to above must commence at 12:00:00 a.m. of the day fixed for receiving bids and must terminate at 12:00:00 a.m. of the 120th day thereafter. If the 120th day falls on a Saturday, Sunday or statutory holiday, such day or days must be omitted from the computation.
- .4** The lowest or any bid will not necessarily be accepted and the Owner reserves the right to reject any and all bids, including without limitation, the lowest priced bid, and to award the Contract who whomever the Owner, in its sole and absolute discretion, deems appropriate, notwithstanding any custom, usage or agreement in the industry or trade, or any other policy or practice to the contrary. The Owner further reserves the right, in its sole and absolute discretion, to accept or reject any bid which is incomplete, obscure, or irregular, which has erasures or corrections in the documents, which omits one or more the prices, fees, or costs required to be stipulated in the bidding forms, which contains prices that the Owner considers unbalanced, or which is not accompanied by the proper bid security.
- .5** Without limiting the generality of the rights prescribed in the preceding paragraph above, the Owner may, in its sole discretion, elect not to proceed with the project and elect not to accept any and all bids for any reason including, but not limited to, bids not being within the Owner's budget. Alternatively, should the Owner not receive any satisfactory bid including, but not limited to receipt of no compliant bids, it may, in its sole and absolute discretion, revise the Instructions to Bidders, or negotiate a contract for the whole or any part of the project with any one or more of the Bidders, or firms not previously pre-qualified. Under no circumstances, must the Owner be responsible for any costs incurred by the Bidders in the preparation of their bid.
- .6** The criteria used and applied by the Owner in evaluating the bids and awarding the contract are within the Owner's sole and absolute discretion. Without limiting the generality of the foregoing, additional criteria to be considered by the Owner in evaluating the bids may also include one or more the following: total costs to the Owner, completion times in the bid, any changes to pre-qualification information, ability to ensure continuous availability of qualified and experienced personnel, proposed Construction Schedule, price compliance of bids, and any other factor that the Owner, in its sole discretion, deems relevant.
- .7** Award of Contract will be by written notification to the successful Bidder
- .8** Delivery by registered mail or common carrier, to the address given by the Bidder in its Bid form, of notification of award of the Contract to the Bidder by the Owner must constitute acceptance of said bid.
- .9** If bidder has not been so notified within the Bid Acceptance Period, the bidder may, unless bidder has otherwise agreed or offered and except as otherwise provided herein, withdraw its bid without penalty, forfeit, or obligation to the Owner of any kind.

11 ERRORS IN BIDS

- 1 Owner will not entertain requests for gratuitous payments arising from any errors alleged to have been made in the Bid that the Owner has accepted with the procedures described in the Bid Documents.

12 CONTRACT (MANDATORY REQUIREMENTS)

- .1 The successful Bidder must be required to sign, , Canadian Standard Construction Document CCDC 2-2020 for Stipulated Price Contract, as amended by Section 00 73 00, as bound herein, and return the executed Contract to the Owner within seven (7) days after award of Contract by Owner.
2. The Bidder accepts and agrees that, after delivery to the Owner of the executed Contract and required Bonds and Certificates of Insurance, the Owner will provide written authorization to the Bidder to commence the Work and that, upon receipt of such authorization, the Bidder will commence the Work actively at the Place of the Work within 10 Working Days.
- .3 The successful Bidder must provide List of Subcontractors and Cost Breakdown, **Contractor HAZMAT Acknowledgement Form** and **Construction Delays due to the COVID 19 Acknowledgement Form**.

13 BONDS AND INSURANCE

13.1 Agreement to Bond

Each Bidder must submit with its bid an Agreement to Bond issued by a duly incorporated surety company authorized and licensed to issue such instruments and Bonds in the Province of Ontario obliging the surety company to issue a Performance Bond and a Labour and Material Payment Bond, each in the amount of for 50% of the Total Amount Payable (after HST) , and in the forms as follows:

- .1 Performance Bond: Form 32, Under Section 85.1 of the Construction Act
- .2 Labour and Material Payment Bond: Form 31, under section 85.1 of the Construction Act.
- .3 The Agreement to Bond must be valid for the Bid Acceptance Period.
- .4 Cost for all bonds is included in the bid price.
- .5 Performance Bond and Labour and Material Payment Bond (collectively the "Bonds") must be issued by a duly incorporated surety company authorized it issue such instruments in the Province of Ontario.

13.2 Bid Security

- .1 Bidders must attach to their Bid a Bid Bond made payable to Sunnybrook Health Sciences Centre for the amount of **10% of the Bid Value** as evidence of good faith that, if awarded the Contract, the Bidder will execute and enter into a formal agreement within the time required and will furnish the security required to secure the performance of the terms and conditions of the Contract.
- .2 Bidders must attach and submit bid security together with Bid Form.

- .3 The Bid Bond must be in force for a period of 120 days from day fixed for receiving bids.
- .4 Bid Bonds must be in accordance with the Construction Act.
- .5 Bid Bonds must be issued by a duly incorporated surety company authorized to transact business in the Province of Ontario.
- .6 Bid bonds must be properly executed by both Bidder and Surety.
- .7 If a Bidder whose bid is accepted by the Owner, within the specified 120 day acceptance period, refuses or fails, within 15 days after a Contract is offered to him for acceptance, (1) to enter into a Contract with the Owner for the performance of the Work or (2) to provide contract performance security, or security for payment of claims, or both, if and as required by the Bid Documents, the Bidder must be liable to the Owner for the difference in money between the amount of his bid and the greater amount for which a Contract for the Work is entered into with some other party, up to the maximum amount of the bid security provided.
- .8 Bid security will be returned to all Bidders after an agreement has been signed by both the Owner and the successful Bidder and the Bonds and Certificate of Insurance have been delivered to the Owner
- .9 Bids submitted without Bid Security will be disqualified.

13.3 Labour and Materials Payment Bond (Mandatory Requirements)

- .1 Bidders must include with their Bid agreements to Bond for 50% labour and materials payment.
- .2 Agreement to bond must be valid for the bid acceptance period.
- .3 Bidders must submit security to Owner within 7 days of date of receiving notification that Bidder has been awarded Contract but before signing Contract.
- .4 Labour and Material Payment Bond must be in accordance with the Form 31 of Section 85.1 of the Construction Act,
- .5 Labour and Material Payment Bond must be issued by a duly surety company authorized to transact business in the Province of Ontario.
- .6 Labour and Material Payment Bond must be issued by Surety Company acceptable to the Owner.
- .7 Labour and Material Payment Bond must be properly executed by both the Bidder and Surety Company.
- .8 Submission of the Labour and Material Payment Bond must be a pre-condition to commencement of the Work.

13.4 Performance Bond (Mandatory Requirements)

- .1 Bidders must include with their Bid agreements to Bond for 50% performance.

- .2 Performance Bond must be in accordance with Form 32 of Section 85.1 of the Construction Act.
- .3 Agreement to bond must be valid for the bid acceptance period.
- .4 Security in the form of a bank letter of credit is not acceptable.
- .5 Bidders must submit security to the Owner within 7 days of the date of receiving notification that the Bidder has been awarded Contract but before signing Contract.
- .6 Bidder must submit with his Bid the Sunnybrook Hospital's standard form of Agreement to Bond stating that Surety Company is prepared to provide the required Performance Bond.
- .7 Performance Bond must be issued by a duly incorporated surety company authorized to transact business in the Province of Ontario.
- .8 Performance Bond must be issued by Surety Company acceptable to the Owner.
- .9 Performance Bond must be properly executed by both the Contractor and Surety Company.
- .10 Submission of the Performance Bond must be a pre-condition to commencement of the Work.

14. NOTE: Submission of Documents

To supplement uploaded Bid Security and Agreement to Bond documents uploaded to the Bonfire portal, original hard copy documents of the Bid Security and Agreement to bond must be received upon request within 48 hours of the request.

15 INSURANCES (MANDATORY REQUIREMENTS)

1. Bidders must submit certificate of insurance confirming a general liability insurance of \$5 million to the Owner within 7 days of the date of receiving notification that Bidder has been awarded Contract but before signing Contract.
2. Certificates of insurance must be issued by a duly incorporated insurance company authorized to transact business in the Province of Ontario.
3. Bidders must submit Builder's Risk Insurance to the Owner within 7 days of the date of receiving notification that Bidder has been awarded Contract but before signing the Contract.
4. Insurance documents shall meet the requirements of CCDC 2 – 2020, as amended by 00 73 13 – Supplementary General Conditions.

16 BID DOCUMENTS

1. Bidder is responsible for checking the Drawings and Specifications received to ensure that the documents are complete in accordance with the List of Bid Documents.

2. After the Contract is signed the successful Bidder will be given a complete set of Specifications and Drawings in addition to the signed and sealed Contract Document set.

17 MATERIALS AND EQUIPMENT

1. Bids must be based upon materials and equipment of manufacture, type and design specified.
2. Bid Price must be based on using materials or equipment of the manufacturer named in the Specification. If more than one manufacturer's name is listed in Specification for a specific item, the Bidder may choose the manufacturer, whose price is used in preparing Bid.
3. Material and equipment, considered equal to that specified, may be proposed at time of Bidding. When requested, submit specifications, information and details of proposals to Consultant.

18 INTERPRETATIONS AND MODIFICATIONS OF BID DOCUMENTS

1. Submit questions about the meaning and intent of the Bid Documents to the Bid Administrator
2. Bidders must promptly notify the Bid Administrator of any ambiguity, inconsistency or error, which they may discover upon examination of the Bid Documents or of the site, existing premises and local conditions.
3. Replies to questions and modification of the Bid Documents will be issued in writing by Addenda. Replies to questions and modifications made in any other manner will not be binding and must be considered without legal effect.
4. The Owner and Consultant will not recognize nor participate in any electronic project management program.

19 CUTTING AND REMEDIAL WORK

1. Refer to General Conditions regarding cutting and remedial work.
2. Bidders must include costs for cutting and remedial work in their bid price.
3. Bidders must obtain required information from their various Subcontractors requiring such cutting and remedial work prior to submission of bid.

20 REVIEW OF BID DOCUMENTS

1. No parts of the Bid Documents must be issued by Contractors to any Subcontractors or material or equipment Supplier, for bidding purposes without Section 00 73 00 and Division 1, General Requirements, being attached thereto.
2. Contractors will be responsible for reviewing the Bid Documents, and ensuring their Subcontractors, Product and materials Suppliers review the Bid Documents, prior to submitting a bid to ensure they have an overall understanding of the entire Project's scope of work. Mechanical and electrical Subcontractors are specifically instructed to review non-mechanical and non-electrical parts of the Bid Documents for additional information and details related to their trades.

3. The Contractor's attention is drawn to the intricacy of working in the existing building or reworking existing building components to accommodate new construction. This involves removals, cutting, restoration, and protection of existing work or conditions during the duration of the Contract.
4. While every effort has been made to show or note the extent of the work in the Contract Documents, the Contractor by submitting its bid acknowledges the complexities involved in a Project of this size and type.
5. It is therefore imperative that Contractor evaluates the Contract Documents and visits the Place of the Work and conducts a survey of existing conditions upon which new work will be dependent. The Owner on account of the Contractor's failure to comply with the foregoing will entertain change in either Contract Time or Contract Price.
6. 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. It is essential for existing building to remain functional at all times. Contractor must, when required on occasion, expedite work outside of Contractor's normal working hours. Owner will cooperate to keep such overtime hours to a minimum.

21 OVERTIME COSTS

- .1 Bids have been requested only from Pre-Qualified Contractors. Overtime costs may be required to perform the Work without adversely affecting the normal operation of the Owner and to maintain the Project schedule as specified.
- .2 Any overtime costs, including extended and/or double shift and weekend work hours, necessary to complete the Work or any part thereof within the Contract Time must to be included in the bid price.
- .3 Bidders are hereby advised that time is of the essence and the Project schedule cannot be extended except as provided for in the Contract Documents.

22 INFECTION CONTROL DURING CONSTRUCTION

- .1 The successful Bidder will be required to provide infection control during the Work in accordance with relevant Spec Section
- .2 Sunnybrook's Infection Prevention Control Services (IPCS) will investigate and advise on the risks of organisms that exist in the Place of Work. In addition to the requirements in the Contract Documents, the Contractor will take all reasonable steps to eliminate any infectious risks where possible and minimize those risks that cannot be eliminated.

23 STAFF

- .1 All Contractors and Subcontractors will be expected to maintain the staff team from start to finish. Any modifications to the team composition from those involved 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.

24 COLD WEATHER WORKING

- .1 Particular attentions is drawn to the requirement that the Bidder must commence work immediately after the Contract is executed and the Certificates of Insurance is delivered to the Owner and must continue full scale operations through winter months until the work described is complete.
- .2 The Bid Price must include the costs for temporary heating, temporary shelters and all other necessary cold weather measures to enable the work to proceed without delay regardless of adverse weather conditions.

25 CASH ALLOWANCES

- .1 Include in bid price cash allowances specified in Section 01 00 00. Cash allowances are to be carried administered by Division 1 (and not by other Divisions), including Mechanical and Electrical allowances.
- .2 Contractors shall make provision in their schedule for incorporation in the work of products/materials and labour covered under cash allowances.
- .3 Cash allowances must be utilized only for the purpose of which the cash allowance was intended.
- .4 Cash allowances may be transferred from one category to another at the discretion of the Consultant and/or Owner. All cash allowances are to be administered through issuance of a change order which identifies the cash allowance item.

26 SCHEDULING OF WORK (MANDATORY REQUIREMENTS)

- .1 Time is the essence of this Contract. The Bidder must indicate in the space provided on the Bid Form all scheduling information requested. Bids submitted without this information will be deemed Disqualified.
- .2 Prior to award of the Contract, Sunnybrook will request that the Bidder supply a final updated Construction Schedule which would include the updated project start date and any other changes to the Construction Schedule from the schedule provided with the Bid Submission. The revised Construction Schedule must be approved by Sunnybrook and Consultant prior to Contract Award.
- .3 In recognition that the COVID-19 pandemic is affecting current construction in Ontario and globally, Sunnybrook is requesting that the Bidder highlight any anticipated scheduling buffering or anticipated delays to the start date as well as any other changes to the Construction Schedule resulting from COVID 19 or otherwise.

27 DEBRIEFING

Unsuccessful Bidders may request a debriefing after receipt of a notification of award. All requests must be in writing sent to same location as described in section 3.02 and must be made within sixty (60) days of notification of award. The intent of the debriefing information session is to aid the

unsuccessful Bidder in presenting a better bid in subsequent bidding opportunities. Any debriefing provided is not for the purpose of providing an opportunity to challenge the procurement process.

28 BID PROCESS PROTEST

A Bidder who wishes to protest the process utilized in this Bid Call must deliver written notice of the protest to the Owner. Sunnybrook shall acknowledge receipt of the protest in writing within five (5) working days; and deliver a response to the Bidder in writing within twenty (20) working days. Sunnybrook' Bid Protest Process is subject to the relevant Bid Protest terms as set out in the AIT and Ontario-Quebec Procurement Agreement.

29 CONFLICTS OF INTEREST

Bidders must disclose any actual or possible conflict of interest that may arise from its submission of a Bid, or execution of a Contract for the provisioning of Work as a result of this bid process. Please declare such information in writing to the Owner, prior to submission of Bid.

If, at the sole and absolute discretion of Owner, it is discovered that a Bidder fails to disclose all actual or potential Conflicts of Interest, Owner may disqualify the Bidder or terminate any Contract awarded to that Bidder pursuant to this bid process.

If there is no declaration, the Bidder will be deemed to declare that: (1) there was no Conflict of Interest in preparing its bid; and (2) there is no foreseeable Conflict of Interest in performing the contractual obligations.

30 FREEDOM OF INFORMATION AND PROTECTION OF PRIVACY ACT

The Freedom of Information and Protection of Privacy Act (Ontario), applies to records in the custody or control of Ontario hospitals, and includes any information provided by Bidders in connection with this RFQ. Such information may be subject to requests for access under that Act, and can only be withheld from disclosure in specific circumstances.

31 COMPETITION ACT

Under Canadian law, a Bidder's submission must be prepared without conspiracy, collusion, or fraud.

For more information on this topic, visit the Competition Bureau website at <http://www.cb.gc.ca/eic/site/cb-bc.nsf/eng/01240.html>, and in particular, part VI of the *Competition Act*, R.S.C. 1985, c. C-34.

32 AGREEMENTS ON INTERNAL TRADE

This bid call is subject to Annex 502.4 ("Procurement – Provisions for Municipalities, Municipal Organizations, School Boards and Publicly Funded Academic, Health and Social Services entities") of the Agreement on Internal Trade.

END OF SECTION

COVID 19 ACKNOWLEDGEMENT FORM

Bidder acknowledges that the ongoing COVID 19 Pandemic may cause the Hospital to require to shut down the unit in the event of an outbreak. The Bidder agrees to indemnify the Hospital from any claim delays or extra charges of any kind related to scheduling requirements needed due to Covid 19.

Name

Date

Signature

SUNNYBROOK HEALTH SCIENCES CENTRE

**CONTRACTOR'S ACKNOWLEDGEMENT
(HAZMAT ACKNOWLEDGEMENT FORM)**

Sunnybrook Health Sciences Centre ("Sunnybrook") has included in the Tendering information for this contract a copy of the list of any designated substances present at the Project or Work site. The Notice of Designated Substances included in the Tendering Information is attached to this Acknowledgement.

If awarded this Contract, the Contractor, as *Contractor* within the meaning of the *OHSA*, undertakes:

to inform other contractors and all subcontractors retained to perform services on the Project or the Work of the existence of the designated substances, if any, which are present at the Project, and to provide to other contractors and all subcontractors a copy of the list of designated substances which is attached to this Acknowledgement, prior to entering into any contracts with those other contractors or subcontractors for the supply of services;

to notify Sunnybrook of the presence of any potentially hazardous materials or toxic substances which will be brought to the Project or the Work by the Contractor, or Contractor's employees and to provide all applicable MSDS sheets, if any, to Sunnybrook;

to ensure that other contractors and all subcontractors retained to supply services for the Project or the work notify Sunnybrook of the presence of any potentially hazardous materials or toxic substances they bring to the Project or the Work and ensure that they provide all applicable MSDS sheets, if any, to the Contractor, other contractors and all subcontractors to so comply.

Contractor:

Contract to be performed:

The Contractor acknowledges that he has received the List of Designated Substances attached to the Tendering Information, and agrees to be bound by the undertakings set out above.

Date

Contractor's Signature

Note: This Acknowledgement is an integral element of the Tender Documents.

This Acknowledgement must be signed and returned with the Tender Bid documents.

TO: Sunnybrook Health Sciences Centre

FROM: _____

1 BID/OFFER

1.1 I/We declare that I/we have carefully examined the bidding documents including Addenda No. ____ to No. ____, prepared by NORR Architects and Engineers Limited, and visited and investigated the site, and examined all conditions affecting the Work for

**Sunnybrook Health Sciences Centre
K Wing – Hematology**

and if notified in writing of the acceptance of this Bid within 120 days from the date of bid closing, I/we agree to provide all materials and labour for the proper completion of the Work for the Stipulated Price of:

_____ and ___/100 Dollars

(\$ _____) in lawful money of Canada; included in which are labour, materials, products, equipment, allowances, services and respective overhead, profit, duties, taxes (except the Harmonized Sales Tax), disbursements and all other charges.

1.2 I/We have identified that the Harmonized Sales Tax, in the amount of _____ and /100 Dollars (\$ _____) in lawful money of Canada, is applicable to the Work, but is excluded from my/our Bid Price

2 COMPLETION DATE

2.1 I/We agree, if notified of award of a Contract, to immediately commence Work actively and will attain the following completion dates:

.1 Substantial Performance of the Work within _____, weeks after receiving notice of Contract Award.

.2 Total Completion Date of the Work within _____, weeks after receiving notice of Contract Award.

3 BONDS AND INSURANCE

3.1 Attached herewith is a Bid Bond issued by a Surety Company licensed to conduct surety in Province of Ontario, made payable to the Owner in the amount of ten percent (10%) of the Bid Price and carrying a 120 day time limit from the time set for receipt of Bids, which may be used in part or in whole, at the discretion of the Owner, in the event we fail to enter into a Contract for the Work when notified.

3.2 Attached herewith is an Agreement to Bond from a Surety Company licensed to conduct surety in Province of Ontario, stating that they agree to provide a Performance Bond for 50% of the Total Amount Payable and a Labour and Material Payment Bond for 50% of the Total Amount Payable.

3.3 I/We agree to comply with the requirements of document CCDC2-2020, as amended, with respect to Bonds and Insurance.

4 PROJECT MANAGEMENT

4.1 I/We agree to assign _____ (name) as the Project Manager and they will assign _____ (name) as their full-time site superintendent for duration of the Contract.

5 LIST OF SUBCONTRACTORS

5.1 I/We 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.

5.2 I/We submit that, in proposing the following Subcontractors, I/we have consulted each and has ascertained to my/our complete satisfaction that those named are fully acquainted with the extent and nature of the work involved and of the proposed construction schedule, and that they will execute the work to conform to the requirements of the Contract Documents.

Description of Work	Subcontractor's Company Name	Price (\$)
Mechanical		
Electrical		
Sprinkler		

5.3 I/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.

5.4 I/We agree to assign _____ (name) as the Electrical Subcontractor, for the price of \$ _____, and they will assign _____ (name) as their full-time mechanical site superintendent for duration of the Contract.

6 BID IN FORCE

6.1 I/We agree that this Bid is valid and subject to acceptance by the Owner for a period of 120 days from date of Bid receipt, and that if notified of award of the Contract I/we will:

- .1 execute a Contract with the Owner on the specified Form of Agreement.
- .2 furnish to the Owner, at time of contract signing, copies of insurance policies as required by the Conditions of the Contract.

- .3 furnish to the Owner, at time of contract signing, a Performance Bond and a Labour and Material Payment Bond, issued by a Surety acceptable to the Owner, each in the amount of 50% of the Total Amount Payable (after HST).
- .4 furnish to the Owner evidence that all Worker's Compensation dues, in accordance with the laws of the Province of Ontario, have been paid.
- .5 undertake to schedule and organize the progress of the Work so that priorities for completion of various areas will be maintained, as indicated by the Construction Schedule.

Name of Company: _____

Address of Company: _____

Signature(s) of Authorized Representative(s)

Name(s) and Title(s) of Authorized Representatives (Please print or type)

Signature of Witness

Name(s) and Title(s) of Witness (Please print or type)

Dated at _____ this _____ day of _____ 20__

H.S.T. Registration Number _____

SEAL

Bids by Limited companies shall be submitted under corporate seal.

Bids by individuals or partnerships shall be witnessed.

END OF BID FORM

CONDITIONS OF CONTRACT

1 FORM OF CONTRACT

- .1 Subject to the modifications specified in Section 00 73 00, the Stipulated Price Contract of the Canadian Standard Construction Document CCDC 2 - 2020, consisting of The Agreement between Owner and Contractor, Definitions, the General Conditions Articles GC 1.1 to GC 12.3 inclusive, CCDC 40 Rules for Mediation and Arbitration of Construction Disputes, and CCDC 41 CCDC Insurance Requirements are hereby made a part of the Contract as though written out in full herein.

2 CONTRACT COPYRIGHT AND AVAILABILITY

- .1 The CCDC form of Contract is a copyrighted document published by the Canadian Construction Documents Committee (CCDC). It is incorporated into the Contract Documents by reference. It is available for purchase from any CCDC document outlet. Refer to www.ccdc.org.

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 agreed upon 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 paragraphs 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 paragraph 10.1.3:

- “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.”

- **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.”

1 SUMMARY OF WORK

1.1 Work covered under this Contract

- .1 Work of this Contract includes labour, materials, equipment, services and other related expenses to execute complete construction of facility specified under Contract Documents.
- .2 It is the Contractor's sole responsibility to examine the Construction Documents, Specifications and Drawings issued to establish/determine total scope of work.
- .3 In accepting award of this Contract, Contractor hereby reaffirms that it is fully informed regarding all conditions affecting Work including its company's provincial taxes are in good standing and further accepts to complete Work for purpose intended in accordance with Contract Documents. Contractor hereby reaffirms that it does not and will not have any conflict of interest in executing work of this Contract.

1.2 Comply with Section 01 35 33 Infection Control Procedures.

1.3 Read specifications and Architectural, Mechanical and Electrical drawings in conjunction to understand the scope of work of the phasing sequencing for the project.

1.4 Work Provided by Owner or Performed Under Separate Contracts

- .1 The term "NIC" means that work of this Project which is not being performed or provided by the Contract; the term means "Not in This Contract" or "Not a Part of The Work to be Performed or Provided by The Contractor".
- .2 "NIC" work is specified and/or indicated on the Drawings as an aid to the Contractor in scheduling the amount of time and materials necessary for the completion of the Contract.

2 SPECIFICATIONS

2.1 Specifications are not intended as detailed description of installation methods but serve to indicate particular requirements in completed Work.

2.2 Where Contract Documents do not provide sufficient information for complete installation of item, then as supplement, comply with manufacturer's written instructions for quality of work.

2.3 Portions of Specifications are written in short form. Therefore, it shall be understood that where item of Work is stated in heading followed by material, equipment, component, or operation, words "shall be", "shall consist of" or similar words or phrases are implied which denote supply, fabricate and supply, install, provide or commission of such materials, equipment or operations for component of Work designated by heading.

2.4 Where the Contract Documents refer to the singular, provide as many as required to complete Work. Words used in one gender only shall mean females and as well as males and conversely.

2.5 Drawings, Lists or Schedules of Items are intended to show scope and arrangement of work. For location of item described refer to such Drawings, Lists or Schedules unless location stipulated in Specifications.

2.6 Wherever words "acceptable", "approved", "reviewed", "satisfactory", "selected", "directed", "designated", "permitted", "inspected", "instructed", "clarification", "required", "report", "submit", "obtain", "consult", "advise", or similar words or phrases are used in Standards or in Contract Documents, it shall be understood that, unless context provides otherwise words "by/to/with/from the Consultant" shall follow them as applicable.

3 **DIVISION OF WORK**

3.1 Work specified in the Specifications is divided into Sections for reference purposes only. Division of work between Contractor and Subcontractors is the Contractor's responsibility. The Owner and Consultant assume no responsibility to act as an arbitrator to establish subcontract limits between Sections or Divisions of the Work.

4 **REFERENCE STANDARDS**

4.1 Conform to latest date of issue of referenced standards in effect on date of submission of bids, except where a specific date or issue is specifically noted.

5 **WORK RESTRICTIONS**

5.1 Owner's Policy and Procedural Requirements

.1 Comply with the Owner's policies and procedural requirements prescribed in Sunnybrook Health and Sciences Centre Owner's Rules and Regulations" and "Construction Policy", appended to these specifications, including, but not limited to, personal conduct and behaviour, patient privacy, facility security, infection prevention and control, mechanical system interruptions, and work scheduling.

.2 Conduct all work in accordance with the most current version of CAN/CSA-Z317.13.

.3 All building materials and supplies must be in compliance with CSA Z8000, governing IPAC measures incorporated into the design and construction of a health care facility or any part thereof.

.4 As determined by the Owner's policies, immediately correct all unsafe conditions that are identified within the active facility that are a result of, or related to, the construction work activities.

5.2 Occupancy

.1 Existing premises outside of the Area of Work will remain occupied during Work. Execute Work to cause minimum interference with activities in existing premises and maintain maximum safety to occupants. Take reasonable measures to minimize and control noise, dirt and dust during Work.

.1 Provide a methodology for phasing and staging of the Work, and indicating safety and fire escape routes for the occupants of the building during construction.

.2 All areas that are only available for demolition and construction activity after hospital operational hours are to be vacuumed and mopped at the end of each construction day for terminal clean by hospital to enable the hospital to resume regular business operations unimpeded each day.

- .2 Access:
 - .1 Different areas of work within the hospital will be restricted to time frames indicated on Construction Phasing and Hoarding drawings.
 - .2 Before entering existing premises outside of the Area of Work to carry out Work or to obstruct or take out of use any area of existing premises, or to cause any other interference, request meeting with Consultant and Owner in order to reach agreement as to time and length of time Contractor may interfere, possess, obstruct or remove from use any such area or services.
- 5.3 Access to Area of Work
 - .1 Work shall be confined to Area of Work limits indicated on Drawings and/or within area defined by property lines.
 - .2 Assume responsibility for care, custody and control of Area of Work and perform work to extent covered in Contract Documents. Make good damage to existing Area of Work and existing building due to Work of this Contract.
 - .3 Maintain temporary entrances to areas of Work and provide enclosed hoardings as required. Maintain access to existing building service entrance(s) at all times.
 - .4 Work on Municipal property shall be carried out under regulations of respective Municipality and authorities having jurisdiction including without any limitations any associated fees, permits, insurance or bonding required.
 - .5 Access to the existing buildings, and access to the neighbouring properties, cannot be blocked or otherwise compromised. Provide a minimum of 14 days' notice to Owner and coordinate with Owner for any major disruptions that may impact access to hospital or surrounding community.
 - .6 Comply with the time frames/schedule of the hospital loading dock supervisor for all materials delivery to site and ensure loading bays are clear of materials/equipment.
- 5.4 Commencement of Work
 - .1 Make all required submittals, receive all reviewed submittals, and marshal all required materials off-site prior to commencing Work on-site.
 - .2 The first on-site Work shall be the construction of the hoarding.
- 5.5 No Smoking Policy
 - .1 Cooperate, respect and comply with the Owner's no smoking policy requirements.
 - .2 Ensure that Contractor's employees, sub-contractors and suppliers, performing work on Site on Contractor's behalf, are instructed to comply with the Owner's no smoking policy requirements.
 - .3 Comply with local By-Law and regulations or any authorities having jurisdiction.
- 6 **CASH ALLOWANCES**
 - 6.1 Cash allowances, unless otherwise specified, cover net cost to Contractor of services, products, construction machinery and equipment, freight, handling, unloading, storage, installation and other authorized expenses incurred in performing the Work.

- 6.2 The Contract Price, and not cash allowance, includes Contractor's overhead and profit in connection with such cash allowance.
- 6.3 The Owner reserves the right to call competitive tenders for portions of the work to be paid for out of any or all cash allowances. The relationship of the Contractor and the trades performing portions of the work to be paid out of cash allowances shall be such as between the Contractor and his Subcontractors.
- 6.4 Make expenditures out of the cash allowance at the sole discretion of the Owner and only on receipt of a Change Order signed by the Owner and Consultant.
- 6.5 Unexpended amounts of cash allowances may be reallocated to other specific cash allowances at the sole discretion of the Owner.
- 6.6 Unexpended amounts of cash allowances shall be deducted from the Contract Price at completion of the Work.

6.7 Include in the Contract Price, cash allowances for the following:

.1	Unforeseeable Conditions	\$35,000.00
	TOTAL	\$35,000.00

7 SCHEDULE OF VALUES (VALUE OF SUBMITTALS)

- 7.1 Within seven Working Days of Contract award, submit a detailed Schedule of Values providing a breakdown of the cost of the Work in a form acceptable to Consultant.
 - .1 Show the cost (value) of the Work broken down by specification section. Identify each line item with number and title of the primary associated specification section, per month, and coincident with approved construction schedule. Identify site mobilization, bonds, insurance, and commissioning. Cost breakdowns when totalled, shall be same as Contract Price.
 - .1 Include in each line item, the amount of specified Allowances. For unit cost Allowances, identify quantities taken from Contract Documents multiplied by the unit cost to achieve the total for the item.
- 7.2 Contractor shall identify general progress and commissioning payment line items for each of the following:
 - .1 1% of total Contract value for provision of as-built drawings, O&M manuals and warranties covering all sub-contracts.
 - .2 1% of Mechanical value for Commissioning process including completion and submission of testing forms and reports.
 - .3 1% of Electrical value for Commissioning process including completion and submission of testing forms and reports.
 - .4 Contractor shall submit all completed tests, reports and verification forms. The Consultant will use these documents to calculate a percentage completion.
 - .5 Contractor may claim up to 60% of the value for commissioning through monthly progress payment requests leading up to performance testing. The remaining 40% of the value for commissioning shall be paid-out after the performance testing and training have been completed.
- 7.3 Revise schedule to list approved Change Orders with each Application for Payment.

7.4 Purpose of the cost breakdown is to assist Consultant with evaluation of progress draws and to assist Owner with cash flow arrangements.

7.5 The Owner reserves the right to withhold the amounts allocated for Submittals indicated above pending their submission.

8 **SPECIAL PROJECT PROCEDURES**

.1 Existing premises will maintain operation during business hours, 6:00 am to 6:00 pm Monday to Friday. Work may be performed during these hours in areas as indicated in phasing drawings. Carry out work in such a manner as to cause a minimum of noise and interference to the use of the existing building. Conform to the requirements of the building management. Be responsible for any overtime work required after business hours.

8.2 Co-ordinate construction activities and use of premises with Owner and building management.

8.3 Maintain operations of building services, data, telephone and alarm. Ensure no interruptions of these services during execution of the Work.

8.4 Provide written notice to the Owner minimum 10 working days before any system shut downs. Major shutdown requires 20 working days' notice. Do not proceed without written approval from Owner.

8.5 Provide adequate protection against dust, water and other damages to Owner's electronic and computer equipment, fittings and furniture. Use covers acceptable to the Owner. Remove protection after each work period.

9 **INSTALLATIONS IN EXISTING HOSPITAL NETWORK HUB ROOMS**

9.1 Access to Sunnybrook Hospital Network Rooms is severely restricted and Contractors will not be allowed to access these rooms un-escorted / un-supervised. The Electrical Subcontractor is responsible for arranging any access they require as specified in Electrical Specification Section 27 15 00.

9.2 To complete this installation, the following applies:

.1 Contractor must provide to the Hospital a minimum of 10 working days' notice.

.2 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 services to a point outside of the Hub Room but cannot install any services into the Hub Room without Security Supervision) and to complete the installation in the Hub Room.

.3 Arrangements for Security Supervision is to be coordinated directly between Security and the Contractor with the Contractor providing a minimum ten days written request

.4 The Hospital's Security Department will charge the Contractor \$50.00 (fifty dollars) per hour for a minimum four hours at any one time

9.3 As the Contractor is responsible to cover any/ all costs required to retain the Hospital's Security Group, it is strongly recommended the Contractor properly schedule the need to access Hub Rooms and that the times requiring access be accurately indicated on the Project Schedule.

9.4 Refer also to Sunnybrook 'Data Centre and Hub Room Access Policy' appended at the end of the Specifications.

10 PROTECTION AND SECURITY

10.1 Protect existing services, structures and other items required to remain and newly installed Work during construction with secure and durable coverings, barricades or guards suitable for the various conditions. Perform the Work in a manner to avoid damage. Remove and replace at no expense to the Owner, any work and materials damaged that cannot be repaired or restored to the Consultant's satisfaction.

10.2 Owner's personnel will be occupying the existing building(s) during construction and alterations. Provide for the safety of occupants and for the security of occupied areas. Provide protection and keep clear areas that are required for access to, and exit from, occupied areas. Maintain clear and safe fire exit routes.

10.3 Where construction operations must be executed or traffic routed over finished floors, lay minimum 6 mm thick plywood coverings tightly fitted over surface in such areas. Secure plywood to prevent movement in a manner, which will not damage finished surfaces.

10.4 Keep floors dry. Keep floors free from oil or other contaminants at all times. Clean up all contaminating liquids where same are likely to damage surfaces.

10.5 Cover openings in equipment, ducts and pipes until final connections are made.

10.6 Protect exposed live electrical equipment during construction for personal safety.

10.7 Shield and mark live electrical parts with appropriate warnings.

10.8 Wherever practical lock or barricade finished areas.

10.9 As soon as construction is sufficiently advanced, enclose accessible openings to provide security. Provide temporary doors with security hardware.

10.10 Ensure continuous security of the Work and construction equipment.

10.11 Provide protection against the elements to maintain Products and installations from damage and deterioration.

11 EXAMINATION OF EXISTING CONDITIONS

11.1 Submission of bid shall be deemed evidence that Contractor has examined the site and is familiar with conditions under which work will be done and obtained all information, which may be necessary for proper execution of Contract.

11.2 Signing of Contract indicates acceptance by Contractor of conditions under which work will be done.

11.3 Extra payments will not be authorized for work that could have been determined by a careful examination of site and existing conditions.

12 EXAMINATION OF SURFACES DURING CONSTRUCTION

12.1 Before executing work against surfaces prepared by other Sections, examine such surfaces. Do not accept defective surfaces, or do any work to or on them, until the defects are remedied.

12.2 Commencement of work shall indicate acceptance of surfaces and responsibility concerning the conditions of same.

13 **EXISTING SERVICES**

13.1 Cut off, cap, divert or remove existing water, gas, electric and other services in areas being altered which are affected by the changes as required or as directed by the municipal authorities and the utility company concerned, and the Consultant. Protect and maintain active services to the existing building.

13.2 Prepare interference and/or installation drawings showing the work of the various Sections as well as the existing installation, and submit these drawings to the Consultant for review before the commencement of work.

14 **LOCATION OF EQUIPMENT AND FIXTURES**

14.1 Location of plumbing, heating and electrical fixtures and outlets, ducts, conduits and pipes shown or specified but not dimensioned shall be considered approximate.

14.2 Locate equipment, outlets, fixtures, devices and distribution systems to provide minimum interference and maximum usable space, and as required to meet safety, access, maintenance, acoustic, and regulatory, including barrier free, requirements.

14.3 Consult with the Consultant to determine the actual location of items not dimensioned as may be required to suit the job conditions.

14.4 Obtain Consultant's acceptance for precise locations of fixtures, access panels, outlets, mechanical, electrical and security items. Relocation caused by failure to determine the actual locations shall be executed without charge to the Owner.

14.5 Consultant reserves the right to relocate fixtures, access panels, outlets, mechanical, electrical and security items at a later date, but prior to installation, without additional cost, provided that the relocation per outlet or fixture does not exceed 3050 mm (10 feet) from the original location

15 **INTERFERENCE DRAWINGS**

15.1 Prepare dimensioned interference drawings indicating relationship of new installations and existing and/or unforeseen conditions prior to commencement of work.

15.2 Before commencing installation, prepare interference drawings, based on the actual field measurements, showing relationship of new and existing ductwork, conduit, piping, sprinklers, partitions, ceiling supports and framing, partition framing, communication and specialized equipment located within ceiling and shaft spaces.

15.3 Indicate locations of visible items such as air handling outlets, light fixtures, smoke detectors, sprinkler heads, communication grilles, and access panels occurring at these locations.

15.4 Drawings shall be initialed by responsible person of each Sub-Contractor involved along with Contractor's signature and submitted to Consultant for review and record purposes.

16 **DOCUMENTS ON SITE**

16.1 Maintain at job site, one copy each document as follows:

- .1 Permit Drawings and Building Permit Posters.
- .2 Contract Drawings and Specifications.
- .3 Addenda.
- .4 Reviewed Shop Drawings.
- .5 List of Outstanding Shop Drawings.
- .6 Change Orders.
- .7 Other Modifications to Contract.
- .8 Field Test Reports.
- .9 Copy of Approved Work Schedule.
- .10 Site-Specific Health and Safety Plan and Other Safety Related Documents.
- .11 Other documents as specified.

17 POWDER ACTUATED FASTENINGS

- 17.1 Powder actuated fastenings shall not be used on any portion of the Work, unless written consent for a specific use is obtained from the Consultant.

18 NOISE LIMITATIONS AND DUST CONTROL

- 18.1 Keep construction noise to a minimum.
- 18.2 No pneumatic or other noisy equipment will be permitted on the project site.
- 18.3 All vehicles and equipment shall be equipped with efficient muffling devices to minimize noise levels in the project area. In particular, construction equipment such as compressors, gas and diesel driven engines shall be equipped with efficient mufflers.
- 18.4 Undertake dust control measures to prevent dust nuisances resulting from any phase of the construction operation.
- 18.5 Carry out dust control practices at all locations on site.
- 18.6 Provide air scrubbers for equipment, including trucks, to prevent exhaust fumes from entering nearby buildings' air intakes. Provide documentation to the Consultant confirming installation of scrubbers prior to equipment arriving on site.

19 OVERLOADING

- 19.1 Take precautions to prevent the overloading of any part of the structure, false work, form work or scaffolding during the progress of the Work, and make good, at no expense to the Owner, all damage resulting from such overloading.
- 19.2 No load bearing members shall be cut, drilled or sleeved without the written consent of the Consultant.

20 HOLES THROUGH FLOORS AND WALLS

- 20.1 Where holes are made in floors for the passage of pipes, ducts and conduit or wires, the holes shall be sealed with cement grout after the pipes, ducts and conduit or wires have been placed.
- 20.2 Where holes are made in walls for the passage of pipes, ducts, conduit or wires, holes shall be filled with a suitable material, cement grout in masonry or concrete walls or plaster in plaster or drywall walls, regardless of whether or not the pipes have escutcheon plates. Grout or plaster around outside of sleeves where holes are sleeved.
- 20.3 In mechanical rooms above grade and in other rooms where faucets occur, the pipes, ducts, conduits or wires or all, which pass through floors, shall be enclosed in a 100 mm high metal sleeve and then grouted around pipes and ducts.
- 20.4 Above requirements shall apply to both exposed and concealed walls and floors.

21 MAKING GOOD

- 21.1 Make good materials and finishes, which are damaged or disturbed during the process of additions and reconstruction under the Contract.
- 21.2 Where existing work is to be made good, match new work exactly with the old work in material, form, construction and finish unless otherwise noted or specified.
- 21.3 Protect work in the existing building, such as floors, finishes, trim, etc., as completely as possible to hold the replacing of damaged work to a minimum.
- 21.4 Preparation for new finishes:
- .1 Remove existing finishes, including painting.
 - .2 Fill cracks and depressions with suitable filler and finish smooth, as recommended by the manufacturer of the new finishes.
 - .3 Grind protrusions level with substrates and finish smooth.
 - .4 Remove all evidences of existing adhesive, grease, oil, soil and other encrustations of foreign material by washing, scraping and grinding if necessary.
 - .5 Clean and prepare substrates to receive new work.

22 CUTTING AND PATCHING

- 22.1 Perform cutting, fitting, and patching to complete the Work. Do not cut, drill or sleeve load-bearing members without obtaining written approval for each condition.
- 22.2 Remove and replace defective and non-conforming work.
- 22.3 Perform work to avoid damage to other work.
- 22.4 Prepare proper surfaces to receive patching and finishing.
- 22.5 Cut rigid materials using power saw or core drill. Pneumatic or impact tools not allowed.
- 22.6 Restore work with new products to match existing in accordance with Contract Documents.

- 22.7 Fit work airtight to pipes, sleeves, ducts, conduit, and other penetrations through surfaces, and with suitable allowance for deflections, expansions, contractions, and firestopping.
- 22.8 Maintain fire ratings of fire rated assemblies where cutting and patching is performed. At penetration of fire-rated wall, ceiling, or floor construction, completely seal voids with fire-rated material, full thickness of construction element.
- 22.9 Refinish surfaces to match adjacent finishes; for continuous surfaces refinish to nearest intersection; for an assembly, refinish entire unit.

23 **SALVAGE AND DISPOSAL OF MATERIALS**

- 23.1 Cut, disconnect and detach items and materials designated to be removed.
- 23.2 All materials resulting from the demolition work except as otherwise specified or directed shall become the property of the Contractor.
- 23.3 Remove all material and debris from the site as quickly as possible and dispose of legally.
- 23.4 Burning of debris or selling of materials on the site will not be permitted.

24 **FIRE SAFETY DURING CONSTRUCTION**

- 24.1 Provide fire prevention and protection measures to existing building as required by all authorities having jurisdiction.
- 24.2 Maintain exits, including stairways and exterior doors to the outside. Provide acceptable alternative exits where an existing exit is blocked off or deleted due to construction activities.
- 24.3 Where access to an exit through construction area is absolutely necessary, clearly define, protect and separate access from the construction area by a smoke tight fire separation equivalent to minimum 3/4 hour fire resistance rating.

25 **SAFETY MEASURES**

- 25.1 Comply with the safety regulations of the Occupational Health and Safety Act and authorities having jurisdiction for the safety of the Work.

26 **PROJECT MEETINGS**

- 26.1 Schedule and administer project progress meetings throughout progress of work.
- 26.2 Distribute written notice of each meeting four days in advance of meeting date to Consultant and Owner.
- 26.3 Provide physical space and make arrangements for meetings.
- 26.4 Record minutes. Include significant proceedings and decisions. Identify 'action by' parties.

26.5 Reproduce and distribute copies of minutes within three days after each meeting and transmit to meeting participants, affected parties not in attendance, Consultant and Owner.

27 **SUBMITTALS**

27.1 Administrative

.1 Submit to Consultant submittals listed for review. Submit with reasonable promptness and in an orderly sequence so as to not cause delay in the Work. Identify Drawing Number and Specification Section number to which the submittal applies.

.2 Unless otherwise specifically permitted by the Consultant, make submittals in groups containing associated items; the Consultant may reject partial submittals as not complying with the provisions of the Contract Documents.

.3 Make submittals far enough in advance of scheduled dates of installation to provide required time for reviews, for securing necessary reviews, for possible revision and re-submittal, and for placing orders and securing delivery so as to cause no delay in the Work or in the work of other contractors. Costs of delays occasioned by tardiness of submittals shall not be borne by the Owner.

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

.5 Review submittals prior to submission to Consultant. This review represents that necessary requirements have been determined and verified, or will be, and that each submittal has been checked and co-ordinated with requirements of the Work and Contract Documents.

.6 Verify field measurements and affected adjacent Work is coordinated.

27.2 Submittals Processing Time: Allow time for submittal review, including time for re-submittals, as follows:

.1 Time for review shall commence on Consultant's receipt of submittal. If a shop drawing is received after 12 noon, it will be considered as received the next working day for the purposes of the processing time.

.2 For scheduling purposes allow minimum 10 working days following submission and minimum 10 working days following resubmission. Consultant will advise Contractor if additional time is required for technical or co-ordination review.

.3 Concurrent Review: When concurrent review of submittals by Consultant's subconsultants, Owner, or other parties is required, allow a minimum of fifteen (15) working days for initial review of each submittal. Direct transmittal to Consultant's subconsultants will not be permitted.

.4 If at any time the Contractor submits unusually large number of shop drawings, the Consultant will, within 5 working days of receipt of such drawings, provide the Contractor with an estimate of time necessary for processing such shop drawings.

.5 Failure to provide submittals in ample time is not considered sufficient reason for extension of Contract Time and no claim for extension will be allowed.

27.3 Shop Drawings and Product Data

- .1 Indicate materials, methods of construction and attachment or anchorage, erection diagrams, connection, explanatory notes and other information necessary for completion of Work.
 - .2 Adjustments made on shop drawings by Consultant are not intended to change Contract Price.
 - .3 Make changes in shop drawings as Consultant may require.
 - .4 Submit Shop drawings and Product Data in electronic format as a PDF or DWG file via the project website or other means of electronic file delivery. Scanned drawings will only be accepted if legible. Illegible drawings will be rejected.
 - .5 Product Data catalogue cuts showing all aspects, design, sizes, components and rough-in information for equipment may be submitted where shop drawings will not be prepared due to standardized manufacture of product. Supplement standard information to provide details applicable to project. Generic documents will be rejected.
- 27.4 Samples
- .1 Submit samples for review as requested in respective specification Sections.
 - .2 Deliver samples prepaid to Consultant's business address.
- 27.5 Operating Maintenance Manuals
- .1 Two weeks prior to Substantial Performance of the Work, submit to Consultant, three copies of operating and maintenance manuals.
 - .2 Manuals to contain operational information on equipment, cleaning and lubrication schedules, filters, overhaul and adjustment schedules and similar maintenance information.
 - .3 Bind contents in a three-ring, hard covered, plastic jacketed binder. Organize contents into applicable categories of work, parallel to specifications Sections.
- 28 **AS BUILT AND RECORD DRAWINGS**
- 28.1 After award of Contract, obtain a set of CAD drawings from the Consultant. Make sets of white prints for purpose of maintaining record drawings. Accurately and neatly record deviations from Contract Documents caused by site conditions and changes ordered by Consultant.
 - 28.2 Record locations of concealed components of mechanical and electrical services.
 - 28.3 Identify drawings as "Project Record Copy". Maintain in new condition and make available for inspection on site by Consultant. On a weekly basis, scan marked-up drawings to Adobe PDF format and provide a copy to Owner and Consultant.
 - 28.4 On completion of Work and prior to final inspection, submit a copy of record documents to Consultant in PDF format.
 - 28.5 Prior to testing, balancing and adjusting, obtain a current set of CAD files from the Consultant and transfer record drawing information to AutoCad 2016 (CAD) files, to record final as-built condition.
 - 28.6 Drawings are to remain set to and follow Consultants AutoCad Standards. Do not alter drawing scales, X-refs, colours, layers or text styles.

- 28.7 The Consultant's CAD files may not reflect all or any construction changes.
- 28.8 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.
- 28.9 As-built drawings to show the final as-built condition.
- 28.10 Identify each drawing in lower right hand corner in letters at least 12 mm (1/2") high and as follows:

"AS-BUILT DRAWINGS. This drawing has been revised to show all systems and conditions as installed". [Signature of Contractor] and [Date]
- 28.11 Provide "AS BUILT DRAWINGS" white prints to Consultant for review. Transfer Consultant's comments to the CAD files. Return AutoCad drawings modified to "As Built" condition to Consultants on CD or DVD Rom.
- 28.12 Submit three (3) sets of final "AS BUILT DRAWINGS" white prints with Operating and Maintenance Manuals.
- 28.13 Submit full set of final "AS BUILT DRAWINGS" to Owner in digital format: AutoCAD and PDF files, on CD or DVD Rom, or USB Flash drive, in triplicate.

29 **QUALITY CONTROL**

29.1 Owner's Quality Control

- .1 The Owner may require during progress of the Work, testing and inspection by an independent testing agency as directed by the Consultant, or as required in these Specifications, to determine if materials provided for the Works meet the specified requirements. The cost of these services shall be paid by Cash Allowances.
- .1 In this case, the Contractor shall pay independent inspection and testing agency charges authorized by the Consultant from the cash allowances included for these services.
- .2 Employment of inspection/testing agencies does not relax Contractor's responsibility to perform Work in accordance with Contract Documents.
- .3 Contractor shall provide equipment required by testing agencies for executing inspection and testing.
- .4 Re-Testing and Re-Inspection:
.1 If defects are revealed during inspection and testing, testing agency will request additional inspection and/or testing to ascertain full degree of defect. Re-testing and re-inspection shall be performed by the same testing agency as the initial tests.
.1 Contractor shall correct defects and irregularities at no cost to Owner;
.2 Contractor shall pay costs for re-testing and re-inspection.

29.2 Code Compliance and Contractor's Convenience Testing

- .1 Code Compliance Testing: Inspection and tests required by codes or ordinances, or by an authority having jurisdiction shall be the responsibility of the Contractor and shall be paid for by the Contractor as part of the Contract Price.
- .2 Contractor's Convenience Testing: Inspection or testing performed exclusively for the Contractor's convenience shall be the sole responsibility of the Contractor and paid for by Contractor as part of the Contractor's overhead expenses.
- .3 Engage a qualified testing agency to perform these quality-control services. Contractor shall not employ same entity engaged by Owner, unless agreed to in writing by Owner.
- .4 Submit a certified written report, in triplicate, of each quality-control service.
- .5 Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.
- .6 Re-testing/Re-inspecting: Provide quality-control services, including re-testing and re-inspecting, for construction that replaced Work that failed to comply with the Contract Documents. Pay costs for re-testing and re-inspection.

30 **SITE SIGNS**

- 30.1 Do not exhibit on the site advertisements or signs other than those required by authorities having jurisdiction, unless otherwise approved by the Consultant, in writing.

31 **CONSTRUCTION FACILITIES AND TEMPORARY CONTROLS**

31.1 Co-ordination

- .1 Co-ordinate with the building management use of temporary controls and facilities not provided under this Contract, including but not necessarily limited to material delivery, unloading and hoisting. Make prior arrangements and schedule use at times acceptable to the building management. Be responsible for payment for use of such facilities.

31.2 Installation/Removal

- .1 Provide construction facilities and temporary controls in order to execute work expeditiously. Remove from site all such work after use.

31.3 Conveying Equipment

- .1 Provide and maintain conveying equipment such as cranes, hoists, derricks and the like as required for the proper execution of the project.
- .2 Assume complete responsibility for construction, strength, placing, anchoring and operation of derricks, cranes, hoists, guy and operating cables and any other mechanical contrivance used for the work, to ensure that any load carried thereon can be safely supported and be free from accidents.
- .3 Provide air scrubbers for crane equipment, including trucks, to prevent exhaust fumes from entering nearby buildings' air intakes. Provide documentation to the Consultant confirming installation of scrubbers prior to equipment arriving on site.
- .4 Where local by-laws and regulations or any authorities having jurisdiction require drawings and specifications on accessory and conveying equipment, obtain and pay for same and assume responsibility for their adequacy.

31.4 Hoisting and Delivery

- .1 Deliveries shall be scheduled between 7:30 am to 3.30 pm. Any deliveries to be made on weekends must be scheduled with the hospital a minimum of three business days in advance. Large deliveries, which could affect the operations of the hospital, shall be scheduled with the hospital a minimum of 10 business days in advance.
- .2 Arrange for delivery and unloading of materials at areas designated by the building management. Do not interfere with vehicular traffic on the streets and pedestrian traffic on the sidewalks.
- .3 One of the existing elevators, as designated by the building management, may be used for construction personnel and material hoisting. Do not overload the elevator beyond the rated capacity. Provide protective coverings for finish surfaces of cars and entrances. Be responsible for safe operation of the elevator and any damages resulted from its usage. Provide alternative means of hoisting if the elevator is of insufficient size and capacity for materials intended.

31.5 Security Provisions

- .1 Maintain and conform to existing security provisions required by the building management. Do not compromise such provisions.

31.6 Hoarding and Barricades

- .1 Erect hoarding and barricades to protect public, workers, public and private property from injury or damage. Provide lockable doors within hoarding for access to site by workers.
- .2 Locks shall be Best construction core. Provide spare keys to Sunnybrook Security.

31.7 Weather Enclosures

- .1 Provide weathertight closures to unfinished door and window openings, tops of shafts and other openings in floors and roofs.
- .2 Close off floor areas where walls are not finished; seal off other openings; enclose building interior work area for temporary heat.

31.8 Parking

- .1 Construction parking is extremely limited. Construction personnel may park in the designated construction parking lot and only with a valid parking permit.
- .2 Parking Permit cost is based on Owner's set fees and is on a first come first serve basis.
- .3 Permits can be purchased at the Parking Service Office.

31.9 Temporary Partitions / Dust-Proof Barriers

- .1 Erect dust-proof barriers between occupied and construction areas to prevent dissemination of dust. Extend from floor to slab ceiling if suspended ceiling are to be removed.
 - .1 Vacuum the area above false ceilings, including duct work and pipes prior to construction.
 - .2 Establish traffic control patterns, which prevent construction dust from being tracked into occupied areas. Provide adhesive strips on floors to catch dust on shoes.

- .2 Follow assembly description of the hoarding / tarps / dust barriers and hoarding details on drawings.
 - .3 Refer to Section 01 35 33 Infection Control Procedures for additional requirements.
 - .4 Maintain and relocate protection until Work is complete.
- 31.10 Site Storage/Loading
- .1 Confine the Work and operations of employees to limits indicated by Contract Documents. Do not unreasonably encumber premises with Products.
 - .2 Do not load or permit to be loaded any part of the Work with a weight or force that will endanger the Work.
 - .3 Storage outside the construction zone is not permitted.
- 31.11 Sanitary Facilities
- .1 Existing facilities as designated may be used during construction period.
 - .2 Maintain in clean condition.
- 31.12 Water and Power Supply
- .1 The Owner will provide and pay for a continuous supply of water, power for construction use as available from the existing facilities. Provide hoses, extensions, valves, connections, and transformers as required for execution of the Work. Provide extra supply if the existing facilities are insufficient or not suitable for construction use.
 - .2 Arrange for connection with appropriate utility company and pay costs for installation, maintenance and removal.
- 31.13 Temporary Lighting
- .1 Provide temporary lighting required during construction period, including attendance and maintenance.
 - .2 Maintain lighting at levels required by Sections doing the work.
- 31.14 Temporary Heating
- .1 Provide temporary heating required during construction period, including attendance, maintenance and fuel.
 - .2 Construction heaters used inside building must be vented to outside or be non-flameless type. Solid fuel salamanders not permitted.
 - .3 Maintain temperatures at levels required by Sections doing the work.
 - .4 Ventilate heated areas and keep building free of exhaust or combustion gases.
- 31.15 Equipment/Tool/Materials Storage
- .1 Provide and maintain, in clean and orderly condition, lockable areas for storage of tools, equipment and materials.
 - .2 Locate materials on site in manner to cause least interference with work activities.
- 31.16 Project Cleanliness

- .1 Maintain the Work in tidy condition, free from accumulation of waste products and debris.
- .2 Remove waste material and debris from site at end of each working day. Do not burn waste materials on site.
- .3 Clean interior areas prior to start of finish work, maintain areas free of dust and other contaminants during finishing operations.

32 MATERIAL AND EQUIPMENT

32.1 Product and Material Quality

- .1 Products, materials, equipment and articles incorporated in Work shall be new, not damaged or defective, and of best quality for purpose intended. If requested, furnish evidence as to type, source and quality of Products provided.
- .2 Whenever Products are specified exclusively by trade name, manufacturer's name or by catalogue reference, use only those items, unless written approval for substitution is obtained from Consultant.
- .3 Whenever manufacturer's catalogue trade name is specified, that product has been used as the Basis of Design and sets the standard of acceptance.
 - .1 It is not the intent that these products are supplied exclusively. The manufacture's names and product numbers are used to denote the minimum requirements for quality, performance, durability, design function, size, style, finish, maintenance and warranty.
 - .2 Other manufacturer's products may be used provided the items are equal or better in all respects to the items specified, subject to the provisions identified in this Article.
 - .3 Whenever classifications, listing, or other certifications by a recognized standards body is a part of the Basis of Design product, proposed substitutions to be accompanied by reports from the equivalent body indicating compliance.
- .4 Proposed substitutions will be considered only under the following conditions:
 - .1 If the materials and products specified are not available; or
 - .2 If substitute materials and products to those specified, which are brought to the attention of and considered by the Consultant as equivalent to those specified, will offer Owner a substantial advantage in cost, time, energy conservation, or other considerations, after deducting additional responsibilities Owner must assume. Owner's additional responsibilities may include compensation to Consultant for redesign and evaluation services, increased cost of other construction by Owner, and similar considerations.
- .5 Requests for substitutions must be fully documented and properly submitted, and must include the following statements:
 - .1 Description of proposed substitution.
 - .2 Respective costs of items originally specified and the proposed substitution.
 - .3 Compliance with the Building Codes and requirements of authorities having jurisdiction.
 - .4 Affect concerning compatibility and interface with adjacent building materials and components.

- .5 Compliance with the intent of the Contract Documents.
- .6 Reason for the request.
- .6 There is no obligation on the part of the Consultant or Owner to accept proposed substitutions. Acceptance of proposed substitutions by Owner does not relieve the Contractor's responsibility under the Contract.
- .7 Defective Products will be rejected, regardless of previous inspections. Inspection does not relieve responsibility, but is precaution against oversight or error. Remove and replace defective Products at own expense and be responsible for delays and expenses caused by rejection.
- .8 Should any dispute arise as to quality or fitness of Products, decision rests strictly with Consultant based upon requirements of Contract Documents.
- 32.2 Storage, Handling and Protection
 - .1 Handle and store Products in manner to prevent damage, adulteration, deterioration and soiling and in accordance with manufacturer's instructions when applicable.
 - .2 Store packaged or bundled Products in original and undamaged condition with manufacturer's seals and labels intact.
- 32.3 Manufacturer's Instructions
 - .1 Unless otherwise indicated in specifications, install or erect Products in accordance with manufacturer's instructions. Do not rely on labels or enclosures provided with Products. Obtain written instructions directly from manufacturers.
 - .2 Notify Consultant in writing, of conflicts between specifications and manufacturer's instructions, so that Consultant may establish course of action.
 - .3 Improper installation or erection of Products, due to failure in complying with these requirements, authorizes Consultant to require removal and reinstallation at no increase to Contract Price.
- 32.4 Workmanship
 - .1 Workmanship shall be best quality, executed by workers experienced and skilled in respective duties for which they are employed. Immediately notify Consultant if required Work is such as to make it impractical to produce required results.
 - .2 Do not employ any unfit person or anyone unskilled in their required duties.
 - .3 Decisions as to quality or fitness of workmanship in cases of dispute rest solely with Consultant, whose decision is final.
- 32.5 Concealment
 - .1 In finished areas, conceal pipes, ducts and wiring in floors, walls and ceilings, except where indicated otherwise.
 - .2 Before installation, inform Consultant if there is a contradictory situation. Install as directed by Consultant.

33 NUMBER OF ITEMS

33.1 In cases where an item or part of materials or equipment is referred to in the singular number, it is intended that such reference shall apply to as many items or parts as are required to complete the Work.

34 RECONSTRUCTION, ALTERATIONS AND MAKING GOOD

34.1 Where new work connects with existing work and where existing work is altered, carry out all necessary cutting and fitting required to make satisfactory connections with the existing work under this contract so as to leave the project in a finished and workmanlike condition.

34.2 Unless otherwise specified or required by codes or By-laws to meet a certain requirement or both, make good new work to match existing work.

34.3 Make good concrete, masonry, steel, plaster, drywall ceilings, walls, flooring and other materials and finishes which are damaged or disturbed during the progress of additions and re-construction under the Contract.

34.4 Existing services shall be disconnected and relocated, where necessary, and reconnected as required to complete the Work. This work shall include, without being limited to, plumbing, drainage, heating, ventilating, air conditioning and electrical services.

34.5 Where existing work is to be made good, the new work shall match exactly the old work in material, construction and finish, unless otherwise noted or specified.

34.6 Drilling or cutting of existing work shall be carefully executed, leaving a clean hole no larger than required.

34.7 Wherever it becomes necessary to cut or interfere in any manner with existing equipment or service lines for short periods of time, do such work at times agreed upon between the Owner, Consultant and the Contractor.

34.8 Coordinate the Work of the various trades, taking into account the existing installations to assure the best arrangement of pipes, conduit, ducts and mechanical, electrical and other equipment, in the available space.

34.9 If required, in critical locations, interference or installation drawings or both, shall be prepared showing the Work of the various trades as well as the existing installations, and shall be submitted to the Consultant for review before the commencement of the Work.

35 CONTRACT CLOSEOUT

35.1 Final Cleaning

.1 When the Work is Substantially Performed, remove surplus products, tools construction machinery and equipment not required for performance of remaining Work.

.2 Leave work broom clean before inspection process commences.

.3 Clean and polish glass, mirrors, hardware, wall tile, stainless steel, chrome, porcelain enamel, baked enamel, plastic laminate, mechanical and electrical fixtures. Replace broken, scratched or disfigured glass.

- .4 Remove stains, spots, marks and dirt from decorative work, electrical and mechanical fixtures, furniture fitments, walls ceilings.
 - .5 Vacuum clean and dust building interiors, behind grilles, louvres and screens.
 - .6 Wax, seal, shampoo or prepare floor finishes, as recommended by manufacturer.
- 35.2 Systems Demonstration / Training
- .1 Prior to final inspection, demonstrate operation of each system to Owner.
 - .2 Instruct personnel in operation, adjustment, and maintenance of equipment and systems, using provided operation and maintenance data as basis for instruction.
 - .3 Provide training to Owner's personnel on operations and maintenance of all systems and equipment.
 - .1 The training session must be video-recorded by a professional media company acceptable to the Owner (no cell phone recording).
- 35.3 Documents
- .1 Collect reviewed submittals and assemble documents executed by Subcontractors, suppliers, and manufacturers.
 - .2 Organize contents within Operation and Maintenance Data binder into applicable sections of work to parallel project specification breakdown using broad scope headings: Architectural, Mechanical, Electrical, etc.
 - .3 Submit material prior to final application for payment.
 - .4 Submit three (3) print copies and three (3) CD-ROM or USB flash drives with electronic files of Project Record Manual consisting of operation and maintenance manuals in PDF format, three (3) sets of final "MAS BUILD DRAWINGS" white prints; and full set of final "AS BUILT DRAWINGS" in digital format: AutoCAD and PDF files on CD-ROM or USB flash drives (in triplicate).
 - .5 Provide warranties fully executed and notarized.
 - .6 Execute transition of Performance Bond to warranty period requirements.
- 35.4 Inspection/Takeover Procedures
- .1 Prior to application for certificate of Substantial Performance, carefully inspect the Work and ensure it is complete, that major and minor construction deficiencies are complete, defects are corrected and building is clean and in condition for occupancy. Notify Consultant in writing, of satisfactory completion of the Work and request an inspection.
 - .2 During Consultant inspection, a list of deficiencies and defects will be tabulated. Correct same.
 - .3 When Consultant considers deficiencies and defects have been corrected and it appears requirements of Contract have been performed, make application for certificate of Substantial Performance.
 - .4 Conform to OAA/OGCA Document No.100 for takeover procedures.
 - .5 Submit a final statement of accounting giving total adjusted Contract Price, previous payments, and monies remaining due.

- .6 Consultant will issue a final change order reflecting approved adjustments to Contract Price not previously made.

End of Section

1 **SUBSTITUTIONS**

- 1.1 Whenever Products are specified exclusively by trade name, manufacturer's name or by catalogue reference, use only those items, unless written approval for substitution is obtained from Consultant.
- 1.2 No substitutions will be permitted without prior written approval of the Consultant.
- 1.3 Proposals for substitutions may only be submitted after award of Contract.
- 1.4 Substitutions submitted on shop drawings without following requirements of this Section prior to submission of the shop drawings will cause the shop drawings to be rejected at any time. Consultant's review of shop drawings shall not be construed as approval of substitutions.
- 1.5 Requests for substitutions must include statements of:
- .1 Description of proposed substitution.
 - .2 Respective costs of items originally specified and the proposed substitution.
 - .3 Compliance with the Building Codes and requirements of authorities having jurisdiction.
 - .4 Affect concerning compatibility and interface with adjacent building materials and components.
 - .5 Compliance with the intent of the Contract Documents.
 - .6 Reason for the request.
- 1.6 Proposed substitutions will be considered only under the following conditions:
- .1 If the materials and products specified are not available; or
 - .2 If substitute materials and products to those specified, which are brought to the attention of and considered by the Consultant as equivalent to those specified, will not change the Contract Price and Contract Time; or
 - .3 If substitute materials and products to those specified, which are brought to the attention of and considered by the Consultant as superior to those specified, will not change the Contract Price and Contract Time; or
 - .4 If a material or product is specified together with a requirement for performance and, in the opinion of the Contractor, the specified material or product will not produce the required results.
- 1.7 There is no obligation on the part of the Consultant or Owner to accept proposed substitutions. Acceptance of proposed substitutions by Owner does not relieve the Subcontractor's responsibility under the Contract.
- 1.8 Should proposed substitution be accepted either in part or in whole, bear full responsibility and costs when substitution affects other work on the project. Pay for design and contract document changes required as result of the substitution.
- 1.9 Amounts of all credits arising from acceptance of substitutions will be determined by the Consultant and the Contract Price adjusted accordingly.

1.10 Wherein the expression "other acceptable equivalents" or similar expressions in specification Sections, submissions under the expression shall be as specified in this Section.

End of Section

Substitution Request No: _____ Date: _____

Project: _____ Project No: _____

Contractor: _____

Specified Product Specification Reference

Section Number	Section Title	Paragraph Number
_____	_____	_____

Proposed Substitution

**Manufacturer and
Product Trade Name**

Address

Phone Number

Contact Name

Model Number

History of Product

New Product ___ 2-5 years old ___ 5-10 years old ___ More than 10 years old ___

Similar Installation

Project Name & Address

Consultant

Owner

**Proposed
Substitution Affects
Other Parts of Work**

No ___ Yes, explain:

**Differences Between
Proposed Substitution
and Specified Product**

**Reason For Not
Providing Specified
Product**

**Changes to Contract
Price**

Add/Deduct \$ _____

**Changes to Contract
Time**

Add/Deduct _____ days

Contractor's Declaration

The Contractor Declares that:

- Proposed substitution has been fully investigated and determined to be equivalent or superior in all respects to specified product, and complies with requirements of authorities having jurisdiction.
- Same warranty will be furnished for proposed substitution as for specified product.
- Cost data as stated above is complete. Claims for additional costs related to accepted substitution which may subsequently become apparent are to be waived.
- Proposed substitution does not affect dimensions and functional clearances.
- Proposed substitution is compatible with adjacent materials and assemblies.
- Coordination, installation, and changes in the Work as necessary for accepted substitution will be complete in all respects.

Signed By: _____ Date: _____

Supporting Data Attached: Drawings Product Data Samples Reports Other _____

Consultant's Review

- Substitution Accepted – Provide submittals in accordance with Specification requirement.
- Substitution Accepted as Noted – Provide submittals in accordance with Specification requirement.
- Substitution Not Accepted – Use specified product.

Signed By: _____ Date: _____

Owner's Acceptance

Signed By: _____ Date: _____

Additional Comments:

Consultant _____

Contractor _____

Owner _____

1 COORDINATION

- 1.1 Coordinate scheduling, submittals, and Work of the various Sections of specifications to assure efficient and orderly sequence of installation of interdependent construction elements, with provisions for accommodating items installed later.
- 1.2 Verify that utility requirement characteristics of operating equipment are compatible with building utilities. Coordinate work of various Sections having interdependent responsibilities for installing, connecting to, and placing in service, such equipment.
- 1.3 Coordinate space requirements and installation of mechanical and electrical work which are indicated diagrammatically on Drawings. Follow routing shown for pipes, ducts, and conduit, as closely as practicable; place runs parallel with line of building. Utilize spaces efficiently to maximize accessibility for other installations, for maintenance, and for repairs.
- 1.4 In finished areas, except as otherwise indicated, conceal pipes, ducts, and wiring within the construction. Coordinate locations of fixtures and outlets with finish elements.
- 1.5 Coordinate completion and clean up of Work of separate Sections in preparation for Substantial Performance and for portions of Work designated for Owners partial occupancy.
- 1.6 After Owner occupancy of premises, coordinate access to site for correction of defective Work and Work not in accordance with Contract Documents, to minimize disruption of Owner's activities.

2 ALTERATION PROJECT PROCEDURES

- 2.1 Materials: As specified in product Sections; match existing products and work for patching and extending work.
- 2.2 Close openings in exterior surfaces to protect existing work from weather and extremes of temperature and humidity.
- 2.3 Remove, cut, and patch work in a manner to minimize damage and to provide a means of restoring products and finishes to original condition.
- 2.4 Refinish visible existing surfaces to remain in renovated rooms and spaces, to specified condition for each material, with a neat transition to adjacent finishes.
- 2.5 Where new work abuts or aligns with existing, perform a smooth and even transition. Patched work to match existing adjacent work in texture and appearance.
- 2.6 When finished surfaces are cut so that a smooth transition with new work is not possible, terminate existing surface along a straight line at a natural line of division and make recommendation to Consultant.
- 2.7 Where a change of plane of 6 mm or more occurs, submit recommendation for providing a smooth transition for Consultant's review or request instructions from Consultant.
- 2.8 Patch or replace portions of existing surfaces which are damaged, lifted, discolored, or showing other imperfections.
- 2.9 Finish surfaces as specified in individual product Sections.

3 **PRE-CONSTRUCTION CONFERENCE**

3.1 Consultant will schedule a conference after Notice of Award and prior to Contractor occupancy of site.

3.2 Attendance Required: Owner, Consultant and Contractor.

3.3 Agenda:

.1 Submission of executed bonds and insurance certificates.

.2 Distribution of Contract Documents.

.3 Submission of list of Subcontractors, list of products, Schedule of Values, and progress schedule.

.4 Designation of personnel representing the parties in Contract, Owner, and Consultant.

.5 Procedures and processing of field decisions, submittals, substitutions, applications for payments, proposal request, contract changes and contract closeout procedures.

.6 Scheduling.

.7 Use of premises by Owner and Contractor.

.8 Owner's requirements and partial occupancy.

.9 Construction facilities and controls provided by Owner.

.10 Temporary utilities provided by Owner.

.11 Security and housekeeping procedures.

.12 Procedures for maintaining record documents.

4 **PROGRESS MEETINGS**

4.1 Schedule and administer meetings throughout progress of the Work at maximum bi-weekly intervals.

4.2 Make arrangements for meetings, prepare agenda with copies for participants, preside at meetings, record minutes, and distribute copies within two days to Consultant, Owner, participants, and those affected by decisions made.

4.3 Attendance Required: Job superintendent, major Subcontractors and suppliers, Owner, Consultant as appropriate to agenda topics for each meeting.

4.4 Agenda:

.1 Review minutes of previous meetings.

.2 Review of Work progress.

.3 Field observations, problems, and decisions.

.4 Identification of problems which impede planned progress.

.5 Review of submittals schedule and status of submittals.

.6 Review of off-site fabrication and delivery schedules.

- .7 Maintenance of progress schedule.
- .8 Corrective measures to regain projected schedules.
- .9 Planned progress during succeeding work period.
- .10 Coordination of projected progress.
- .11 Maintenance of quality and work standards.
- .12 Effect of proposed changes on progress schedule and coordination.
- .13 Other business relating to Work.

5 PRE-INSTALLATION CONFERENCES

- 5.1 When required in individual specification Section, convene a pre-installation conference at work site prior to commencing work of the Section.
- 5.2 Attendance Required: Parties directly affecting, or affected by, work of the specific Section.
- 5.3 Notify Consultant four days in advance of meeting date.
- 5.4 Prepare agenda, preside at conference, record minutes, and distribute copies within two days after conference to participants, with two copies to Consultant.
- 5.5 Review conditions of installation, preparation and installation procedures, and coordination with related work.

End of Section

1 SCHEDULES REQUIRED

- 1.1 Submit the following schedules:
- .1 Construction Progress Schedule.
 - .2 Two-week look-ahead detailed construction schedule.
 - .3 Submittal Schedule for Shop Drawings and Product Data.
 - .4 Submittal Schedule for Samples.
 - .5 Product Delivery Schedule.

2 FORMAT

- 2.1 Prepare schedule in the form of a horizontal bar chart.
- 2.2 Provide a separate bar for each trade or operation.
- 2.3 Provide horizontal time scale identifying the first work day of each week.
- 2.4 Format for listings: the table of contents of this specification.
- 2.5 Identification of listings: by specification section numbers.

3 CONSTRUCTION SCHEDULE

- 3.1 The Construction Schedule shall be in the form of a series of activities and milestones that are logically linked utilizing Critical Path Methodology. The Construction Schedule shall identify early dates and late dates as well as the Project critical path of activities and completion milestones through the Project
- 3.2 Coordinate the construction schedule with the Owner.
- .1 Develop and submit Construction Schedule to the Consultant and regularly review the progress of the work with the Consultant.
 - .2 Allow for facilitating the work of the Consultant who will be monitoring the progress of activities within the Master Project Schedule and reporting to the Owner on a monthly basis the schedule status of the project.
 - .3 Master Project Schedule: The Master Project Schedule is the schedule which facilitates the Owner's planning or activities and requirements for the Project, of which this work is part. In addition to the major milestones for the Work from the Construction Schedule provided by the Contractor, the Master Project Schedule contains activities to be performed by the Owner, the Consultant, and Authorities of Jurisdiction.

4 SUBMISSION

- 4.1 Submit initial schedules with bid submission.
- 4.2 Submit digital document in both PDF and Microsoft Project formats.
- 4.3 Consultant will review schedule and return review copy within 10 days after Contract award.
- 4.4 Resubmit finalized schedule within 7 days after return of review copy.

- 4.5 Submit revised progress schedule with each application for payment.
- 4.6 Distribute copies of the revised schedule to:
 - .1 Job site office.
 - .2 Subcontractors.
 - .3 Other concerned parties.
- 4.7 Instruct recipients to report to the contractor within 10 days, any problems anticipated by the timetable shown in the schedule.
- 5 **CONSTRUCTION PROGRESS SCHEDULE**
- 5.1 Include the complete sequence of construction activities.
- 5.2 Include the dates for the commencement and completion of each major elements and phasing of construction including the following.
 - .1 Selective Demolition.
 - .2 Framing.
 - .3 Special procedures.
 - .4 Special Subcontractor work.
 - .5 Equipment Installations.
 - .6 Finishes.
- 5.3 Show projected percentage of completion of each item as of the first day of the month.
- 5.4 Indicate the following:
 - .1 Cordinated sequence of tasks following the contract documentation
 - .2 Linking of critical path
 - .3 Lead time of major items with delivery schedule
 - .4 Major inspections points
 - .5 Major milestone completion dates to include Each Phase construction completion, and partial occupancy Substantial Completion, occupancy, etc.
 - .6 Commissioning activities
 - .7 Deficiencies identification and clearance
 - .8 Phasing details
 - .9 Estimate dates for access and duration of Work outside of the Area of Work.
 - .10 Deliveries of materials, advance order dates, and lead times.
- 5.5 Indicate progress of each activity to date of submission schedule.

- 5.6 Show changes occurring since previous submission of schedule:
- .1 Major changes in scope.
 - .2 Activities modified since previous submission.
 - .3 Revised projections of progress and completion.
 - .4 Other identifiable changes.
- 5.7 Provide a narrative report to define:
- .1 Problem areas, anticipated delays, and the impact on the schedule.
 - .2 Corrective action recommended and its effect.
 - .3 The effect of changes on schedules of other prime contractors.
- 6 TWO-WEEK LOOK-AHEAD SCHEDULE**
- 6.1 Format: agenda style calendar, to fit 8 1/2" x 11" pages
- 6.2 Indicate each trade activity on each day, including deliveries, submittals, and coordination activities.
- 6.3 Indicate coordination activities with Owner, Consultant, Subcontractors.
- 6.4 Indicate the following:
- .1 All required advance notice elements
 - .2 Details on all testing and inspection.
 - .3 All work that is to be done during regular and after hours following the requirements of the construction documents.
 - .4 All tasks that require tie in to existing service within the building
- 6.5 Two-week period shall commence on the first working day of the week following the Progress Meeting at which it is submitted.
- 6.6 Submit up-to-date two-week look-ahead schedule at each Progress Meeting and at maximum two-week intervals.
- 7 SCHEDULE OF VALUES (VALUE OF SUBMITTALS)**
- 7.1 Refer to Section 01 00 00, General Requirements
- 8 SUBMITTALS SCHEDULE**
- 8.1 Include schedule for submitting shop drawings, product data, and samples.
- 8.2 Indicate dates for submitting, review time, resubmission time, float time, last date for meeting fabrication schedule.
- 8.3 Include dates when submittals and delivery will be required for owner-furnished products.

8.4 Include dates when reviewed submittals will be required from the Consultant.

End of Section

1 SUMMARY OF WORK

- 1.1 Provide staff, Subcontractor, Suppliers, and own forces with training in infection prevention and control procedures. Design and implement training seminar by an environmental consultant with healthcare experience and whose educational program has been approved by the Owner. Acceptable firms are but not necessary limited to the following:
 - .1 Maple Environmental (Kyle Prosser, 905-601-6301).
 - .2 Safetech Environmental Ltd. (Romeo Milano, Tel: 905-624-2722).
 - .3 Golder Associates (Jason McGonigle, Tel 905-723-2727 Ext. 256).
- 1.2 Directly engage and enter into a contract with the approved environmental consultant. Coordinate with the environmental consultant and include in the Contract Price the required number of training sessions to adequately cover the duration of the Project.
- 1.3 Prior to commencement and during the course of the Work, as required, promptly provide the Owner with written confirmation of such training by way of a certificate issued by the environmental consultant.
- 1.4 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.
- 1.5 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.
- 1.6 Inspection of on-going infection control procedures shall be undertaken on a regular basis by the Owner's infection control representative and the Contractor. The Owner's monitoring checklist is found in Appendix II.
- 1.7 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. Construct barriers as per final instruction on site by the Owner at no additional cost to the Owner.
- 1.8 Definitions:
 - .1 Final cleaning is defined as; post construction cleaning as provided by the Owner's workforce or Owner's contracted cleaning service
- 1.9 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.

- 1.10 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.
- 1.11 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.

2 REFERENCES

- 2.1 Canadian Standards Association (CSA Group):
 - .1 CAN/CSA-Z317.2-15, Special requirements for heating, ventilation, and air-conditioning (HVAC) systems in health care facilities.
 - .2 CAN/CSA-Z317.13-17, Infection control during construction, renovation, and maintenance of health care facilities.

3 WORK COVERED UNDER THIS CONTRACT

- 3.1 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.
- 3.2 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.

4 PRE-CONSTRUCTION

- 4.1 At Contract start-up meeting, at meetings convened prior to the start of the Work, at pre-installation meetings, and at regular progress meetings, review infection prevention and control procedures. The Owner's infection control representative will 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 CAN/CSA-Z317.13.
 - .2 Project and/or phases are subjected to preventative measures assessment and categorization in accordance with CAN/CSA-Z317.13.
 - .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 shall 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 permits requirements prior to opening concealed spaces.
- 4.2 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
- 5 **CONSTRUCTION**
- 5.1 Breaches in infection prevention containment measures, as outlined in Appendix I or as prescribed by CAN/CSA-Z317.13 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.
 - 5.2 Construction area and all related traffic routes shall be maintained in an "acceptable" state of cleanliness as specified by the IPCS during the project without exception.
 - 5.3 Cleaning will be provided as categorized by IPCS as specified in Appendix I. 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.
- 5.4 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.
- 5.5 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 shall consult with the IPCS or designate on packaging necessary to protect devices prior to final install
 - .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.
 - .1 For Project- specific delivery hours refer to Section 01 00 00, General Requirements.
 - .8 Incoming construction material must be handled in accordance with CAN/CSA-Z317.13. 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.
- 5.6 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.
 - 5.7 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.
 - .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 CAN/CSA-Z317.2 and CAN/CSA-Z317.13.
 - 5.8 Contractor shall:
 - .1 When constructing the hoarding, install an electronic magnehelic gauge complete with recording capability and local audible alarm.
 - .2 Maintain a daily log for full duration of the construction and provide the data to the Consultant and Owner upon request.
 - 5.9 Ensure that mandatory vacuuming and cleaning of Contractors and Subcontractors clothes is done, prior to leaving areas of the Work to prevent dispersion of dust.
 - 5.10 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.
- End of Section

1 **DEFINITION**

1.1 Containment Areas: Include all areas of construction activities, including staging and storage areas, and passage areas for workers, supplies and waste. It also includes ceiling spaces above and adjacent to construction activities.

2 **PROJECT CLEANLINESS**

- 2.1 Airborne contaminants control is critical in all hospital areas. Contractor shall limit dissemination of airborne contaminants produced by construction-related activities, including dust, chalk, powders, aerosols, fumes, fibers and other similar materials.
- 2.2 Clean interiors of the containment areas on a continuous basis daily to provide suitable conditions for Work and remove mud and dirty footprints.
- 2.3 Use wet cleaning methods and HEPA-filtered vacuum cleaners to minimize release of airborne contaminants in work area, adjacent hallways and passage areas. No sweeping allowed
- 2.4 Regardless of containment strategies, execute work by methods to minimize raising dust from construction operations. Water may be used to assist in controlling airborne dust.
- 2.5 Provide adhesive mat for project entrances and exits. Item to be of sufficient size to allow personnel exiting project site to clean debris and dust from shoes. Tracking dust and debris through working areas of hospital is not acceptable. Any dust or debris tracked out of construction site, either by foot traffic or by debris hauling vehicles, shall be cleaned and removed by Contractor at no additional cost to the Owner.
- 2.6 Provide mats at each entry point to the Work, and at other areas as directed by Owner. Replace mats daily or as requested by Owner.
- 2.7 Implement airborne contaminants control in accordance with Section 01 35 33 Infection Control Procedures.
- 2.8 Remove debris and rubbish from pipe chases, plenums, attics, crawl spaces, and other closed or remote spaces, prior to closing such spaces
- 2.9 Maintain Work in tidy condition, free from accumulation of waste products and debris.
- 2.10 Remove waste materials from site at daily regularly scheduled times or dispose of as directed by Owner.
- 2.11 Provide on-site covered containers for collection of waste materials and debris.
- 2.12 Provide and use marked separate bins for recycling.
- 2.13 Clean interior areas prior to start of finishing work, and maintain areas free of dust and other contaminants during finishing operations.
- 2.14 Use only cleaning materials recommended by manufacturer of surface to be cleaned, and as recommended by cleaning material manufacturer.
- 2.15 Schedule cleaning operations so that resulting dust, debris and other contaminants will not fall on wet, newly painted surfaces nor contaminate building systems.

3 FINAL CLEANING

- 3.1 Execute a thorough cleaning prior application for Substantial Performance, and remove surplus products, tools, construction machinery and equipment not required for performance of remaining Work.
- 3.2 Remove waste products and debris and leave Work clean and suitable for occupancy.
- 3.3 Prior to final review, remove surplus products, tools, construction machinery and equipment.
- 3.4 Clean and polish glass, mirrors, hardware, wall tile, stainless steel, chrome, porcelain enamel, baked enamel, plastic laminate, and mechanical and electrical fixtures. Replace broken, scratched or disfigured glass.
- 3.5 Remove stains, spots, marks and dirt from decorative work, electrical and mechanical fixtures, furniture fitments, walls, floors and ceilings.
- 3.6 Clean lighting reflectors, lenses, and other lighting surfaces.
- 3.7 Vacuum clean and dust building interiors, behind grilles, louvres and screens.
- 3.8 Wax, seal, shampoo or prepare floor finishes, as recommended by manufacturer.
- 3.9 Inspect finishes, fitments and equipment and ensure specified workmanship and operation.
- 3.10 Broom clean and wash exterior walks, steps and surfaces.
- 3.11 Remove dirt and other disfiguration from exterior surfaces.
- 3.12 Clean light wells.
- 3.13 Clean equipment and fixtures to sanitary condition; replace filters of mechanical equipment used for temporary heat and ventilation.
- 3.14 Remove debris and surplus materials from crawl areas and other accessible concealed spaces.
- 3.15 Prior to hospital use of premises, Contractor and Owner with jointly conduct an inspection of sight-exposed surface to verify that the entire Work is clean. Correct conditions found to be inadequate. If Contractor fails to correct inadequate conditions, Owner will proceed with the thorough cleaning and deduct the cost from the final payment.

End of Section

PART - 1 GENERAL

1.1 SUMMARY

- .1 Section Includes:
 - .1 Labour, Products, equipment and services necessary to complete the work of this Section.
- .2 Related Requirements:
 - .1 Comply with Conditions of the Contract and Division 01 - General Requirements.

1.2 SECTION INCLUDES

- .1 This Section of the Work covers the requirements for demolishing, salvaging, relocating and removing wholly or in part the various items designated on the drawings or required to be removed or partially removed for the receipt of the Work of this Contract.
- .2 Selective demolition includes, but is not necessarily limited to:
 - .1 Alteration and renovations to existing building.
 - .2 Cutting and removing of walls, ceilings, floor finishes, etc., in the existing buildings as indicated on drawings.
 - .3 Patching, making good walls, floors and ceilings including painting, as required.
 - .4 Removal of rubbish, debris, demolished fixtures, fitments and items not scheduled to remain Owner's property, resulting from the demolition and preparatory work.
 - .5 Dust Control during the operations of the work of this section.

1.3 QUALITY ASSURANCE

- .1 Comply with pertinent codes, regulations and insurance carriers providing coverage for this Work.
- .2 Execute the work in strict accordance with 'The Occupational Health and Safety Act and Regulations for Construction Projects' latest addition. Keep copy of the Act at the place of the Work at all times.
- .3 Carry out demolition work in accordance with CSA S350-M.
- .4 Submit fire safety plan in accordance with requirements of Owner.

1.4 SUBMITTALS

- .1 Submit demolition and cutting schedule to Consultant for review. Schedule to show timing and phasing of the Work in the various areas of the existing building. Deviation from schedule will not be permitted without approval.
- .2 Submit drawings to Consultant for review of demolition of structural elements.
 - .1 Make sure drawings bear the seal and signature of a licensed Professional Engineer, registered to practice in the Province of Ontario.
 - .2 Drawings to indicate extent of demolition and method of temporary shoring of existing structure where required.

1.5 PROTECTION

- .1 Erect barricades, covered ways, barriers, scaffolding, screens, notice and warning boards and maintain all lights, signals and protection of all kinds for the protection of workmen on the Work, for the protection of property and for the protection of public.
- .2 Use all means necessary to protect existing objects designated to remain and in the event of damage, immediately make all repairs and replacements necessary to the approval of the Consultant and at no additional cost to Owner.
- .3 Provide protection required to enable existing building and equipment to remain in continuous and normal operations, and maintain construction schedule.
- .4 Protect work in the existing building, such as floors, finishes, trim, etc., as completely as possible to hold the replacing of damaged work to a minimum

PART - 2 PRODUCTS

2.1 MATERIALS

- .1 Temporary braces, tie-rods, clamps, supports and cratings: constructed in accordance with plans prepared by Contractor.

2.2 TEMPORARY PARTITIONS

- .1 Erect Temporary Partitions / Dust-Proof Barriers / Hoarding prior to demolition. Adjust and relocate partitions as required for various operations of Work.
- .2 Follow assembly descriptions and hoarding details on drawings and Section 01 00 00.
- .3 Comply with Infection Control Procedures, Section 01 35 33.

PART - 3 EXECUTION

3.1 PREPARATION

- .1 Notify the Consultant at least seven (7) days prior to commencing of the work.
- .2 The drawings do not purport to show all objects existing on the site. Before commencing the Work, carefully check drawings and verify with the Consultant regarding all objects to be removed and all objects to be preserved.
- .3 Schedule all Work in a careful manner with all necessary consideration for the requirements of Owner, his employees and the public.
- .4 Avoid interference with the use of, and passage to and from, adjacent buildings and facilities.
- .5 Before shutting-down any system verify with the Owner and schedule acceptable shut-down date with minimum 14 days' notice.
- .6 Before starting the operations, arrange with the appropriate trade concerned for the disconnection of all utility services, affecting the work.
- .7 Preserve in operating condition all active utilities to remain.

3.2 **DEMOLITION AND PREPARATORY WORK**

- .1 In order to afford the least interference with the efficient operations of the existing building and to keep the risk of fire to a minimum at all times, ensure that demolished materials are continuously removed from the buildings and grounds as they accumulate, that no hazard condition is left during non-working hours and that full measures are taken by sprinkling and other means to keep dust to a minimum and to confine what dust there is within the working area.
- .2 Maintain proper and safe means of fire exit from all zones of the existing building to the approval of the authorities having jurisdiction.
- .3 Confine operation to those parts of the buildings which are to be altered or renovated. Do not damage existing construction beyond that necessary for performance of new work and repair such damage as required.
- .4 Carefully remove in re-usable condition, transport and store on site where directed by Owner and protect against damage all materials and equipment to be salvaged or relocated for reuse in the new work as directed by the Owner.
- .5 Take possession of all other materials arising from the demolition work and remove from the site daily.
- .6 Demolished materials become Contractor's property, unless such materials are identified on Contract Documents to be reused or turned over to Owner.
- .7 Demolish work into sections of practical size for removal without alteration or damage to the existing building remaining in place.
- .8 Cut openings through existing walls, partitions and floors. Establish exact location of steel reinforcing in existing concrete slabs or walls before holes are made. Be responsible for damage to existing steel reinforcing and be liable for structural failure. Make good surfaces disturbed with materials to match existing.
- .9 Cut to accommodate new structural steel members.
- .10 Sawcut floors, walls, ceiling and other elements before demolition is started, to minimize damage. Make cuts with clean, true, smooth edges. New openings required in existing walls and partitions shall be carefully cut and formed to blend into existing work.
- .11 Where items are to be removed from existing structure or surfaces that are to remain in place, remove those items complete with hangers, brackets and other readily removable supports and fastenings:
 - .1 Remove bolts, but not inserts embedded in concrete or masonry.
 - .2 Remove bolt and rivet fastenings from steel structure.
- .12 Join and make good new work to existing in such a manner that the joint is structurally sound and inconspicuous.
- .13 Cuts, breaks and other temporary openings into existing surfaces, which are required for installation or application of new fixtures, fitments, materials or services shall be, at completion of work, patched and/or made good and finished to blend with surrounding finishes. Openings to allow passage of ducts shall be closed tight to perimeters of duct at all locations where fire dampers are required.

- .14 Where fireproofing membranes or coverings to existing structural steel members and open web steel joists are disturbed, restore the fire protection with materials and methods acceptable by the authorities having jurisdiction.
- .15 In areas where work is required to be performed over acoustic ceilings composed of lay-in panels in a supporting grid, carefully remove panels to avoid damage and replace when work is completed. If existing lay-in panels in a room are damaged and cannot be matched with new panels, then replace all the panels in that room with new units to the Consultant's approval at no additional expense to Owner.
- .16 Materials and other equipment not required for re-use shall not be stored or sold from the site. Maintain the existing building in a weather and watertight condition at all times. Maintain security of existing building.
- .17 Upon completion of demolition, leave interior surfaces clean and dust free.

3.3 **MAKING GOOD**

- .1 Make good materials and finishes which are damaged or disturbed during the process of additions and reconstruction under the Contract. Where existing work is to be made good, match new work exactly with the old work in material, form, construction and finish unless otherwise noted or specified.
- .2 Preparation for new finishes:
 - .1 Remove existing finishes, including painting.
 - .2 Fill cracks and depressions with suitable filler and finish smooth, as recommended by the manufacturer of the new finishes.
 - .3 Grind protrusions level with substrates and finish smooth.
 - .4 Remove all evidences of existing adhesive, grease, oil, soil and other encrustations of foreign material by washing, scraping and grinding if necessary.
 - .5 Clean and prepare substrates to receive new work.

3.4 **CUTTING AND PATCHING**

- .1 Perform cutting, fitting, and patching to complete the Work. Do not cut, drill or sleeve load-bearing members without obtaining written approval for each condition.
- .2 Cut rigid materials using power saw or core drill. Pneumatic or impact tools not allowed.
- .3 Remove and replace defective and non-conforming work.
- .4 Perform work to avoid damage to other work. Prepare proper surfaces to receive patching and finishing.
- .5 Restore work with new products to match existing in accordance with Contract Documents.
- .6 Fit work airtight to pipes, sleeves, ducts, conduit, and other penetrations through surfaces.
- .7 At penetration of fire rated wall, ceiling, or floor construction, completely seal voids with fire rated material, full thickness of construction element.

- .8 Refinish surfaces to match adjacent finishes; for continuous surfaces refinish to nearest intersection; for an assembly, refinish entire unit.

END OF SECTION

PART - 1 GENERAL

1.1 SUMMARY

.1 Section Includes:

.1 Labour, Products, equipment and services necessary to complete the work of this Section.

1.2 REFERENCES

.1 ASTM A53: Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless

.2 ASTM A307: Standard Specifications for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength

.3 ASTM A325M: High-Strength Bolts for Structural Steel Joints

.4 ASTM A653/A653M: Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process

.5 ASTM F436: Hardened Steel Washers (for Use with High Strength Bolts)

.6 CSA-G40.20/G40.21-M: General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel

.7 CAN/CGSB-1.181: Ready Mixed Organic Zinc Rich Coating

.8 CAN/CSA G164-M: Hot Dip Galvanizing of Irregularly Shaped Articles

.9 CAN/CSA-S16.1: Limit States Design of Steel Structures

.10 CSA W47.1: Certification of Companies for Fusion Welding of Steel Structures

.11 CSA W48 Series: Electrodes

.12 CSA W59-M: Welded Steel Construction (Metal Arc Welding)

.13 CSA-W117.2: Safety in Welding, Cutting and Allied Processes

.14 CGSB 85-GP-16M: Painting Galvanized Steel

.15 CISC/CPMA 2.75: Canadian Institute of Steel Construction/Canadian Paint Manufacturers Association "A Quick-Drying Primer for Use on Structural Steel"

.16 CISC: Canadian Institute of Steel Construction, "Code of Standard Practice"

.17 SSPC: Steel Structures Painting Council, "Steel Structures Painting Manual, Vol. 2"

1.3 SUBMITTALS

.1 Shop Drawings

.1 Submit shop drawings for each item showing:

.1 Product and material identification, thicknesses, gauges, finishes.

.2 Dimensions and jointing details.

.3 Cuts and drilled holes.

.4 Anchorage and securement systems.

.5 Interfaces with the work of other Sections.

.2 Where structural or miscellaneous metal shapes and sizes, including shapes and sizes of hangers, bracing and anchors, are indicated on Architectural drawings it is the responsibility of the Metal Fabrications Subcontractor's structural engineer to

review these shapes and sizes and confirm that they are adequate to support the loads anticipated. Consult with the Consultant regarding loading allowed by building structure. Subcontractor's structural engineer shall stamp and sign each shop drawing ensuring that the assemblies are provided in accordance with the engineer's design.

- .3 Clearly show and describe all items; sections, dimensions, erection details, anchors and fastenings, connection and jointing details.
- .4 Clearly indicate any deviation from the specifications or drawings.
- .2 Test Reports: Provide certified test reports showing compliance with specified performance characteristics and physical properties.
- .3 Product Data: Submit manufacturer's printed product literature, specifications and data sheets.
- .4 Samples: Duplicate samples of 300 mm square sheet, 300 mm long members of each finished metal work. Show each combination of mechanical and chemical treatments to be used on alloy. Prepare samples on metal of same alloy and gauge to be used for work. Show typical welds, fasteners, screws, mitres, and anticipated joints for compatible finish.

1.4 **QUALITY ASSURANCE**

- .1 Employ a professional structural engineer registered in the province of Place of the Work to review components and supporting systems for the Work of this Section requiring structural performance, to be responsible for determining sizes, joint spacing to allow thermal movement, and loading of components in accordance with applicable codes and regulations, and to consult with the Project structural Consultant regarding loading allowed by building structure.
- .2 It is imperative that the Metal Fabrications Subcontractor's structural engineer review and coordinate shop drawings with respective Subcontractors specified to ensure proper interface of Work between both Subcontracts.
- .3 Employ welding operators licensed per CSA W47.1 for types of welding required by the Work.

1.5 **PRODUCT DELIVERY, STORAGE AND HANDLING**

- .1 Coordinate deliveries to comply with construction schedule and arrange ahead for strategic off-the-ground, covered storage locations. Do not load areas beyond the designed limits.
- .2 Handle and store metal materials at job site in a manner to prevent damage to other materials, to existing buildings or property.
- .3 Handle components with care, and provide protection for surfaces against marring or other damage. Ship and store members with cardboard or other resilient spacers between surfaces. Use lifting chokers of material which will not damage surface of steel members.
- .4 Use strippable coatings or wrappings to protect exposed surfaces of prefinished metal work which does not receive site finishing. Use materials recommended by finishers or manufacturers of metals, to ensure that method is sufficiently protective, easily removed, and harmless to the finish.
- .5 Prevent the formation of wet storage stain on galvanized articles by complying with the following measures:
 - .1 Stack articles or bundle to allow air between the galvanized surfaces during transport from supplier. Load materials in such a manner that continuous drainage could occur.

- .2 Raise articles from the ground and separate with strip spacers to provide free access of air to most parts of the surface. Incline in a manner which will allow continuous drainage. Do not lay galvanized steel on cinders, clinkers, wet soil or decaying vegetation.
 - .3 Handle galvanized articles in such a manner as to avoid any mechanical damage and to prevent distortion.
 - .6 Tag metal fabrications, including associated anchor bolts, sleeves, and bases, or otherwise mark for ease of identification at project site.
- 1.6 **COORDINATION**
- .1 Supply to other Sections, materials requiring setting and/or building-in in concrete, masonry or other trades. This includes inserts, anchors, frames, sleeves, etc. Verify locations of said materials.
- 1.7 **PROJECT CONDITIONS**
- .1 Field Measurements: Take measurements at the building to assure proper fitting, fabrication, and erection of the work. Check dimensions in the field, whether or not shown, upon which the accurate fitting together and building-in of the metal fabrication work may depend or which affects the proper installation of the work of others.
- PART - 2 PRODUCTS**
- 2.1 **MATERIALS**
- .1 Metals - General: free from defects which impair strength or durability, or which are visible; new, of best quality and free from rust, waves or buckles, and clean, straight throughout entire length, of sharply defined profiles and true in web and flange.
 - .2 Steel - General:
 - .1 Structural Shapes, Plates: New material conforming to CSA-G40.20/G40.21-M, Grade 350W for W and H shapes, and Grade 300W for other shapes, and plates.
 - .2 Hollow Structural Sections: New material conforming to CSA-G40.20/G40.21-M Grade 350W, Class H.
 - .3 Steel Pipe: Conforming to ASTM A53, Type "S", bare, Schedule 40, Grade A steel pipe.
 - .3 Stainless Steel - General
 - .1 Stainless Steel Shapes: to ASTM A276, Type 304 for interior use; to AISI No. 4 (2B) finish.
 - .2 Stainless Steel Plate: to ASTM A167, Type 304 for interior use; to AISI No. 4 (2B) finish.
 - .3 Stainless Steel Sheet: to ASTM A167, Type 304 for interior use; to AISI No. 4 (2B) finish.
 - .4 Stainless Steel Fasteners: Type 304 or Type 316 to suit
 - .4 Galvanizing, steel shapes: CSA G164 Table 1, hot dip galvanized and passivated after fabrication of individual components.
 - .5 Galvanizing, sheet steel: commercial quality to ASTM A653/A653M, Grade A, with zinc coating designation Z275, minimized spangle, in accordance with CSSBI Technical Bulletin No. 6. Galvanized sheets temper rolled and unpassivated zinc coating where required to receive paint or other applied finish.

- .6 Slotted Channel Framing: Cold-formed metal box channels (struts), complying with MFMA-4.
 - .1 Material: Galvanized steel, ASTM A 653/A 653M, commercial steel, Type B, with Z275 (G90) coating; minimum 1.6mm (0.064") nominal thickness.
 - .2 Size of Channels: As indicated.
- .7 Welding Materials: Conforming to CSA W48.1-M and CSA W59-M.
- .8 High Strength Bolts with Bolts, Nuts and Washers (for structural connections): Conforming to ASTM A325M with each type and size of bolt and nut sourced from same manufacture and of same lot. Use hot dipped galvanized where used in exterior connections or in unheated areas inside the building.
 - .1 Bolts: Heavy, hexagon head high strength structural bolts, of standard size, of lengths required for thickness of members joined and for type of connection.
 - .2 Nuts: Heavy hexagon semi-finished nuts.
 - .3 Washers: Flat and smooth hardened washers, quenched and tempered per ASTM F436.
- .9 Common or Ordinary Bolts and Anchor Bolts (for general applications): Unfinished bolts conforming with ASTM A307, Grade A, with hexagon heads and nuts where exposed in the finish work. Use hot dipped galvanized where used in exterior connections or in unheated areas inside the building.
 - .1 Common bolts: of lengths required to suit thickness of material being joined, but not projecting more than 6 mm beyond nut, without the use of washers.
 - .2 Anchor bolts: of lengths noted, but projecting not less than 13 mm beyond nut unless otherwise noted.
- .10 Galvanized Primer: Zinc rich conforming to CAN/CGSB-1.181 for new galvanized metal in compliance with CGSB 85-GP-16M. For galvanized fabrications touch-up to remain unpainted in finished work, use W.R. Meadows of Canada Ltd. "Galvafruid" or Kerry Industries "Z.R.C." or Niagara Paint Inc. "PL052898" zinc rich coating.

2.2 **FABRICATION**

- .1 Fabricate the work true to dimensions, square, plumb and level. Joints and intersecting members shall be accurately fitted with adequate fastenings.
- .2 Finished work shall be free from distortion and defects detrimental to appearance and performance.
- .3 Unless otherwise specified, noted or approved, all connections shall be welded.
- .4 Where not possible connections shall be bolted or secured in an approved manner. Exposed fastenings shall be countersunk, bolts cut off flush with nuts and made as inconspicuous as possible. Exposed fastenings where approved shall be of the same material, colour and finishes as the base metal on which they occur.
- .5 Shop and field connections shall comply with CSA S16.
- .6 Connections to structural steel members shall be welded. No bolting or drilling of holes shall be done unless approved in writing by the Consultant.
- .7 Fabricate items that are to be built into masonry or concrete and deliver to project site for setting; furnish items complete with bolts, anchors, clips, etc., ready to set. Furnish, completely install and connect other items. Erect items to proper lines and levels, plumb and true, and in correct relation to adjoining work. Secure parts in a rigid and substantial manner using concealed connections where practicable.

- .8 Where necessary to secure work to the structure by means of expansion bolts, cinch anchors, and similar connections, lay out the work and install such connections, install the work and bolt up, unless otherwise noted.
- .9 Provide bolts, shims, blocks, nuts, washers, wedging pieces, etc., required for complete installation, unless otherwise noted.
- .10 Drill field holes for bolts or rivets. Do not burn holes.
- .11 Furnish fitting-up bolts, drift pins, other tools and equipment and do necessary reaming of unfair holes found in field connections. New holes or enlargement of unfair holes by use of cutting torch is cause for rejection of the entire member. Replacement shall be made at Contractor's expense.
- .12 Mill joints to a tight, hairline fit; cope or miter corners. Form joints exposed to weather to exclude water.
- .13 Remove burrs from all exposed cut edges.
- .14 Accurately cut, machine and fit joints so that finished work presents a neat appearance.
- .15 Assemble members without twists or open joints.
- .16 Drill properly sized holes for connecting the work of other trades where such can be determined prior to fabrication. Where possible, show such holes on shop drawings. Place holes so not to cause an appreciable reduction in strength of member.
- .17 Metal members shall be isolated where necessary in an approved manner to prevent corrosion due to metal to metal contact, or contact between masonry and concrete and metal.

2.3 **WELDING**

- .1 Execute welding to avoid damage or distortion to the Work. Should there be, in the opinion of Consultant or Inspection and Testing company, doubt as to adequacy of welds, such welds shall be tested for efficiency and any work not meeting specified Standards shall be removed and replaced with new work satisfactory to Consultant. Execute welding in accordance with the following standards:
 - .1 CSA W48: for Electrodes. If rods are used, only coated rods are allowed.
 - .2 CSA W59: for design of connections and workmanship.
 - .3 CAN/CSA-W117.2: for safety.
- .2 Welding shall be done by a fabricator fully approved by the Canadian Welding Bureau under the requirements of CSA W47.1.
- .3 Thoroughly clean welded joints and expose steel for a sufficient space to perform welding operations. Neatly finish welds. Where exposed to view and finish painted, apply weld continuously and grind to a uniformly smooth finish.

2.4 **GALVANIZING**

- .1 Unless otherwise specified galvanize exterior ferrous metals including members exposed to exterior elements when in final location; members embedded on the exterior side of exterior walls; members built into roof construction; members imbedded in concrete; members specified in this Section or noted on Drawings.
- .2 Hot-dip galvanize steel, in accordance with CSA G164 coating weight as prescribed for type of article, or ASTM A525M coating weight of 380 g/sq.m. as applicable. Galvanize after fabrication where possible. Follow recommended precautions to avoid embrittlement of the base metal by overpickling, overheating or during galvanizing.

- .3 Perform hot dip galvanizing after fabrication. Straighten shapes and assemblies true to line and plane after galvanizing. Repair damaged galvanized surfaces with galvanize primer in accordance with manufacturer's printed directions.
- .4 Where the specification requires that material be zinc-coated it shall be zinc-coated after fabrication and in accordance with CGSB1-GP-181M (or) 1-GP-183M.
- .5 Wet Storage Stain: Remove wet storage stain that may have developed in the coating before installation so that premature failure of the coating does not occur. Remove wet storage stain in accordance with galvanizer's recommendations.
- .6 Repair of Galvanized Items: Repair coatings damaged by welding, cutting, or during handling, transport or erection using cold galvanizing compound specified, and as follows:
 - .1 Ensure surface is clean, dry, and free of oil, grease and corrosion.
 - .2 Power clean surface to near white metal condition, extending into undamaged galvanized coating.
 - .3 Apply touch up material to a dry film thickness of 0.203 mm (8 mils) minimum. If touched up work is to remain exposed in the finished work, apply a finish coat of aluminum paint to provide a colour blend with the surrounding galvanizing.
 - .4 Coating shall be continuous, adherent, as smooth and evenly distributed.

2.5 **FINISHES**

- .1 Where stainless steel is specified in subsequent articles of this section it shall have an AISI No. 4 finish, unless another finish is specified in the particular article.

PART - 3 EXECUTION

3.1 **EXAMINATION**

- .1 Examine substrate surfaces to receive the work of this Section and ensure that work done as part of the work of other Sections is complete and that there are no conditions which will adversely affect the performance of this work.
- .2 Verify the accuracy and alignment of structural framing to which work of this Section is connected.
- .3 Do not proceed with work until unsatisfactory conditions have been corrected. Commencement of work implies acceptance of surfaces and conditions.

3.2 **ERECTION**

- .1 Fit joints and intersecting members accurately. Make work in true planes with adequate fastenings. Build and erect work plumb, true, square, straight, level and accurate to sizes detailed, free from distortion or defects detrimental to appearance or performance.
- .2 Fit door frames and jambs with temporary steel spreaders to prevent springing frames and jambs out of shape.
- .3 Weld as specified herein.
- .4 Take adequate care to prevent damage to any material such as weld burns, etc.
- .5 Include all cutting and patching of masonry walls where necessary. Obtain Contractor's approval of cut-outs in advance.
- .6 Insulate where necessary to prevent electrolysis due to dissimilar metal to metal contact, or metal to masonry and concrete. Use bituminous paint, butyl tape, building paper or other approved means.

- .7 Install materials in a good and workmanlike manner, cleaning and grinding all welding laitance and touching up primer where necessary.

3.3 **CONNECTIONS**

- .1 Weld or high strength bolt main member connections. Use CISC double angle header connections wherever possible. High strength bolted connections shall be bearing type using 19mm dia. bolts conforming to ASTM A325M. Secondary members may be bolted with machine bolts.
- .2 Perform high tensile bolted connections in accordance with CSA-S16.1. Accurately space holes of size 1.6 mm larger than the nominal diameter of the bolt. Install bearing type high tensile bolted connections unless shown otherwise on Drawings. Provide compressor or electrical equipment capable of supplying and maintaining required pressure at the wrench. Make connections without the use of erection bolts, some high tensile bolts will serve that purpose. Prevent nuts on bolts, except high tensile bolts, from becoming loose by burring bolt thread, by welding or by lock washers or lock nuts.
- .3 Execute welding as specified under shop welding in Part 2 and as follows:
 - .1 Provide continuous welds on exterior work to provide proper weathering.
 - .2 Take necessary safety precautions in accordance with CSA Standards when welding is carried out in cold weather.

3.4 **FIELD TOUCH-UP**

- .1 Paint bolt heads, washers, nuts, field welds and previously un-primed items. Touch up shop primer damaged during transit and installation with material to match shop primer or galvanize coating.
- .2 Clean off dirt on installed miscellaneous metal surfaces.

3.5 **SCHEDULE OF METAL FABRICATION ITEMS**

- .1 General
 - .1 Provide metal fabrication items specified herein and items not indicated to be supplied under other Sections.
 - .2 Refer to drawings for details of metal fabrication work and related items not specifically listed in this Section.
 - .3 Where work is required to be built into work of other Sections supply such members to respective Sections.
 - .4 Provide anchor bolts and expansion bolts or other means of anchorage required for building into floors, walls and ceilings, where it is necessary to secure metal and wood to concrete, masonry or steel work. Supply anchor bolts, nuts and similar hardware to the respective Sections for fastening.
- .2 Steel Sections
 - .1 Supply and install steel sections which are:
 - .1 Not shown on structural drawings.
 - .2 Shown in outline, but not identified on structural drawings.
 - .3 Not noted on drawings to be supplied by another section.
 - .4 Not specified to be supplied under another section.

- .2 Cutting of these steel sections in the field shall be done under this section and as directed. The cost of field cutting shall be borne by the trades requiring such cutting.
 - .3 Where sections are required to be built into masonry or concrete, supply such members to respective trades.
 - .4 This work shall include, without being limited to -
 - .1 Steel struts to support suspended lead shielding
 - .2 Steel posts to counters.
 - .3 **Stainless Steel Items**
 - .1 Supply and install stainless steel items indicated on drawings, complete with fastenings and other incidentals required and as detailed. Refer to 'Materials' articles for alloy.
 - .2 Stainless steel finish: as specified under 'Finishes' article of this section, unless specified otherwise below.
 - .4 **Concealed support elements and framing**
 - .1 Construct concealed support elements and framing from rolled steel sections assembled by welding.
 - .2 Design work to withstand, within acceptable deflection limitations, their own weight, the weight of the items to be supported, loads imposed by the motion of supported items, where applicable, and all live loads, static and dynamic which might be applied to the supported items in the course of their normal function. Design supports with a safety factor of 3. Design supports further as required to accommodate structural deflection.
 - .3 Provide accessories, inserts and fixings necessary for attachment of supports to building structure. Drill supports to receive attachment of supported items. Arrange supports to avoid conflicts with pipes, ducts, pre-cast concrete connections, thermal and air/vapour barrier construction, framing provided under other Sections, and such that supports and their fixings are fully concealed from view within the finished work.
 - .4 Paint all supports unless galvanizing is specified.
 - .5 **Steel Frames for Miscellaneous Openings**
 - .1 Connections: Connect built-up members of frames by means of plug welding. Miter or cope and join members with continuous welding beads.
- 3.6 **RECONSTRUCTION, ALTERATIONS AND MAKING GOOD**
- .1 Do all re-construction, alterations, fitting, patching and making good of the existing building and to join new work to existing.

END OF SECTION

PART - 1 GENERAL

1.1 SUMMARY

.1 Section Includes:

.1 Labour, Products, equipment and services necessary to complete the work of this Section.

1.2 QUALITY ASSURANCE

.1 Lumber identification: By grade stamp of an agency certified by Canadian Lumber Standards Accreditation Board.

.2 Fire-rated treated lumber: to ULC S102

.3 Plywood identification: By grade mark in accordance with applicable CSA standards.

.4 Align and plumb faces of furring and blocking to tolerance of 1:600.

.5 Regulatory requirements: Provide finished wall assemblies flame spread rating of not more than 150 and finished ceiling assemblies flame spread of not more than 25.

1.3 SUBMITTALS

.1 Test reports: Duplicate copies of flame spread classification test reports by independent testing agency to requirements of ULC S102.

PART - 2 PRODUCTS

2.1 MATERIAL

.1 Lumber: Acceptable to authorities having jurisdiction and unless specified otherwise, softwood, S4S, moisture content 19% or less in accordance with CSA-O141 and NLGA Standard Grading Rules for Canadian Lumber.

.2 Furring, blocking, nailing strips, grounds, and rough bucks: S2S, Standard or better grade.

.3 Douglas fir plywood: CSA O121, standard construction.

.4 Canadian softwood plywood: CSA O151, standard construction.

.5 Poplar plywood: CSA 0153, standard construction.

.6 Interior mat-formed wood particleboard: ANSI/NPA-A208.1

.7 Hardboard: CAN/CGSB-11.3.

.8 Nails, spikes and staples: CSA B111.

.9 Bolts: 12.5 mm diameter unless indicated otherwise, complete with nuts and washers.

.10 Galvanizing: CSA G164, use galvanized fasteners for interior highly humid areas, pressure-preservative and fire-retardant treated work.

.11 Fire retardant treated wood: To ULC S102, flame spread, fuel contributed and smoke developed ratings of 25 or less, pressure treated.

.1 Lumber and plywood: FirePro FRTW by Osmose, or Dricon FRT by Arch Wood Products Inc., or other acceptable equivalents.

.2 Particleboard: Duraf Flake FR by Weyerhaeuser, or other acceptable equivalents.

PART - 3 EXECUTION

3.1 INSTALLATION - GENERAL

- .1 Install members true to line, levels and elevations.
- .2 Construct continuous members from pieces of longest practical length.
- .3 Install spanning members with "crown-edge" up.
- .4 Install materials so that grade-marks and other defacing marks are not visible or are removed by sanding.

3.2 FURRING AND BLOCKING

- .1 Install furring and blocking as required to space-out and support casework, cabinets, wall and ceiling finishes, facings, washroom accessories, equipment and other work as required.

3.3 NAILING STRIPS, GROUNDS AND ROUGH BUCKS

- .1 Install rough bucks, nailers and linings to rough openings as required to provide backing for frames and other work.

3.4 FASTENERS

- .1 Frame, anchor, fasten, tie and brace members to provide necessary strength and rigidity.
- .2 Countersink bolts where necessary to provide clearance for other work.
- .3 Use nailing disks for soft sheathing as recommended by sheathing manufacturer.

3.5 ELECTRICAL, DATA AND TELEPHONE EQUIPMENT BACKBOARD

- .1 Provide fire retardant treated backboards for mounting electrical equipment as indicated. Use 19 mm thick plywood on 38 mm x 89 mm furring around perimeter and at maximum 300 mm intermediate spacing.

END OF SECTION

PART - 1 GENERAL

1.1 SUMMARY

- .1 Section Includes: Labour, Products, equipment and services necessary to complete the work of this Section.

1.2 REFERENCES

- .1 Abbreviations and Acronyms:
 - .1 AWMAC: Architectural Woodwork Manufacturers Association of Canada; www.awmac.com.
 - .2 GIS: Guarantee and Inspection Service; an inspection program to ensure quality in woodwork as administered by AWMAC.
 - .3 NAAWS: North American Architectural Woodwork Standards – 3.1, 2017, including all errata and supplements, a jointly sponsored by Architectural Woodwork Manufacturers Association of Canada (AWMAC) and the Woodwork Institute (WI).

1.3 DEFINITIONS

- .1 Exposed Surfaces: Surfaces exposed to view. Surfaces visible when doors and drawers are closed, backs of hinged doors and edges of hinged doors exposed when opened.
- .2 Semi-Exposed Surfaces: Surfaces that become visible when drawers and doors are opened.
- .3 Concealed Surfaces: Surfaces not visible after installation.

1.4 SUBMITTALS

- .1 Woodwork quality standard compliance certificates: submit AWMAC GIS program certificates as follows:
 - .1 Manufacturer/Installer Letter of Accreditation: Submit a copy of the AWMAC letter of accreditation for the Manufacturer/Installer that they are currently accredited to label as “Premium Grade” for compliance with all sections of the Quality Standards, including finishing.
 - .2 Project Certifications: submit a copy of the letter of acceptance from AWMAC to the Manufacturer/installer for the project listing the project as eligible for inspection and labelling under the AWMAC GIS program.
- .2 Product Data, Samples and Shop Drawings will not be reviewed until AWI GIS program letter of accreditation has been submitted.
- .3 Product Data: Manufacturer’s specifications, data, and installation instructions for each manufactured product specified, including fire-retardant-treated materials, hardware, accessories and finishing materials.
 - .1 Include data for fire-retardant treatment from chemical-treatment manufacturer and certification by treating plant that treated materials comply with requirements.
- .4 Shop Drawings: Submit shop drawings for architectural woodwork which meet the architectural intent and are indicative of the architectural woodwork shown on Drawings.
 - .1 Detail architectural woodwork construction at large scale not less than one-quarter (1/4) full size;
 - .2 Show location of each item, dimensioned plans and elevations joints, sections and connections to adjacent work;

- .3 Show construction details of all woodwork, general arrangements, locations of all service outlets; typical and special installation conditions; material being supplied and all connections, attachments, hardware, anchorage and location of exposed fastenings, and sizes of veneer and plastic laminate sheets;
 - .4 Show locations and details of framing, blocking and furring and co-ordination for interface work at substrates: details and layout of cutouts for finish hardware, cabinet hardware, audio/visual, mechanical and electrical services;
 - .5 On casework and countertop elevations show location of backing required for attachment within walls:
 - .6 For panelling veneered in fabrication shop, show veneer leaves with dimensions, grain direction, exposed face, and identification numbers, indicating flitches and sequence within the flitch for each leaf.
 - .7 For panelling produced from pre-manufactured sets, show finished panel sizes, set numbers, sequence numbers within sets, and method of cutting panels to produce indicated sizes;
- .5 Samples: Submit three (3) samples in each specified finish and material.
- .1 Wood veneers: 300 mm x 300 mm veneer leaves representative of and selected from flitches to be used.
 - .2 Solid lumber members, standing and running trim: 460 mm long x full width x full depth sections of each type of frames and trims for each required profile and finish.
 - .3 Submit 300 mm x 300 mm samples of laminated plastic for colour selection.
 - .4 Submit samples of laminated plastic joints, edging, cutouts and postformed profiles.
 - .5 Panelling: 460 mm square x full depth corner samples with typical perforations for each required profile and finish.
 - .6 Flush doors: 460 mm square x full depth corner samples.
 - .7 Factory finish samples: Submit sample sets showing full range of grain, colour, texture and finish expected in completed work. Sample sets shall consist of minimum three samples in each set to indicate high, middle and low range of colour and finish for each type of species.
 - .8 Samples will not be reviewed until AWMAC GIS program letter of accreditation has been submitted.
- .6 Control Samples: Provide 460 mm x 460 mm control sample of factory finish on plywood backing board for approval. Adjust finish and resubmit control samples to approval of Consultant. After approval is obtained, carefully cut control sample into four equally sized panels and submit one panel each to Owner, Consultant, Site and this Section. Finish of work of this Section shall match approved control sample.
- .7 Test reports: Duplicate copies of flame spread classification test reports by independent testing agency to requirements of CAN/ULC S102.
- .8 Maintenance Data and Operating Instructions: Supply 3 copies of detailed instructions for maintaining, preserving and keeping work of this Section clean and give adequate warning of maintenance practices or materials detrimental to the factory finished work.

1.5 **QUALITY ASSURANCE**

- .1 Qualifications: Work of this Section shall be done by manufacturer and tradesmen with experience in successful manufacture and installation of this type of work and of quality as indicated on Drawings and as specified. Submit proof of such experience with list of installations in Ontario upon Consultant's request.
- .2 Fabricator Installer Qualifications:
 - .1 Member in Good Standing of AWMAC.
 - .2 Certified participant in AWMAC GIS program.
 - .3 Minimum 10 years of successful experience in the custom fabrication and installation comparable to this project, whose qualifications indicate ability to comply with requirements of this Section.
- .3 Single Source Manufacturing and Installation responsibility: Engage a qualified manufacturer to assume undivided responsibility for architectural woodwork items specified in this Section, including fabrication, finishing, and installation. The manufacturer shall maintain an organized quality control program and retain facilities with sufficient capacity and quality to produce the required architectural woodwork without causing delay to the project.
- .4 Source Limitations of Veneers:
 - .1 All wood veneer for the interior architectural woodwork, the wall and ceiling panelling, including pre-finished wall panels, Glazed Feature Wall, and the flush wood doors shall be provided by the architectural woodwork subcontractor and be from the same wood veneer source, and from same production run, in sufficient quantities to ensure completion of the entire project.
- .5 Quality of work and materials:
 - .1 Comply with the requirements for Premium Grade in accordance with the NAAWS standards.
 - .2 Provide AWMAC GIS program labels or certificates indicating that woodwork, including installation, complies with requirements of grades specified.
 - .3 Register the project with the AWMAC GIS program.
- .6 Site Quality Control: Provide full-time, factory trained architectural woodwork supervisor to be present at Site at all times during execution of work specified in this Section.
- .7 Veneer Matching: Trial fit three (3) full size panels in the shop for verification of veneer matching between panels for Consultant's approval. Approved panels establish the standard of quality for the Work.
- .8 Finish Matching: Finish for solid wood members shall match wood veneer finish.
- .9 Factory Finish: Apply finish in accordance with the NAAWS standards and to match Control sample at Consultant's office.
- .10 Regulatory requirements: Provide finished wall assemblies flame spread rating of not more than 150 and finished ceiling assemblies flame spread of not more than 25, listed and labelled by an organization accredited by Standards Council of Canada in conformance with CAN/ULC-S104 and CAN/ULC-S105.

1.6 **GUARANTEE AND INSPECTION SERVICE**

- .1 AWMAC Guarantee and Inspection Service program is an integral component of the scope of work.

- .2 Architectural woodwork shall be manufactured and installed to NAAWS standards (Premium Grades) and shall be subject to an inspection at the plant and/or site, by an appointed inspector approved by the relevant local AWMAC Chapter. Inspection costs shall be included in the Contract Price for this project.
 - .1 Submit copies of inspection reports to the Consultant within 3 working days upon completion of inspection.
- .3 Submit shop drawings to the AWMAC Chapter office for review before work commences. Work that does not meet Contract Documents and the NAAWS standards, shall be replaced, reworked and/or refinished by the Subcontractor, to the approval of AWMAC, at no additional cost to the Owner and to the satisfaction of the Consultant and the Inspector.
- .4 Where it is deemed necessary by the Consultant, a sample cabinet, consisting of a minimum of 1 drawer and 1 door, or other architectural woodwork items, showing precisely the materials, hardware and the type of construction the manufacturer intends to use, shall be submitted for inspection.
- .5 Provide two (2) year AWMAC Guarantee Certificate. The AWMAC Guarantee shall cover replacing, reworking and/or refinishing deficient architectural woodwork due to faulty workmanship or defective materials supplied and installed by the woodwork Subcontractor, which may appear during two (2) year period following the Substantial Performance of the Project.
 - .1 Defect in materials and workmanship include but not necessary limited to warpage, delamination, staining and discolouration.

1.7 **PRE-INSTALLATION MEETING**

- .1 Before framing completed hold a meeting with the Contractor, woodwork manufacturer, installer, and framing sub-contractor.
 - .1 Review locations of backing required for woodwork installation as shown on shop drawings.

1.8 **DELIVERY, STORAGE, AND HANDLING**

- .1 Handle all materials and components carefully to prevent damage.
- .2 Deliver materials only when project is ready for installation and clean storage area is provided.
- .3 Do not deliver components until painting and similar operations that could damage woodwork have been completed in installation areas.
- .4 Store work in a temperature and humidity controlled area. If millwork items must be stored in other than installation areas, store only in areas where environmental conditions comply with requirements specified in "Field Conditions" Article below.

1.9 **FIELD CONDITIONS**

- .1 Environmental Limitations: Do not deliver or install millwork items until wet work is complete, and HVAC system is operating and maintaining temperature between 16 and 32 deg. C and relative humidity between 25 and 55 percent during the remainder of the construction period.
- .2 Field Measurements: Where millwork items are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication, and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work
- .3 Locate concealed framing, blocking, and reinforcements that support millwork items by field measurements before being enclosed, and indicate measurements on Shop Drawings.

- .4 Established Dimensions: Where millwork items are indicated to fit to other construction, establish dimensions for areas where items are to fit. Coordinate construction to ensure that actual dimensions correspond to established dimensions.

1.10 **CO-ORDINATION**

- .1 Verify all dimensions on job site prior to shop fabrication and work on site. Alert Consultant immediately where discrepancies occur.
- .2 Co-ordinate fabrication, delivery, and installation with other Sections whose work affect work of this Section, including finish hardware, audio/visual, mechanical and electrical services.
- .3 It shall be the responsibility of this Section to verify the dimensions and installation details for Owner's supplied equipment and furnishings requiring cut-outs, adaptations and interfacing with woodwork items.

PART - 2 PRODUCTS

2.1 **GENERAL**

- .1 All composite wood and agrifibre products (including core materials) used in the building shall not contain added formaldehyde.
- .2 Adhesives used to fabricate laminated assemblies used in the building that contain composite wood and agrifibre products shall not contain added formaldehyde.
- .3 Adhesives used must meet VOC requirements.

2.2 **MATERIALS**

- .1 Wood veneer (WDV):
 - .1 Refer to Finish Schedule for complete list of wood veneer types, indicating wood species, designations, grain, and finishes.
 - .2 NAAWS Grade AA, to match approved samples, plain sliced, flitches of equal width, uniform, carefully selected for architectural quality with respect to cutting lengths, uniformity of colour, figure grain, character, clean, sound without open defects, patches, plastic repair, minimum 0.80 mm thick after sanding.
 - .3 Wood veneer shall be Book matched, unless noted otherwise, centred and balanced, carefully selected with good even colour, sound with no open defect.
 - .4 Colour and figure of veneer shall be selected by Consultant. Hand select veneer from architectural grade flitches of the specified specie as required to provide uniform grain pattern and colour throughout. Veneer representative of low end architectural grade quality will be unacceptable and will be rejected. Semi-exposed veneers shall be selected to match general grain pattern and colour of exposed surface veneer.
 - .5 Finishes to match Consultant's sample.
- .2 Back Veneer: same thickness and having similar characteristics as face veneer.
- .3 Crossbanding: Hardwood.

2.3 **SOLID WOOD**

- .1 Solid wood, exposed and semi-exposed (WD): Refer to Section 09 06 00, Finish Schedule for wood types, indicating wood species, designations, and finishes.
 - .1 Carefully selected and matched for grain pattern and uniform colour.

- .2 Premium Grade of uniform grain and colour, free from knots, blemishes and excess mineral marks. Wood having cross grain will not be permitted. The lumber shall be air-dried for at least one year, then kiln-dried in vapour kilns to a moisture content of 3-5%. The materials shall then be tempered to a moisture content of not more than 6%, which shall be maintained throughout production.
- .3 Finish for solid wood members shall match wood veneer finish.
- .2 Blocking, Framing and Furring: Sound, thoroughly-seasoned, well manufactured and free from warp that cannot be corrected in process of bridging or nailing. Use same species for members in any one assembly.
- .3 To prevent telegraphing, inset solid wood edging shall have similar moisture content as panel core, be glued securely and calibrated with panel core thickness prior to being laminated with a veneer on both faces.
- .4 Wood Block Core for Flush Doors: Kiln dried soft wood blocks, relative density not less than 0.30 at 12% moisture content; of random lengths placed vertically or horizontally not exceeding 50 mm wide, staggered joints, laminated by heat and pressure.

2.4

COMPONENTS

- .1 Lumber: In accordance with the NAAWS Premium Grade.
- .2 Wood members: Clean, seasoned, straight, square and true on all four sides. Comply with minimum size and tolerances of CSA O141. Grade-mark all wood materials. Kiln dry wood materials for interior use to a moisture content of 4% to 8%, and 7% to 10% for exterior use.
- .3 Medium Density Fibreboard Core (MDF): to ANSI A208.2, Grade 155, manufactured from 100% recycled materials, without the use of added formaldehyde resins, minimum density of 770 kg/m³ (48 lb./cu.ft.).
 - .1 Where indicated on drawings or required by authorities having jurisdiction, provide industrial grade MDF certified to meet Class 1 surface burning characteristics of ASTM E84, CAN/ULC S-102 and UL 723 (maximum flame spread ≤25, maximum smoke development ≤200).
- .4 Veneer Core (Plywood): Provide exterior grade, veneer core (plywood) conforming to NAAWS.
 - .1 Softwood plywood (concealed locations): Canadian Softwood Plywood (CSP) to CSA O151, standard construction, grade as required, of thickness as indicated, as recommended by NAAWS.
 - .2 Hardwood plywood: CSA O115, Type II (Type I for high humidity conditions), with a non telegraphing grain manufactured with exterior glue meeting requirements of NAAWS. Exposed faces of Good Sequence Matched, selected veneers, and unexposed faces of Sound Grade, So, veneers.
 - .3 Douglas Fir plywood: CSA O121; Western Softwood Plywood: CSA O151. Exposed two sides shall be Grade S2S, and exposed one side shall be Grade S1S. Consider fitment doors exposed on both sides.
 - .4 Birch-faced hardwood plywood: CSA O115, Good Sequence Matched, Select White or Select Red.
- .5 Particleboard Core: 100% pre-consumer recycled wood fiber particleboard, no added formaldehyde, to ANSI/NPA A208.1, Grade R, minimum density of 720 kg/m³ (45 lb./cu.ft.), sanded both sides with thickness as recommended by NAAWS for specified applications.

- .6 Plastic laminate (PLAM): ANSI/NEMA LD-3, High Pressure, Paper Base, Decorative Laminates. Unless otherwise specified, use the following:
 - .1 Horizontal postform work: Grade HGP, minimum 1 mm (0.040") thick.
 - .2 Horizontal flat work: Grade HGS, minimum 1.2 mm (0.048") thick.
 - .3 Vertical postform work: Grade VGP, minimum 0.7 mm (0.028") thick.
 - .4 Vertical flat work: Grade VGS minimum 0.7 mm (0.028") thick.
 - .5 Casework Liner (for semi-exposed surfaces): type CLS.
 - .6 Backing sheet: BK, same thickness as facing sheets, sanded one face and manufactured by the same manufacturer as the facing sheet.
 - .7 Test for acceptable VOC emissions in accordance with ASTM D2369 and ASTM D2832.
 - .8 Plastic Laminate Types: Refer to Section 00 01 30, List of Materials for complete list of plastic laminate types, indicating designations, suppliers, textures and finishes.
- .7 Fire retardant treated wood: Pressure treated, flame spread classification of not more than 25 as tested to CAN/ULC S102.
 - .1 Concealed lumber and plywood framing, blocking, furring, and strapping: FirePro FRTW by Osmose, or Dricon FRT or other acceptable equivalents.
 - .2 Particleboard: Duraflake FR by Flakeboard or other acceptable equivalents.
 - .3 Medium density fiberboard: Premier FR (Fire Rated) MDF by Flakeboard or other acceptable equivalents.
- .8 Douglas Fir plywood: CSA O121; Western Softwood Plywood: CSA O151. Exposed two sides shall be Grade S2S, and exposed one side shall be Grade S1S. Consider fitment doors exposed on both sides.
- .9 Birch-faced hardwood plywood: CSA O115, Good Sequence Matched, Select White or Select Red.
- .10 Concealed Framing: NLGA, S-Dry No. 1 grade Ontario White Pine or Douglas Fir, comply with BCLMA Construction grade.
- .11 Exposed Framing, Solid Members and Trim: of species indicated, quarter sawn, architectural grade, matched for compatibility of grain and colour.
- .12 Sealer: Water-repellant, clear, colourless, penetrating wood preservative, LePage's Wood Preservative by LePage's Ltd., Super Solignum by Solignum Inc., Pentox by Osmose-Pentox Inc., or other acceptable equivalents.
- .13 Hardboard: CAN/CGSB 11.3, impregnated, pressed wood with a tempering compound and polymerized by baking.
- .14 Glue for wood assemblies: CSA O112 Series, polyvinyl adhesive.
- .15 Melamine board: Melamine resin impregnated paper, thermally fused to particle board or MDF core, furniture finish in solid colour to be selected by Consultant from manufacturer's standard range.
- .16 Fasteners: Size and type to suit application.
- .17 Bolts, Nuts, Washers, Lags, Pins, and Screws: Of size and type to suit application; nickel plated finish in concealed locations and stainless steel finish in exposed locations.

2.5 SOLID SURFACING

- .1 Homogeneous filled acrylic sheets; not coated, laminated, or of composite construction; superficial damage to a depth of 0.25 mm shall be repairable by sanding and polishing.
 - .1 Refer to Section 00 01 30 List of Materials for product, manufacturer, thickness, pattern, texture, and colour.
- .2 Joint adhesive, solid surfacing: Manufacturer's standard two-part adhesive kit to create inconspicuous, non-porous joints, with a chemical bond.
- .3 Panel adhesive, solid surfacing: Manufacturer's standard neoprene-based panel adhesive.
- .4 Sealant, solid surfacing: Manufacturer's standard mildew-resistant silicone sealant colour formulated to match sheets.

2.6 MILLWORK HARDWARE

- .1 Concealed Hinges: Nickel plated, soft-close European Hinge with 110° pivot point; CLIP top Blumotion by Blum or other acceptable equivalents.
- .2 Pulls: types as indicated on the drawings.
- .3 Shelf Supports: Nickel plated steel, for 5 mm drill holes, 80 kg load bearing capacity; Item #282.04.711 by Hafele America Co., or other acceptable equivalents.
- .4 Drawer Slides: Electro-plated zinc screw mounted, heavy duty, full extension type with captive profile to eliminate side movement, soft close, positive in and out stops and, load capacity to suit drawer size with minimum static load rating of 27 kg for drawers 150 mm and less, and 40 kg for drawers over 150 mm in depth, lengths to suit application, side-mounted type.
- .5 Silencer: Round vinyl, self-adhered, provide 2 per door.
- .6 Magnetic catch: Cast aluminum; 918 by Knappe & Vogt or other acceptable equivalents.

2.7 FABRICATION - GENERAL

- .1 As far as practical, shop assemble work for delivery to site ready for installation and in size easily handled and to ensure passage through building openings. Leave ample allowance for fitting and scribing on the job.
- .2 Fabricate work square and to the required lines. Recess and conceal fasteners and anchor heads. Fill with matching wood plugs.
- .3 Make each unit rigid and self-supporting, suitable for individual removal.
- .4 Provide wood members free from bruises, blemishes, mineral marks, knots, shake and other defects and select for colour, grain and texture. Machine and hand sand surfaces exposed in the finished work to an even, smooth surface free from defects detrimental to appearance.
- .5 Finish exposed edges and curves smooth. Keep contrast in colour and grain in adjoining materials to a minimum.
- .6 Provide running members in the maximum lengths obtainable. Provide thickness of members in maximum dressed size of standard lumber. Where thickness or width indicated is not available in hardwoods, use glue laminations to obtain sizes required.
- .7 Spline or key solid boards 150 mm and wider and glue under pressure. Unless otherwise specified or indicated, book-match veneered faces, using selected and approved veneers. Provide unexposed backs of veneers having the same physical characteristics as the face veneer.

- .8 Design and fabricate work to allow for expansion and contraction of the materials. Unless otherwise specified, work shall be glued, and blind screwed or nailed. Properly frame material with tight, hairline joints and hold rigidly in place. Use glue blocks where necessary.
- .9 Conceal joints and connections wherever possible. Locate prominent joints where directed. Glue and pin mortise and tenon joints. Intermediate joints between supports will not be permitted. Set and fill surface nails. Prevent opening-up of glue lines in the finished work.
- .10 Comply with glue manufacturer's recommendations for lumber moisture content, glue shelf life, pot life, working life, mixing, spreading, assembly time, time under pressure and ambient temperature.
- .11 Provide exposed end grain of solid members and edges of exposed plywood with matching solid edging at least 6 mm thick.
- .12 Seal finish carpentry wood items before they leave the fabricating shop. For surfaces to receive a natural or stain finish ensure that the sealer is compatible with the final finish. Cooperate with Section 09 91 00 Painting and obtain written approval of proposed sealer.
- .13 Fit shelf, door, drawer, gable and cabinet edges and other edges with 12 mm hardwood edging prior to application of laminated plastic edging or subsequent finishing.
- .14 Set nails and screws, apply wood filler to indentations, sand smooth and prepare to receive finish. Clean, ensure surfaces are free of dust.

2.8

FABRICATION - CABINETS

- .1 Framing: Solid stock framing assembled with machined dovetailed, mortised tennoned or blind dado joints adequately glued and secured with screws.
- .2 Countertops: 19 mm nominal thickness plywood, or particleboard. Provide cut-outs for services as required.
- .3 Gables: 19 mm particle board or plywood. Attach gables to framing with tongue and groove. Reinforce connections with supplementary metal angles. Route gables to receive shelf standards and fixed shelvings. Provide plastic laminate finished wood cleats for closet shelving and coat rod installation.
- .4 Backs: 6 mm thick plywood. Conceal joints behind framing, rout backs into end gables.
- .5 Bottoms: 19 mm plywood attached to front rails with tongue and groove.
- .6 Doors: 19 mm thick particle board.
- .7 Drawers: Birch or Maple solid stock, 19 mm thick fronts, 12 mm backs, 6 mm drawer dividers and 15 mm sides. Fasten sides to fronts with dovetail joints, and grooved joints for backs. Bottoms of 6 mm thick Birch plywood grooved into front and sides and glued.
- .8 Shelving: 19 mm plywood. Apply plastic laminate to visible edges, except that adjustable shelves shall be edged on front and back.
- .9 Base: Solid stock of height equal to base in room.

2.9

FABRICATION - PLASTIC LAMINATE FACED WORK

- .1 Factory apply plastic laminate to interiors of all cabinetwork except drawers, but including drawer fronts and shelves, including underside of cabinets.
- .2 Edge band doors, drawers, gables and all visible edges of plywood and particle board components with plastic laminate to match faces, strips same width as plywood or particle board.

- .3 Apply backing sheet to laminated flatwork. Apply uniform coating of sealer on exposed edges. Provide backing sheet of sufficient thickness to compensate stresses caused by the facing sheet.
- .4 Self-edge straight-line-edging with 1.2 mm standard material and radius corners with post-forming material; apply with same adhesive as facing sheet. Chamfer edges uniformly at approximately 20 degrees using machine router.
- .5 Locate joints at 2400 mm to 3000 mm o.c. At L-shaped corners mitre plastic laminate, to the outside corner. Accurately fit members together to provide tight and flush butt joints, in true planes. Provide 6 mm blind spline and approved type draw bolts; one draw bolt for widths up to 150 mm at maximum 450 mm centres for widths exceeding 150 mm. Colour-match adjoining units.
- .6 Provide cut-outs as required for inserts, fixtures and fittings. Use radiused corners and chamfer edges around cut-outs to avoid chipping laminate.
- .7 Post-form laminate work to details indicated. Provide same core and laminate profiles to provide continuous support and bond for the entire surface.
- .8 Assemble work, true and square. Arrange adjacent parts of continuous laminate work to match in colour and pattern.

2.10 **FABRICATION – WOOD VENEER WORK**

- .1 Check job dimensions and conditions. Do not proceed until unsatisfactory conditions are corrected.
- .2 As far as practical, assemble work at the shop and deliver to the job ready for installation. Leave ample allowance for fitting and scribing on the job.
- .3 Fabricate work square and to required lines. Recess and conceal fasteners and anchor heads.
- .4 Parallel clip veneer pieces in equal widths and join by tapeless splicer and glue.
- .5 Provide unexposed backs of panels with backing veneer having the same physical characteristics as the face veneer.
- .6 Properly join panels with tight, hairline joints and hold rigidly in place with assembly bolts. Use glue blocks where necessary. Conceal joints and connections. Locate prominent joints where directed. Intermediate joints between supports will not be permitted. Prevent opening-up of glue lines in the finished work.
- .7 Comply with glue manufacturer's recommendations for moisture content, glue shelf life, pot life, working life, mixing, spreading, assembly time, time under pressure and ambient temperature.

2.11 **FABRICATION – SOLID SURFACING**

- .1 Shop fabricate work to greatest extent practical and to sizes and shapes indicated, in accordance with reviewed shop drawings and solid polymer manufacturer requirements.
- .2 Form joints between work using manufacturer's joint adhesive. Make joints inconspicuous in appearance and without voids. Attach 50 mm wide reinforcing strip of solid polymer material under each joint or as recommended by the manufacturer.
- .3 Cut holes and cutouts for items penetrating the work to templates. Reinforce holes and cutouts to manufacturer's requirements.
- .4 Provide edge details indicated. Rout and finish component edges to a smooth, uniform finish. Rout all cutouts, then sand all edges smooth. Repair or reject defective or inaccurate work.

2.12 **FABRICATION - METAL WORK**

- .1 Fabricate the work true to dimensions and square. Accurately fit members with hairline joints. Maintain continuous, unbroken profiles during joining and assembly process.
- .2 Construct finish work free from distortion and defects detrimental to appearance and performance. Work shall have smooth finished surfaces.
- .3 Fabricate metal work complete with all components required for anchoring in a safe and secure manner.
- .4 Countersink exposed fastenings, where such are shown on final reviewed shop drawings and make as inconspicuous as possible.

PART - 3 EXECUTION

3.1 **INSTALLATION**

- .1 Set and secure materials and components in place, rigid, straight, level, plumb and square with hairline joints. Scribe neatly to adjoining surfaces; install blocking and fillers required. Secure units using concealed fasteners.
- .2 Provide matching scribing closer strips between units and gypsum wallboard or similar surfaces.
- .3 Provide heavy duty fixture attachments for wall mounted cabinet work.
- .4 Apply sealant between units and adjacent wall and floor surface, around sills, pipes and escutcheon plates and similar areas to seal and finish installation, in accordance with Section 07 92 00.
- .5 Make allowances around perimeter where fixed objects pass through or project into carpentry work to permit normal movement without restriction.
- .6 Touch up cut edges and surfaces with sealer.
- .7 Apply water resistant building paper or bituminous coating over wood framing members in contact with cementitious construction.
- .8 Install handrails and bumpers level and plumb; bracket spacing shall not exceed 900 mm o.c., adjust to suit. .
- .9 After installation, adjust operating hardware for proper fit and function.
- .10 Protect finished surfaces by approved means. Do not remove until immediately before final inspection.

3.2 **INSTALLATION - CABINET HARDWARE**

- .1 Install hardware to fitments in accordance with manufacturer's requirements and templates. Adjust hardware as and when required to provide smooth operation and ensure clearances are maintained. Repair damage to adjacent surfaces resulting from failure to conform with this requirement.
- .2 Provide lubricants required and use in manner to ensure smooth function of hardware consistent with manufacturer's recommendations.
- .3 Ensure fastening components are tightened snugly. Do not burr or otherwise mar the edges of surfaces of hardware components.

3.3

CLEANING

- .1 On completion, remove manufacturer's identification markings and clean plastic laminate surfaces.

END OF SECTION

PART - 1 GENERAL

1.1 SUMMARY

- .1 Section Includes: Labour, Products, equipment and services necessary to complete the work of this Section in accordance with the Contract Documents, including, but not limited to:
 - .1 Installing new and patching, repair, or replacement of firestop and smoke seal systems damaged by construction activities.

1.2 ADMINISTRATIVE REQUIREMENTS

- .1 Coordination: Coordinate with Subtrades affected by the work of this Section; give a minimum of 1 week notice of dates and locations where work will take place throughout the areas of Work.
- .2 Pre-installation Conference: Two weeks prior to commencing work of this Section, arrange for manufacturer's technical representative to visit the site and review procedures to be followed, conditions under which the work will be done, and inspect the surfaces to receive the work of this Section. Advise the Consultant of the date and time of the meeting.

1.3 SUBMITTALS

- .1 Shop Drawings: Submit complete and detailed shop for each condition encountered on Site. Indicate following:
 - .1 Material and thickness of firestopping and smoke seals; primers, damming materials, reinforcements, and anchorages/fastenings.
 - .2 ULC assembly number certification and description of assembly, unless proposed assembly is approved by authorities having jurisdiction and meets Consultant's approval.
 - .3 Required temperature rise and flame rating.
 - .4 Hose stream rating (where applicable).
 - .5 Size of opening; adjacent materials.
 - .6 Installation methods.
 - .7 Number and location of penetrations.
- .2 Product Data: Submit up-to-date manufacturer's product data proposed for use under this Section. Include manufacture printed instructions for installation.
- .3 Reports: Submit test reports from a qualified testing and inspection agency indicating that firestopping materials and systems conform to, or exceed, specified requirements.
- .4 Samples: If requested, submit samples of each type of firestopping systems, smoke seals and accessories. Indicate location where material/system shall be used.

1.4 QUALITY ASSURANCE

- .1 Manufacturer Qualifications: Company specializing in manufacturing the Products of this Section with minimum five years documented experience and a Firestop Contractors International Association (FCIA) Manufacturer Member in good standing.

- .2 Installer Qualifications: Company specializing in performing the work of this Section with minimum five years documented experience, trained and approved by material or system manufacturer for application of materials and systems being used.
 - .1 Approved applicators of fireproofing materials to select, with manufacturer's recommendations, ULC rated assembly to achieve required fire resistance rating.
 - .3 Source and Performance Limitations:
 - .1 Obtain materials and systems of this Section from a single manufacturer.
 - .2 Perform work of this Section using a single applicator responsible for firestopping materials and systems for all of the Work.
 - .4 Fire rated assemblies: Labelled and listed by a nationally recognized testing agency having factory inspection service in conformance with CAN4-S104 and CAN4-S105 for ratings indicated.
 - .5 Inspections: Manufacturer's Technical Representative and Consultant to perform field review as specified in PART 3 – FIELD QUALITY CONTROL.
- 1.5 **DELIVERY, STORAGE AND HANDLING**
- .1 Deliver materials to Site in manufacturer's sealed and labelled containers. Materials shall be subject to Consultant's inspection.
 - .2 Store materials inside building for 24 hours prior to use; store in area designated by Consultant; protect from damage and environmental conditions detrimental to material.
- 1.6 **PROJECT CONDITIONS**
- .1 Maintain minimum temperature of 5°C for minimum period of 1 week before application, during application and until application is fully cured.
 - .2 Conform to manufacturer's recommended temperatures, relative humidity and substrate moisture content for storage, mixing, application and curing of firestopping materials.
 - .3 Ventilate areas in which firestopping is being applied. Protect water-soluble material from wetting until fully cured.
- 1.7 **WARRANTY**
- .1 Warrant work of this Section against defects and deficiencies for period of 5 years commencing at the date of Substantial Performance. Promptly correct any defects or deficiencies which become apparent within warranty period, to satisfaction of Consultant and at no additional cost to Owner. Defects shall include but shall not be limited to cracking, breakdown of bond, failure to stay in place or bleeding.
- PART - 2 PRODUCTS**
- 2.1 **SYSTEM DESCRIPTION**
- .1 Work of this Section is inclusive of all firestopping specified herein and indicated on Drawings including firestopping and smoke seals around outside of mechanical and electrical assemblies where they penetrate fire rated separations.
 - .1 Firestopping and smoke seal within mechanical assemblies (i.e. inside ducts, dampers, intumescant pipe sleeves) and electrical assemblies (i.e. inside bus ducts) are part of work of the Mechanical and Electrical Divisions.

- .2 Firestopping materials and systems to be capable of providing effective barrier against passage of fire, smoke, gasses, and, where specifically indicated, passage of liquids. Materials and systems are to fire stop and smoke seal (draft-tight):
 - .1 All through-penetrating items, termination devices, receptacles or any cut-out openings or joints, including openings and spaces at perimeter edge conditions, with wall and floor assemblies having fire-resistance rating.
 - .2 All gaps, expansion joints, and penetrations in fire separations and fire walls.
 - .3 At angle support at fire dampers.

2.2 **PERFORMANCE REQUIREMENTS**

- .1 Firestopping system to provide fire-resistance rating (flame and temperature) not less than fire resistance rating of surrounding floor, wall or assembly, in accordance with requirements of OBC.
- .2 Firestop system rating: Comply with F, FH, FT, or FTH ratings as required by authorities having jurisdiction.
- .3 Supply systems tested in accordance with CAN/ULC S115, be ULC listed, or be acceptable by authorities having jurisdiction.
- .4 Site system assembly to be in accordance with ULC listed system design limitations, unless proposed assembly is approved by authorities having jurisdiction and meets Consultant's approval.

2.3 **MATERIALS**

- .1 Ensure suitability of products for application and compatibility of materials with surfaces to which it will be applied.
- .2 Select exposed firestopping products for walls and ceilings capable of receiving specified paint finish.
- .3 All materials asbestos-free and PCB-free.
- .4 Primer: As recommended by firestopping material manufacturer for specific substrate and use.
- .5 Damming and backup materials, support and anchoring devices: Non-combustible, in accordance with tested assembly and as recommended by manufacturer. Combustible material for damming purpose may be permitted only if they are removed after permanent firestop materials are cured. Sheet steel covers over temporarily unused sleeves shall be minimum 0.8 mm thick galvanized steel sheet.
- .6 Pipe and duct insulation and wrappings: Compatible with firestopping material; as recommended by manufacturer.
- .7 Fire stopping and smoke seals at opening intended for ease of re-entry such as cable: Elastomeric seal. Do not use cementitious or rigid seal at such locations.
- .8 Fire stopping and smoke seals at opening around penetrations for ductwork and other mechanical items requiring sound and vibration control: Elastomeric seal. Do not use cementitious or rigid seal at such locations.
- .9 Sealants at vertical surfaces: Non-sagging.
- .10 Sealants on floor surfaces requiring level finish: Self-levelling.

PART - 3 EXECUTION

3.1 PREPARATION

- .1 Remove combustible material and loose material detrimental to bond from edges of penetration. Clean, prime or otherwise prepare substrate material to manufacturer's recommendation.
- .2 Do not apply firestop material to surfaces previously painted or treated with sealer, curing compound, water repellent or other coatings unless tests have been performed to ensure compatibility of materials. Remove coatings as required.
- .3 Verify openings, dimensions and surfaces conform to fire and smoke seal assembly.
- .4 Comply with manufacturer's recommended requirements for temperature, relative humidity, moisture content and presence of any sealer or release agents on substrate during application and curing of materials. Surfaces shall be dry, dust and frost free.
- .5 Fully protect walls, windows, floors and other surfaces around areas to be firestopped from marring or damage.
- .6 Prime surfaces in accordance with manufacturer's directions. Mask where necessary to avoid spillage on to adjoining surfaces. Remove stains on adjacent surfaces as required.
- .7 Remove insulation from area of insulated pipe and duct where such pipes or ducts penetrate fire separation unless ULC certified assembly permits such insulation to remain within assembly.
- .8 Provide temporary forming, packing and bracing materials necessary to contain firestopping. Upon completion, remove forming and damming materials not required to remain as part of system.
- .9 Install damming and firestopping materials as per manufacturer's instructions.
- .10 Mix materials at correct temperature and in strict accordance with manufacturer's directions.

3.2 INSTALLATION

- .1 Seal penetrations through and gaps in fire rated separations. Fill gap in accordance with ULC details for tested system selected.
- .2 Apply firestopping materials in strict accordance with manufacturer's written instructions and tested designs to provide required temperature and flame rated seal. Apply with sufficient pressure to properly fill and seal openings to ensure continuity and integrity of fire separation. Tool or trowel exposed surfaces as required.
- .3 Remove excess compound promptly as work progresses and upon completion.
- .4 Examine sizes, anticipated movement and conditions of opening and penetration to establish correct system and depth of backup materials and of firestopping material required. Use firestopping and smoke seals best suited for specific application as required, indicated or specified. Use only components specified in fire test of system. Do not eliminate any component for firestop system that was present in fire tests.
- .5 Do not cover materials until full cure has taken place.
- .6 Provide firestop systems at following locations, without being limited to:
 - .1 At openings, voids and penetrations through floor slabs except openings within shafts constructed with a fire resistance rating and slabs on granular fill.
 - .2 At openings, voids and penetrations through fire rated masonry, concrete and gypsum board walls, partitions and shaft walls.

- .3 At openings, voids and penetrations installed for future use through fire rated masonry, concrete and gypsum board walls, partitions and shaft walls.
- .4 Around mechanical and electrical assemblies penetrating fire assemblies.
- .5 Between perimeter of floor and roof slabs and exterior wall construction, and cladding systems.
- .6 Between tops of fire rated walls and partitions and underside of floor or roof slabs.
- .7 At all expansion joints in walls, floors and assemblies as detailed
- .7 Refer to all other sections of Specifications and the Drawings to ascertain where firestops are to be used and, if noted, type of firestop required.
- .8 Cure materials in accordance with manufacturer's directions.
- .9 Label all firestopping assemblies with adhesive stickers in accordance with Owner's procedures.
- .10 Install a warning card that is clearly visible adjacent to all large and medium openings that may be re-penetrated. This card should contain the following information:
 - .1 Warning that the opening has been firestop protected.
 - .2 Indicate the firestop system used (ULC or cUL).
 - .3 Rating.
 - .4 Firestop products used.
 - .5 Person to contact and phone number in case of modification or new penetration of firestop system.

3.3 **FIELD QUALITY CONTROL**

- .1 Product Manufacturer's Technical Representative to inspect the work at suitable intervals during application and at conclusion of the work of this Section to ensure the work is correctly installed.
 - .1 Inspection of through-penetration firestopping shall be performed in accordance with ASTM E2174 or other recognized standard.
- .2 Consultant to inspect completed systems before they are covered.
- .3 Keep areas of work accessible until inspection by applicable code authorities.
- .4 Remove and replace unacceptable firestopping assemblies at no cost to the Owner.

3.4 **CLEANING**

- .1 Remove excess materials and debris and clean adjacent surfaces immediately after application to satisfaction of Consultant. Remove and/or correct staining and discolouring of adjacent surfaces as directed.
- .2 Remove temporary combustible damming materials after initial set of firestopping materials. Such dams may be required to remain in place if flame spread rating is below 25, in accordance with CAN/ULC-S102.

END OF SECTION

PART - 1 GENERAL

1.1 SUMMARY

.1 Section Includes:

- .1 Labour, Products, equipment and services necessary to complete the work of this Section for joint sealants as indicated on drawings and as required.
- .2 This Section specifies sealing work not specified in other Sections. Refer to other Sections for other sealants.

.2 Related Requirements:

- .1 Comply with Conditions of the Contract and Division 01 - General Requirements.

1.2 REFERENCES

.1 American Society for Testing and Materials (ASTM)

- .1 ASTM C719, Standard Test Method for Adhesion and Cohesion of Elastomeric Joint Sealants Under Cyclic Movement (Hockman Cycle)
- .2 ASTM C834, Standard Specification for Latex Sealants
- .3 ASTM C920, Standard Specification for Elastomeric Joint Sealants
- .4 ASTM C1248, Standard Test Method for Staining of Porous Substrate by Joint Sealants
- .5 ASTM E90, Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements

1.3 ACTION SUBMITTALS

.1 Product Data: Submit to Consultant Product information from sealant manufacturer prior to commencement of work of this Section verifying:

- .1 Selected sealant materials are from those specified.
- .2 Composition and physical characteristics.
- .3 Surface preparation requirements.
- .4 Priming and application procedures.
- .5 Suitability of sealants for purposes intended and joint design.
- .6 Test report on adhesion, compatibility and staining effect on samples of adjacent materials used on Project.
- .7 Sealants compatibility and adhesion with other materials and Products with which they come in contact including but not limited to sealants provided under other Sections, insulation adhesives, bitumens, membranes, stone, concrete, masonry, metals and metal finishes, ceramic tile, plastic laminates and paints.
- .8 Suitability of sealants for temperature and humidity conditions at time of application

.2 Samples: Submit duplicate samples of each type of material and colour. Submit samples of primer, bond breaker tape and joint backing material, if requested.

1.4 INFORMATION SUBMITTALS

.1 Product Certificates: For each kind of joint sealant and accessory, from manufacturer.

- .2 Manufacturer's Instructions: submit manufacturer's installation instructions and special handling criteria, installation sequence, cleaning procedures.

1.5 **ADMINISTRATIVE REQUIREMENTS**

- .1 Pre-installation meeting:
 - .1 Two (2) weeks prior to commencing work of this Section, arrange for manufacturer's technical representative to visit the site and review with installer preparatory and installation procedures to be followed, conditions under which the work will be done, and inspect the surfaces to receive the work of this Section.
 - .2 Establish a procedure to maintain optimum working conditions and to coordinate this work with related and adjacent work.
 - .3 Advise the Consultant of the date and time of the meeting.

1.6 **QUALITY ASSURANCE**

- .1 Applicators: Recognized and established sealant applicators with at least five years experience and having skilled mechanics thoroughly trained and competent in the use of sealant equipment and the specified materials.
- .2 Single source responsibility: Use sealants from single manufacturer for each different product required to ensure compatibility.
- .3 Pre-installation compatibility and adhesion testing: Provide sealant manufacturer samples of actual materials that will contact or affect their sealants in the Work for compatibility and adhesion testing. This testing will not be required where sealant manufacturer is able to furnish data acceptable to Consultant based on previous testing for adhesion and compatibility to materials matching those of the Work.
- .4 Pre-installation field adhesion testing:
 - .1 Conduct site field-tests for adhesion of sealants to actual joint substrates using proposed preparation methods and materials recommended by manufacturer.
 - .2 Conduct tests for each type of sealant and substrate.
 - .3 Locate field-test joints where inconspicuous or as directed by Consultant. Include areas typical of those requiring removal of existing sealants and utilize methods proposed for sealant removal.
 - .4 Test method: Use manufacturer's standard field adhesion test methods and methods proposed for joint preparation to verify proper priming and joint preparation techniques required to obtain optimum adhesion of joint sealants to joint substrate.
 - .5 Evaluate and report results of field adhesion testing.
 - .6 Do not use joint preparation methods or sealants that produce less than satisfactory adhesion to joint substrates during testing.
- .5 Standard of acceptance: Retain at least one 1500 mm long acceptable joint for each type of sealant and substrate installed during pre-installation field adhesion testing as standard of acceptability for the Work. Acceptable joints may form part of the Work.
- .6 Mockups: Install sealant in mockups of assemblies specified in other Sections that are indicated to receive joint sealants specified in this Section. Use materials and installation methods specified in this Section.

1.7 **DELIVERY, STORAGE, AND HANDLING**

- .1 Deliver and store materials in original wrappings and containers with manufacturer's seals and labels, intact. Protect from freezing, moisture and water.

1.8 **PROJECT CONDITIONS**

- .1 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 deg C (40 deg 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.

PART - 2 PRODUCTS

2.1 **MATERIALS - GENERAL**

- .1 Provide interior joint sealants establishing and maintaining water tight, water resistant and air tight continuous joint seals without staining or deteriorating joint substrates.
- .2 Ensure joint sealants comply with specified type, grade, class and uses.
- .3 Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.
- .4 Provide Products with capability, when tested, for adhesion and cohesion under maximum cyclic movement in accordance with ASTM C719, to withstand required percentage change in joint width existing at time of installation and remain in compliance with other requirements of ASTM C920 for uses indicated.
- .5 VOC Content of Interior Sealants: Sealants and sealant primers used inside the weatherproofing system shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
 - .1 Architectural Sealants: 250 g/L.
 - .2 Sealant Primers for Nonporous Substrates: 250 g/L.
 - .3 Sealant Primers for Porous Substrates: 775 g/L.
- .6 Low-Emitting Interior Sealants: Sealants and sealant primers used inside the weatherproofing system shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- .7 Liquid-Applied Joint Sealants: Comply with ASTM C 920 and other requirements indicated for each liquid-applied joint sealant specified, including those referencing ASTM C 920 classifications for type, grade, class, and uses related to exposure and joint substrates.

- .8 Stain-Test-Response Characteristics: Where sealants are specified to be non-staining to porous substrates, provide products that have undergone testing according to ASTM C 1248 and have not stained porous joint substrates indicated for Project.
- .9 Sealants, cleaning solvents and primers: Compatible with each other.
- .10 Colours of Exposed Joint Sealants: As selected by Consultant from manufacturer's full range. Allow for special colours as selected by the Consultant.

2.2 **JOINT SEALANTS**

- .1 **Sealant Type 1:** Single-component, non-sag, polyurethane joint sealant meeting specified requirements of ASTM C 920, Type S, Grade NS, Class 25, for Use NT.
 - .1 Dymonic by Tremco (Canada),
 - .2 SikaFlex 1a by Sika Canada Inc.
 - .3 Sonolastic NP1 by BASF Construction Chemicals, LLC-Building Systems.
- .2 **Sealant Type 2:** Acrylic latex or siliconized acrylic latex joint sealant meeting specified requirements of ASTM C 834, Type OP, Grade NF.
 - .1 Tremflex 834 by Tremco Incorporated,
 - .2 Sonolac by BASF Construction Chemicals, LLC-Building Systems.
- .3 **Sealant Type 3:** Mildew-resistant, single-component, acid-curing silicone joint sealant, meeting specified requirements of ASTM C 920, Type S, Grade NS, Class 25, for Use NT, G, A and O.
 - .1 Tremsil 200 by Tremco (Canada).
 - .2 Dow Corning 786 by Dow Corning Corporation.
 - .3 GE SCS1700 Sanitary by Momentive Performance Materials Inc.
 - .4 OmniPlus by BASF Construction Chemicals, LLC-Building Systems.

2.3 **MISCELLANEOUS MATERIALS**

- .1 Joint primer: As recommended by sealant manufacturer for substrates, conditions and exposures indicated.
- .2 Bond breaker: Polyethylene tape or other adhesive faced tape as recommended by sealant manufacturer to prevent sealant contact where it would be detrimental to sealant performance.
- .3 Joint backer: Polyethylene foam rod or other compatible non-waxing, non-extruding, non-staining resilient material in dimension 25 percent to 50 percent wider than joint width as recommended by sealant manufacturer for conditions and exposures indicated. Ensure backing is compatible with sealant, primer and substrate.
- .4 Masking tape: Non-staining, non-absorbent tape product compatible with sealants and adjacent joint surfaces that is suitable for masking.
- .5 Cleaning Material: Non-corrosive, non-staining, solvent type, xylol, MEK, toluol, IPA or as recommended by sealant manufacturer and acceptable to material or finish manufacturers for surfaces adjacent to sealed areas free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way and formulated to promote optimum adhesion of sealants with joint substrates.

PART - 3 EXECUTION

3.1 EXAMINATION

- .1 Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.
- .2 Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- .1 Prepare surfaces to receive work in accordance with sealant manufacturer's instructions and recommendations except where more stringent requirements are indicated.
- .2 Thoroughly clean joint surfaces using cleaners approved by sealant manufacturer whether primers are required or not.
- .3 Remove all traces of previous sealant and joint backer by mechanical methods, such as by cutting, grinding and wire brushing, in manner not damaging to surrounding surfaces.
- .4 Remove paints from joint surfaces except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer.
- .5 Remove wax, oil, grease, dirt film residues, temporary protective coatings and other residues by wiping with cleaner recommended for that purpose. Use clean, white, lint-free cloths and change cloths frequently.
- .6 Remove dust by blowing clean with oil-free, compressed air.
- .7 Joint backer: Provide joint backer uniformly to depth required for proper joint design using a blunt instrument. Fit securely by compressing backer material 25 percent to 50 percent so no displacement occurs during tooling. Avoid stretching or twisting joint backer.
- .8 Bond breaker: Provide bond-breaker recommended by sealant manufacturer, adhering strictly to the manufacturer's installation requirements.
- .9 Priming: Prime joint substrates where required. Use and apply primer to sealant manufacturers recommendations. Confine primers to sealant bond surfaces; do not allow spillage or migration onto adjoining surfaces.
- .10 Taping: Use masking tape, where required, to prevent sealant or primer contact with adjoining surfaces that would be permanently stained or otherwise damaged by such contact or the cleaning methods required for removal. Apply tape so as not to shift readily, and remove tape immediately after tooling without disturbing joint seal.

3.3 INSTALLATION

- .1 Do not apply sealants to joint surfaces treated with sealer, curing compound, water repellent, or other coatings unless tests have been performed to ensure compatibility of materials. Remove coatings as required.
- .2 Install sealants immediately after joint preparation.
- .3 Mix, apply and cure sealants in accordance with manufacturer's printed instructions.
- .4 Install sealants to fill joints completely, without voids or entrapped air, using proven techniques, proper nozzles and sufficient force that result in sealants directly contacting and fully wetting joint surfaces.

- .5 Install sealants to uniform cross-sectional shapes with depths relative to joint widths that allow optimum sealant movement capability as recommended by sealant manufacturer.
- .6 Dry tool sealants in manner that forces sealant against back of joint, ensures firm, continuous full contact at joint interfaces and leaves a finish that is smooth, uniform and free of ridges, wrinkles, sags, air pockets and embedded impurities.
 - .1 Tooling liquids that are non-staining, non-damaging to adjacent surfaces and approved by sealant manufacturer may be used if necessary when care is taken to ensure that the liquid does not contact joint surfaces before the sealant.
 - .2 Provide concave tooled joints unless otherwise indicated to provide flush tooling or recessed tooling.
 - .3 Provide recessed tooled joints where the outer face of substrate is irregular.
- .7 Remove sealant from adjacent surfaces in accordance with sealant and substrate manufacturer recommendations as work progresses.
- .8 Do not cover up sealants until proper curing has taken place.
- .9 Protect joint sealants from contact with contaminating substances and from damages. Cut out, remove and replace contaminated or damaged sealants immediately, so that they are without contamination or damage at time of Substantial Performance.

3.4 **LOCATION SCHEDULE**

- .1 Refer to Drawings for sealing work not specifically listed in this Section.
- .2 Use one of the sealants specified for each type in following locations. Ensure sealant chosen from several specified types listed under Part 2 Materials, and recommended by manufacturer for use for conditions encountered:
- .3 Seal following joints with Sealant Type 1 one component modified polyurethane sealant:
 - .1 Interior gypsum board control joints.
- .4 Seal following joints with Sealant Type 2 acrylic sealant:
 - .1 Joints between interior metal and/or wood frames and adjacent construction in interior partitions.
 - .2 Joints between interior aluminum door, window and screen frames and adjacent construction in interior partitions.
 - .3 Interior joints to receive paint finish.
- .5 Seal following joints with Sealant Type 3 mildew resistant silicone sealant:
 - .1 Typically used in joints between around washrooms accessories, at corners of walls, between splash backs and walls, in shower, damp or wet areas, at ceramic tiles where mildew resistant sealant is required.
 - .2 Underside of rims of sinks between sink rims and counters.
 - .3 Around pipes and conduits passing through walls and ceilings in washrooms. Conceal sealant with escutcheons.
 - .4 Joints between counters/vanities and walls in washrooms.

- .5 Joints between water closets and walls in washrooms.
- .6 Joints between wall mounted lavatories and walls in washrooms.

END OF SECTION

PART - 1 GENERAL

1.1 SUMMARY

- .1 Section Includes: Labour, Products, equipment, and services necessary to complete the work of this Section, including but not limited to:
 - .1 Hollow metal doors and frames, non-rated.
 - .2 Metal frames for Wood doors, refer to Section 08 14 00.
 - .3 Interior glazed steel frames, including transom frames, sidelight frames, and borrowed lights and screens.
 - .4 Pre-wired hollow metal doors and frames with CSA approved wiring system, including CSA approved conduit and fittings, where indicated on Hardware Schedule.
- .2 Related Requirements
 - .1 Comply with Conditions of the Contract and Division 01, General Requirements.

1.2 REFERENCES

- .1 American Society for Testing and Materials (ASTM):
 - .1 ASTM A568/A568M, Standard Specification for Steel, Sheet, Carbon, Structural, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, General Requirements for
 - .2 ASTM A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - .3 ASTM A924/A924M, Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.
 - .4 ASTM E90, Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements
 - .5 ASTM E413, Classification for Rating Sound Insulation.
- .2 Canadian Standards Association (CSA):
 - .1 CSA-W59: Welded Steel Construction.
- .3 Canadian General Standards Board (CGSB):
 - .1 CAN/CGSB-1.40, Anti-corrosive Structural Steel Alkyd Primer.
 - .2 CAN/CGSB-1.181, Ready-Mixed Organic Zinc-Rich Coating.
 - .3 CAN/CGSB-82.5: Insulated Steel Doors.
- .4 Underwriters' Laboratories of Canada (ULC):
 - .1 CAN/ULC-S104-15, Standard Method for Fire Tests of Door Assemblies
 - .2 CAN/ULC-S105-2016(R2020), Standard Specification for Fire Door Frames Meeting the Performance Required by CAN/ULC-S104.
 - .3 CAN/ULC-S106-15 (R2020), Standard Method for Fire Tests of Window and Glass Block Assemblies.
 - .4 CAN/ULC-S702: Standard for Thermal Insulation, Mineral Fibre, for Buildings.
 - .5 CAN/ULC-S704: Standard for Thermal Insulation, Polyurethane and Polyisocyanurate Boards, Faced.

- .6 Underwriters Laboratories of Canada, List of Equipment and Materials.
- .5 DHI (Door Hardware Institute) - The Installation of Commercial Steel Doors and Steel Frames, Insulated Steel Doors in Wood Frames and Builder's Hardware.
 - .1 ANSI/DHI A115.IG-1994: Installation Guide for Doors and Hardware.
- .6 CSDFMA (Canadian Steel Door and Frame Manufacturers Association).
- .7 NFPA 80 - Fire Doors, Fire Windows.
- .8 NFPA 252 - Fire Tests for Door Assemblies.
- .9 SDI-100 - Standard Steel Doors and Frames.
- .10 Steel Door Institute: ANSI/SDI A250.8-17, Specifications for Standard Steel Doors and Frames (SDI-100).
- .11 NAAMM HMMA 802: Manufacturing of Hollow Metal Doors and Frames.
- .12 NAAMM HMMA 805: Recommended Selection and Usage Guide for Hollow Metal Doors and Frames.
- .13 NAAMM HMMA 840: Guide Specification for Installation and Storage of Hollow Metal Doors and Frames.

1.3

SUBMITTALS

- .1 Shop drawings: Indicate each type of door and frame, door and frame elevations, configurations, material, steel core thicknesses, mortises, reinforcements, anchor types and spacing, location of exposed fasteners, openings, arrangement of hardware, cut-outs for hardware, glazing, louvers, finishes, and fire rating.
- .2 Product Data: Submit manufacturer's literature and data sheets illustrating door and frame construction.
 - .1 Ensure data sheets provide required information including detailed instructions for installing as well as maintaining, preserving, and keeping materials in clean and safe conditions. Provide adequate warning of maintenance practices or cleaning agents detrimental to specified materials.
- .3 Samples: Submit samples indicating 1 cut-away corner sample and minimum 300 mm square for each type of door to indicated following:
 - .1 Core.
 - .2 Reinforcing.
 - .3 Facing.
 - .4 Frame.
- .4 Submit a copy of NAMMA-HMMA 840 to the contractor responsible for the storage and installation of hollow metal doors and frames.

1.4

QUALITY ASSURANCE

- .1 Qualifications: Provide evidence that the:
 - .1 Manufacturer has fabricated product of types under this Section, for projects of similar size and scope, for a continuous period of not less than five (5) years prior to award of Subcontract, has personnel and plant equipment capable of fabricating steel door and frame product of the types specified and has a written quality control system in place.

- .2 Product supplier is a qualified direct distributor of the products to be furnished, and has in his regular employ, an AHC, CDC, or person of equivalent experience, available at reasonable times to consult with the Consultant, Subcontractor and/or Owner.
 - .3 Installer is a firm with five (5) years continuous experience prior to the award of Subcontract, in installing product covered by this Section and Section 08 71 00, is knowledgeable of the manufacturers' and ANSI/NFPA 80 requirements relating to the installation of labelled fire rated products covered by this section and Section 08 71 00 Door Hardware.
 - .2 Quality Criteria:
 - .1 Ensure all door and frame Products meet the performance requirements specified herein. Fabricate assemblies on strict accordance with reviewed submittal drawings.
 - .3 Conform to Canadian Steel Door and Frame Manufacturers Association standards.
 - .4 Welding: to CSA W59.
- 1.5 **DELIVERY, STORAGE, AND HANDLING**
- .1 Brace and protect assemblies to prevent distortion during shipment. Store in a secure dry location.
 - .2 Store doors vertically, resting on planks, with blocking between to allow air to circulate.
- 1.6 **WARRANTY**
- .1 Steel door and frame Products provided under this Section, touched up only with zinc-rich rust inhibitive primer where coating has been removed during its manufacture, shall be warranted by the manufacturer for a period of ten (10) years from the date of supply:
 - .1 Against rust perforation, when stored, installed and finish painted in accordance with manufacturer's published instructions.
 - .2 For finish paint adhesion, when stored and cleaned in accordance with manufacturer's application recommendation, and finish painted with commercial quality paint in accordance with Section 09 91 00 and to paint manufacturer's application recommendations.

PART - 2 PRODUCTS

2.1 DESIGN AND PERFORMANCE REQUIREMENTS

- .1 Ensure door and frame Products are fabricated in strict accordance with CSDMA recommendations and manufacturer's requirements. Ensure steel is free of scale, pitting, coil breaks, surface blemishes, buckles, waves, and other defects. Ensure Product quality meets standards set by Canadian Steel Door Manufacturers Association (CSDMA).
- .2 Ensure door and frame assembly meets acceptance criteria of ANSI A224.1 and is certified as Level "A" (1,000,000 cycles) and Twist Test Acceptance Criteria (deflection not to exceed 6 mm/13.6 kg (1/4"/30 lb) force, total deflection at 136 kg (300 lb) force not to exceed 64 mm (2-1/2") and permanent deflection not to exceed 3 mm (1/8")) when tested in accordance with ANSI A250.4. Ensure tests are conducted by an independent nationally recognized accredited laboratory.

2.2 MATERIALS

- .1 Sheet Steel: Commercial grade steel to ASTM A568/A568M, Class 1, hot-dip galvanized to ASTM A653/A653M, ZF120 (A40), known commercially as "Colourbond", "Satincoat", or

"Galvanneal". Steel sheet thicknesses specified are base metal thicknesses prior to galvanizing.

.2 Core Materials:

.1 Interior Doors:

- .1 Steel Stiffened: vertically stiffened with 0.912 mm steel ribs at 152mm o.c. maximum, with all voids filled completely with semi-rigid mineral wool insulation. Fabricate door faces with a single sheet of steel welded to steel stiffeners.
- .2 Honeycomb: Structural small cell, 25 mm maximum kraft paper 'honeycomb'; weight: 36.3 kg per ream minimum; density: 16.5 kg/m³ minimum. Provide items sanded to required thickness.
- .3 Insulation – Standard non-insulated doors: Loose batt type, density: 1.5 pcf (24kg/m³) minimum, conforming to ASTM C665.

2.3 **ACCESSORIES**

- .1 Glazing Stops: rolled steel channel shape, 0.9 mm minimum thickness, butted corners; prepared for countersink style tamper-proof screws.
- .2 Reinforcements: regular galvanneal steel, thicknesses as follows:
 - .1 Flush Bolt, Lock and Strike Reinforcement: minimum 1.6 mm (16 ga).
 - .2 Hinge Reinforcements: minimum 3.5 mm (10 ga).
 - .3 Door Closer and Holder Reinforcements: minimum 2.6 mm thick (12 ga) steel.
 - .4 Reinforcement for Surface Applied Hardware: minimum 1.2 mm thick (18 ga) steel.
 - .5 Concealed Door Closer or Holder Reinforcements: minimum 2.6 mm thick (12 ga) steel.
 - .6 Top and Bottom End Channels: minimum 1.2 mm thick (18 ga) steel.
 - .7 Jamb Spreaders: minimum 0.912 mm thick (20 ga) steel
- .3 Anchors: regular galvanneal steel, as follow:
 - .1 T-Strap Type: 1.2 mm thick.
 - .2 Stirrup-strap Type: 50 x 250mm size, 1.6 mm thick.
 - .3 Jamb Floor Type: 1.6 mm thick.
 - .4 Stud Type: 1.0mm thick.
- .4 Conduit and Fittings: 20 mm o.d. EMT conduit and fittings, as specified in Division 26.
- .5 Bituminous Coating: fibrous asphalt emulsion.
- .6 Mortar Guard Boxes: regular galvanneal steel, 0.8 mm thick.
- .7 Joint Sealer: as specified in Section 07 92 00.
- .8 Frame thermal break: Rigid PVC extrusion to CGSB 41-GP-19Ma.
- .9 Fasteners for Stops: Cadmium plated steel, counter sunk flat or oval head sheet metal Phillips screws.

- .10 Adhesives:
 - .1 Steel Components: Heat resistant, spray grade, resin reinforced neoprene/rubber (polychloroprene) based, low viscosity, contact cement.
 - .2 Polyisocyanurate Cores: Heat resistant, epoxy resin based, low viscosity, contact cement.
 - .3 Lock-Seam Doors: Fire resistant, RRPC, fire resistant, high viscosity sealant/adhesive.
 - .11 Resilient bumpers: Round, black rubber, stud mount.
 - .12 Primer: Zinc rich primer.
 - .13 Standard Duty Interior Hollow Metal Doors and Transom Panels:
 - .1 1.2 mm thick (18 ga) minimum commercial quality steel sheet faces, flush design, paintable galvanneal finish.
 - .2 Vertical Stiffeners: 0.912 mm thick (20 ga) minimum steel sheet.
 - .3 Glazing Stops: 0.912 mm thick (20 ga) minimum steel sheet, formed, drilled and countersunk for fastenings.
 - .14 Heavy Duty Interior Hollow Metal Doors and Transom Panels:
 - .1 Face Sheets: 1.519 mm thick (16 ga) minimum steel sheet.
 - .2 Vertical Stiffeners: 0.912 mm thick (20 ga) minimum steel sheet.
 - .3 Glazing Stops: 1.519 mm thick (16 ga) minimum steel sheet, formed, drilled and countersunk for fastenings.
 - .15 Interior Hollow Metal Door Frames and Transom Frames: Minimum 1.60 mm (0.063") 16 gauge thick steel, cold-rolled commercial quality steel; paintable galvanneal finish; sizes as indicated on Door Schedule and Drawings.
- 2.4 **FABRICATION - GENERAL**
- .1 Blank, reinforce, drill and tap doors and frames for mortised hardware. Reinforce doors and frames for surface mounted hardware.
 - .2 Apply, at factory, touch up primer to doors and frames manufactured from galvanized steel where coating has been removed during fabrication.
 - .3 Make provisions in doors and frames to suit requirements of Section providing security devices.
 - .4 Fabricate fire rated assemblies to ULC requirements and bearing ULC, ULI or Warnock-Hersey International Ltd., label, as acceptable to authorities having jurisdiction.
 - .5 Locate fire rating labels on the inside of the frame hinge jamb and door hinge edge midway between the top hinge and the head of the door.
- 2.5 **FABRICATION - DOORS**
- .1 Fabricate doors to HMMA 802, and to the standards and specifications published by the Canadian Steel Door and Frame Manufacturer's Association.
 - .2 Provide continuous faces free from joints, tool markings and abrasions; with hardware reinforcement plates welded in place.
 - .3 Welding: to CSA W59. Grind exposed welds smooth and flush. Fill open joints, seams, and depressions with filler or by continuous brazing or welding. Grind and sand to a smooth, true, uniform finish.

- .4 Fabricate fire-rated doors in accordance with Canadian Fire Labelling Guide for Steel Doors and Frames as published by the Canadian Steel Door and Frame Manufacturer's Association.
- .5 Fabricate doors to accommodate scheduled glazing. Secure glazing stops to doors with counter sunk oval head sheet metal screws.
- .6 Attach fire rated label to each fire rated door unit.
- .7 Completely fill door cores with specified core materials.
- .8 Pre-wire door complete with CSA approved EMT metallic conduit and fittings for Electrolynx system where indicated on Hardware Schedule.
 - .1 Electrolynx wiring supplied by Section 08 71 00.
- .9 Preparation for hardware:
 - .1 Prepare doors for heavy weight oversize butt hinges, mortise locksets, rim and surface vertical rod exit devices, surface door closers and concealed overhead stops.
 - .2 Conform to approved finish hardware schedule.
 - .3 Blank, mortise, reinforce, and drill doors to receive template hardware, as required. Coordinate with Section 08 71 00.
 - .4 Where electrified hardware is specified on the approved hardware schedule, steel door and frame product, shall be provided with Electrolynx system consisting of CSA approved conduit, junction boxes and wire harness complete with modular plugs for coordinated connection directly to the electrified hardware.
- .10 Reinforce door edges with channel reinforcing.
- .11 Door faces of all steel doors shall be fabricated without visible seams, free of scale, pitting, coil brakes, buckles and waves.
- .12 Longitudinal edges of doors shall be mechanically interlocked and adhesive assisted.
- .13 Tack weld and fill seam between faces and door edges of doors
- .14 Bevel stiles minimum 3mm.
- .15 Coordinate louvre openings with Division 23.
- .16 Fabrication Tolerances:
 - .1 Fabricated door deformation (bow, cup, twist, warp) shall not exceed 3 mm when measured with a straight edge placed diagonally across door extending from top to bottom.
 - .2 Widths of door openings shall be measured from inside of frame jamb rebates with a tolerance of +1.5 mm, -1 mm.
 - .3 Unless builders' hardware requirements dictate otherwise, doors shall be sized so as to fit openings and allow a 3 mm clearance at jambs and head. Provide 19 mm clearance between bottom of door and finished floor (exclusive of floor coverings). Tolerances on door sizes shall be 1.2 mm.
 - .4 Provide doors with 1.5 mm clearance at heads and jambs, and no more than 3 mm door and threshold.

2.6 **FABRICATION - FRAMES**

- .1 Fabricate frames as welded unit. Knock down frames will not be allowed.
- .2 Conform to HMMA 802. Conform to HMMA 805 for frame thickness selection in relation to door thickness.
- .3 Transom Bars for Glazed Lights: Fixed type, of same profiles as jamb and head.
- .4 Welding: to CSA W59. Grind exposed welds smooth and flush. Fill open joints, seams, and depressions with filler or by continuous brazing or welding. Grind and sand to a smooth, true, uniform finish.
- .5 Mitre corners of frames. Cut frame mitres accurately and weld continuously on inside of frame.
- .6 Protect strike and hinge reinforcements and other openings with mortar guard boxes welded to frame.
- .7 Reinforce frames wider than 1.2 metres with roll formed steel channels fitted tightly into frame head, flush with top.
- .8 Fit frames with channel or angle spreaders, minimum two per frame, to ensure proper frame alignment. Install stiffener plates to spreaders between frame trim where required to prevent bending of trim and to maintain alignment when setting and during construction.
 - .1 Channel or angle spreaders are to be removed prior to installation and are not to be used as part of the installation process.
- .9 Attach fire rated label to each fire rated unit.
- .10 Fabricate frames to accommodate scheduled glazing. Secure glazing stops to frames with counter sunk oval head sheet metal screws.
- .11 Provide 3 bumpers on strike jamb for each single door.
- .12 Preparation for hardware:
 - .1 Prepare frames for heavy weight oversize butt hinges, mortise locksets, rim and surface vertical rod exit devices, surface door closers and concealed overhead stops.
 - .2 Conform to approved finish hardware schedule.
 - .3 Blank, mortise, reinforce, drill and tap frames to receive template hardware, as required. Coordinate with Section 08 71 00.
 - .4 Where electrified hardware is specified on the approved hardware schedule, steel door and frame product, shall be provided, consisting of CSA approved conduit, junction boxes and wire harness complete with modular plugs for coordinated connection directly to the electrified hardware. Refer to Finish Hardware Schedule for openings that require electrified hardware.
- .13 Fabrication Tolerances:
 - .1 Widths of door openings shall be measured from inside of frame jamb rebates with a tolerance of +1.5 mm, -1 mm.
 - .2 Manufacturing tolerances on formed frame profiles shall be 1 mm for faces, stop heights and jamb depths. Tolerances for throat openings and door rebates shall be 1.5 mm and 0.5 mm respectively. Hardware cutout dimensions shall be as per template dimensions, +0.38 mm, -0.

PART - 3 EXECUTION

3.1 **INSTALLATION - GENERAL**

- .1 Touch up with primer galvanized finish damaged during installation.

3.2 **INSTALLATION - FRAMES**

- .1 Install frames plumb, square, aligned, without twist at correct elevation, to HMMA 840, ANSI/DHI A115.IG, Canadian Steel Door and Frame Manufacturers Association standards and manufacturer's instructions and templates.
- .2 Provide suitable anchors to suit construction. Use one base anchor and two wall anchors per jamb side for frames up to 1500 mm and one additional wall anchor per jamb side for each additional height of 750 mm or fraction thereof.
- .3 Secure anchorages and connections to adjacent construction.
- .4 Brace frames rigidly in position while building-in. Install temporary horizontal wood spreader at third points of door opening to maintain frame width. Remove temporary spreaders after frames are built-in.
- .5 Make allowances for deflection of structure to ensure structural loads are not transmitted to frames.
- .6 Coordinate installation of glass and glazing.
- .7 Seal openings between frames and walls as specified in Section 07 92 00.

3.3 **INSTALLATION - DOORS**

- .1 Install doors to HMMA 840, ANSI/DHI A115.IG, Canadian Steel Door and Frame Manufacturers Association standards and manufacturer's instructions and templates.
- .2 Coordinate installation of finish hardware.
- .3 Coordinate installation of glass and glazing.
- .4 Provide even margins between doors and jambs and doors and finished floor and thresholds as follows:
 - .1 Hinge side: 3 mm.
 - .2 Latchside and head: 3 mm.
 - .3 Finished floor for non-rated assemblies: 12 mm.
 - .4 Finished floor for rated assemblies: 6 mm.
- .5 Install louvres.

3.4 **ADJUSTING**

- .1 Adjust door for smooth and balanced door movement.

END OF SECTION

PART - 1 GENERAL

1.1 SUMMARY

- .1 Section Includes:
 - .1 Labour, Products, equipment and services necessary to complete the work of this Section, including but not limited to:
 - .1 Solid-core wood doors with, plastic laminate and MDO faces.
 - .2 Transom panels.
 - .2 Related Requirements
 - .1 Comply with Conditions of the Contract and Division 01 - General Requirements.

1.2 REFERENCES

- .1 Abbreviations and Acronyms:
 - .1 AWMAC: Architectural Woodwork Manufacturers Association of Canada; www.awmac.com.
 - .2 FSC: Forest Stewardship Council; www.fsccanada.org.
 - .3 MDO: Medium Density Overlay.
 - .4 NAAWS: North American Architectural Woodwork Standards, latest edition including all errata and supplements, a jointly sponsored by Architectural Woodwork Manufacturers Association of Canada (AWMAC) and the Woodwork Institute (WI).
- .2 Reference Standards:
 - .1 ANSI/WDMA IS-1A, Architectural Wood Flush Doors.
 - .2 ASTM E90, Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.
 - .3 ASTM E413, Classification for Rating Sound Insulation.
 - .4 CSA O112 Series-M77 (R2006), CSA Standards for Wood Adhesive.

1.3 DEFINITIONS

- .1 Exposed surfaces: Surfaces visible when doors are opened, backs of hinged doors and edges of hinged doors exposed when opened.
- .2 Pre-machined: Factory prepared cut-outs for hardware and glazing. Site trimming of work will not be permitted, except trimming of door height.

1.4 SUBMITTALS

- .1 Product Data: For each type of door include details of core and edge construction, and trim for openings.
- .2 Samples:
 - .1 Door Sample: Submit one 300 mm x 300 mm (12" x 12") corner sample showing construction, edge details, core, and face veneers.
 - .2 Frame Sample: Submit one 300 mm (12") long corner sample showing profiles, jointing method, face veneer, and glazing details.
 - .3 Provide glass size, type and thickness for factory glazed doors.

- .3 Shop Drawings: Indicate location, size, type, and hand of each door; elevation of each kind of door; construction details not covered in Product Data; door schedule; and other pertinent data including the following:
 - .1 Dimensions and locations of hardware blocking.
 - .2 Dimensions and locations of cutouts, mortises and holes for hardware.
 - .3 Identify cut outs for louvers and glazing.
 - .4 Undercuts.
 - .5 Factory finish requirements.
 - .6 Jointing, fastening and related items.

1.5 **QUALITY ASSURANCE**

- .1 Qualifications: Work of this Section shall be done by manufacturer and tradesmen with experience in successful manufacture and installation of this type of work and of quality as indicated on Drawings and as specified. Submit proof of such experience with list of installations in Ontario upon Consultant's request.
- .2 Quality of work and materials: Unless otherwise specified, comply with the requirements for Premium Grade in accordance with the NAAWS standards.
- .3 Factory Finish: Apply finish in accordance with the NAAWS standards and to match samples at Consultant's office.
- .4 Finish Matching: Finish for solid wood members shall match wood veneer finish.
- .5 Source Limitations, Doors: Obtain doors through one source from a single manufacturer.
- .6 Source Limitations, Frames: Obtain frames through one source from a single manufacturer.

1.6 **DELIVERY, STORAGE, AND HANDLING**

- .1 Package doors individually in cardboard cartons and wrap bundles of doors in plastic sheeting.
- .2 Ensure complete protection of edges and finishes during shipment to the job site.
- .3 Mark each door on top and bottom rail with opening number used on Shop Drawings.
- .4 Store work in well ventilated room, off floor, in accordance with manufacturer's recommendations.

1.7 **PROJECT CONDITIONS**

- .1 Environmental Limitations: Do not deliver or install doors until building is enclosed, wet work is complete, and HVAC system is operating and will maintain temperature and relative humidity at occupancy levels during the remainder of the construction period.

1.8 **WARRANTY**

- .1 Provide a life-time warranty commencing on date of Substantial Performance against defects in the materials and workmanship for wood doors, including but not limited to warping, cupping, twisting, shrinkage, swelling, delamination and splitting.

PART - 2 PRODUCTS

2.1 **GENERAL**

- .1 All composite wood and agrifibre products (including core materials) used in the building must not contain added formaldehyde.

- .2 Adhesives used to fabricate laminated assemblies used in the building that contain composite wood and agrifibre products must not contain added formaldehyde.
- .3 Adhesives used must meet VOC requirements.
- .4 Regulatory Requirements:
 - .1 Conform to NAAWS standards Section 9 or ASNI/WDMA I.S. 1A for wood flush doors and NAAWS standards Section 9 or ANSI/WDMA I.S. 6A for stile and rail doors, except as specified herein.
 - .2 Submit certification that acoustic rated door construction meets ASTM E90 and ASTM E413 classification as indicated on Drawings or Schedule.

2.2 **MATERIALS**

- .1 Plastic Laminate Veneer: NEMA LD3, HGS, high pressure paper based decorative laminates, 1.2 mm (0.048") thick. Refer to Section 00 01 30 List of Materials for product, manufacturer, colour and other requirements.
- .2 Plywood Door Face for Paint Finish: CSA 0115, 3 ply, 3 mm (1/8") thick minimum, birch veneer, paint grade.
- .3 Exposed solid members and trim: wood species as indicated in Section 00 01 30 List of Materials, quarter sawn, architectural grade, matched for compatibility of grain and colour.
- .4 Exposed Vertical Edges: Veneer minimum 13 mm (1/2") thick, of same species as face veneer for transparent finish; hardwood for paint finish.
- .5 Particleboard: CSA-O188.1, extruded particle board, minimum density of 448 kg/cu.m. (28 pcf).
- .6 Medium Density Fibreboard: Premium grade, minimum 768 kg/cu.m. (48 pcf.) density, fire retardant treated, acceptable to authority having jurisdiction.
- .7 Crossbanding: Composite or 1.6 mm(1/16") thick hardwood.
- .8 Stiles and Rails: Hardwood or structural composite lumber/hardwood. Stile thickness minimum 38 mm(1-1/2") and rail thickness minimum 28 mm(1-1/8").
- .9 Hardware Blocking, Non-Rated Doors: 150 mm(6") glued block or structural composite lumber in particleboard core doors as follows:
 - .1 Top rail blocking in doors indicated to have closers.
 - .2 Bottom rail blocking in doors indicated to have kick or mop plates, and mortised or surface bottom door sweeps.
 - .3 Midrail blocking, in doors indicated to have exit devices.
- .10 Resilient Bumpers: Round, black rubber, 3 mm(1/8") thick, adhesive mount.
- .11 Factory Finish: NAAWS System 5, Premium Grade, Conversion Varnish .
- .12 Adhesive: Waterproof type, suitable for specific end use.
- .13 Metal Louvres: in accordance with Division 23.
- .14 Vision Frames for Unrated Doors: Wood, of same species as door facing; mitre corners; prepared for countersink tamper resistant screws.
- .15 Glazing: Refer to Section 08 80 00.
- .16 Transom and Side Panels:
 - .1 Construction: To match adjacent door.

2.3 **FABRICATION - GENERAL**

- .1 Pre-machine work in factory.

2.4 **FABRICATION - DOORS**

- .1 Plastic Laminate Clad Doors, Solid Core: Particleboard core, 5 ply construction, full length stiles and rails bonded to core. NAAWS Type D edge unless indicated otherwise. Laminate crossbandings to core, stiles and rails. Hot press veneer in accordance with manufacture's instructions.
- .2 Paint Grade Doors, Solid Core: Particleboard core, 7 ply construction, full length stiles and rails bonded to core. NAAWS Type A edge unless indicated otherwise. Laminate plywood face to stiles, rails and core, under pressure and in accordance with manufacturer's instruction.
- .3 Completely seal wood edges and edges of cut-outs in shop for doors scheduled to receive paint finish. Apply sealer in accordance with the manufacturer's printed instructions.
- .4 Bevel edges of single acting doors 3 mm(1/8") on lock side and 1.6 mm(1/16") on hinge side.
- .5 Undercut doors for carpet in the plant.
- .6 Sand smooth work and clean surfaces free of dust before applying successive coat. Carefully sand with even strokes to provide perfect, scratch-free surface.

PART - 3 EXECUTION

3.1 **INSTALLATION**

- .1 Install work of this Section plumb, square, true, rigid and secure. Conceal fastenings in the finished work unless otherwise indicated on final reviewed shop drawings and in accordance with manufacturer's printed instructions.
- .2 Install wood doors after finishing of walls.
- .3 Ensure that top and bottom edges of wood doors are sealed if they are cut to fit, in accordance with door manufacturer's instructions and warranty requirements.
- .4 Install doors in accordance with manufacturer's instructions.
- .5 Pilot drill screw and bolt holes.
- .6 Machine cut for hardware. Core for handsets and cylinders.
- .7 Coordinate installation of doors with installation of frames specified in Section 06 20 00, and hardware specified in Section 08 71 00.
- .8 Conform to NAAWS standards for fit, clearance, and joint tolerances
- .9 Provide even margins between doors and jambs and doors and finished floor as follows:
- .1 Hinge side: 3 mm (1/8").
- .2 Latchside and head: 3 mm(1/8").
- .3 Finished floor for non-rated assemblies: 12 mm (1/2").

3.2 **ADJUSTMENT 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 instructions.
- .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 instructions.
- .5 Sand and clean woodwork to leave free from finish defects in any exposed part.

END OF SECTION

PART - 1 GENERAL

1.1 SUMMARY

- .1 Section Includes:
 - .1 Labour, Products, equipment and services necessary to complete the work of this Section.

1.2 SUBMITTALS

- .1 Shop Drawings:
 - .1 The hardware specialist shall prepare and submit shop drawings containing a completely itemized schedule of hardware for review. The schedule of hardware shall list all doors by number (in sequence) and location with complete details of the hardware to be supplied, including installation, location and mounting heights of each type of hardware, and special instructions. Format of schedule to be approved.
 - .2 The schedule of hardware shall incorporate the catalogue numbers of hardware as specified.
 - .3 The Contractor shall furnish copies of final reviewed shop drawings to the doors and frames fabricators and to the door and hardware installers.
- .2 Product Data: Manufacturer's specifications and technical data including catalogue cut sheets on each item of hardware. Annotate manufacturer's model numbering systems to explain meaning.
- .3 Wiring Diagrams: Include complete wiring diagrams indicating all component parts, disconnect switches, conduit, and voltage requirements provided under other Sections and required to operate assembly.
- .4 Samples: The hardware specialist shall submit complete samples of hardware items for review.
- .5 Templates: The hardware specialist promptly furnishes templates and information necessary for proper preparation of doors and frames and for the installation of hardware to the doors and frames fabricator and to the doors and hardware installer, in ample time to facilitate the progress of the work.
- .6 Furnish manufacturers' instructions for proper installation of each hardware component.
- .7 Closeout Submittals:
 - .1 Warranty documents executed by manufacturers' authorized official.
 - .2 Operation and Maintenance data: Prior to Date of Substantial Performance, hand over to the Owner, a manual containing a final "as built" hardware schedule, full instructions for the adjustment, maintenance, spare part list etc. of all hardware items, together with special keys, wrenches etc. required to carry out normal adjustments to hardware. Include methods for maintaining installed products and precautions against cleaning materials and methods detrimental to finishes and performance.
- .8 Certification: Prior to date of Substantial Performance, have the hardware specialist provide a letter which certifies that the hardware has been furnished and installed in accordance with hardware manufacturer's instructions and in accordance with requirements of Contract Documents.

1.3 **QUALITY ASSURANCE**

- .1 Conduct pre-installation meeting to verify project requirements, manufacture's installation instructions and manufacturer's warranty requirements.
- .2 Have the supervision, administration and servicing of the work of this Section performed by a hardware specialist certified as an Architectural Hardware Consultant (AHC).
- .3 Installer's Qualifications: Firm experienced in installation of systems similar in complexity to those required for this Project, plus the following.
 - .1 Not less than 3 years of experience with systems.
 - .2 Successfully completed not less than 5 comparable scale projects using this system.
- .4 Have the hardware installer fully cooperate with the hardware specialist to ensure doors and hardware are properly and securely installed and that the installed doors and hardware are functioning properly.

1.4 **INSPECTION AND SUPERVISION**

- .1 The hardware specialist shall examine the Drawings, Hardware Schedules and shop drawings to determine final dimensions, sizes and quantity of the hardware items required, ensure that the hardware listed shall fit and operate properly and make adjustments to the hardware at no extra cost to the Owner.
- .2 The hardware specialist shall obtain electrical characteristics of the security and fire alarm systems from the electrical Subcontractor and furnish electrically operated hardware which suits the electrical characteristics and wiring connection requirements at no extra cost to the Owner.
- .3 The hardware specialist shall obtain and examine shop drawings for doors and frames to ensure proper provisions and preparations for hardware are made.
- .4 The hardware specialist shall make periodic inspections of the hardware and door installations, report improper and unsatisfactory conditions and expedite the replacement or correction of faulty hardware.
- .5 The hardware specialist and the door and hardware installer shall attend job site meetings when so requested.

1.5 **LABELLING, PACKAGING, DELIVERY AND STORAGE**

- .1 Deliver and store each hardware item in the manufacturers' original containers. The containers shall be clearly labelled as to content and door on which the hardware is to be installed, in accordance with the shop drawing schedule of hardware.
- .2 The hardware specialist shall be responsible for ensuring the timely delivery of hardware so that all on site work progresses without delay and interruptions.
- .3 Store hardware in a locked storage room in the building. Lay out all hardware in an organized manner on shelves.
- .4 Stockpile items sufficiently in advance to ensure their availability and make all necessary deliveries in a timely manner to ensure orderly progress of the total Work.
- .5 Store items in such a manner to allow easy access to each hardware item/group as needed without significantly disrupting storage arrangement.
- .6 Review shipments at time of arrival on the site to ensure agreement with respect to items shipped and received, quantity, back ordered or short-shipped items, and adherence to hardware schedule.

1.6 **PROJECT CONDITIONS**

- .1 Maintain environmental conditions (temperature, humidity and ventilation) within limits recommended by manufacturer for optimum results. Do not install product under environmental conditions outside manufacturer's absolute limits.

1.7 **EXTENDED WARRANTY**

- .1 Fully warrant exit devices, locksets, latchsets and door closers for a period of five (5) years from the date of Substantial Performance of the Project.
- .2 The warranty shall state expressly that all hardware will be replaced on the doors and frames at no cost to the Owner in the event of breakage or other defect occurring, willful damage excluded.

PART - 2 PRODUCTS

2.1 **HARDWARE SCHEDULE AND ALTERNATIVES**

- .1 The Hardware Contractor shall submit a complete physical sample of each hardware type for review prior to the preparation of shop drawings. All hardware delivered to the job sites shall be equal in all respects to the accepted sample.

2.2 **MATERIALS**

- .1 General:
 - .1 Hardware shall be as specified in the hardware schedule prepared under the direction of the Consultant and as specified in this Section.
 - .2 Installed hardware shall comply with applicable fire and building codes and requirements of local authorities having jurisdiction over doors and hardware.
 - .3 All hardware applied to metal doors and frames shall be made to template.
 - .4 Supply hardware complete with all necessary screws, bolts and other fastening of suitable size and type to anchor the hardware in position neatly and properly in accordance with the best practices and to the Consultant's approval.
 - .5 All fastenings shall harmonize with the hardware as to materials and finishes.
 - .6 Hardware for fire rated and labelled door and frame assemblies: ULC listed or as accepted by authorities having jurisdiction.
 - .7 Finish on all stainless steel items (C32D) shall be equal to No. 4 finish.
- .2 Hinges:
 - .1 Hinges for exterior doors shall be non-ferrous metal parts so that rust will not bleed from the bearing or other parts. Screws shall be provided in stainless steel.
 - .2 Where specified, provide hinges with non-removable pins or with safety stud feature to prevent doors being removed from frames even if pins are removed.
 - .3 Stamp hinge catalogue numbers on face of leaf of each hinge at factory to enable easy recognition of hinge material and manufacture after doors are hung.
 - .4 Where doors are required to swing to 180 degrees, furnish hinges of sufficient throw to clear trim.
 - .5 Furnish non-removable pins at out-swinging exterior doors.
 - .6 Supply concealed wired electric hinges with ULC label. Hinges to have 8 wires.
- .3 Locks and Latches:

- .1 Provide and install all locks and latches exactly as specified, complete with cylinders.
- .2 Strikes shall be ANSI standard size with curved lip strikes for latch bolts and no lip strikes for dead locks. Provide complete with wrought boxes finished to match strike.
- .4 Exit Devices:
 - .1 All exit devices installed on labelled fire doors shall bear the ULC Label.
 - .2 Through bolts complete with sleeves for mineral core doors.
 - .3 Coordinate exit devices with astragals, coordinators, carry open bars and thresholds for correct and safe operation.
- .5 Keying:
 - .1 All locks and exit devices with cylinder operation shall be keyed alike for construction. Provide 4 change keys for each lock.
 - .2 Permanent keying by Owner at project completion.
- .6 Closers:
 - .1 All door closers shall be hydraulically controlled and full rack and pinion in operation.
 - .2 Each closer shall have adjustable general speed, latch speed and back check control.
 - .3 The swing power of door closers shall be adjustable.
 - .4 Supply to the Owner special closer keys and wrenches as usually packed with closers.
 - .5 Install all necessary attaching brackets, mounting channels, cover plates, etc. where necessary for correct application of door closers.
 - .6 Closers to have parallel arms at out swinging exterior doors and at interior doors where specified.
 - .7 Coordinate closers with overhead holders.
 - .8 Through bolts complete with sleeves for mineral core doors.
- .7 Thresholds:
 - .1 Provide and install thresholds exactly as specified in required widths and lengths to suit door openings.
 - .2 The ends of the thresholds shall be cut to follow exactly the door frame profile.
 - .3 All thresholds shall be supplied in aluminum and installed complete with lead shields and stainless steel screws.
- .8 Push Plates and Kickplates
 - .1 Provide and install stainless steel plates in C32D finish and install secure with screw fastening.
 - .2 Length of kick plates shall be 40 mm less than door width for single doors and 19 mm less than door width for doors in pairs.
 - .3 All stainless steel plates are to be 1.3 mm thick, free of rough or sharp edges. Corners and edges to be slightly radiused. Install kick plates and armor plates on both sides of the door with 3M tape.

- .4 Engrave pushplates with pictographs as noted in hardware schedule.
- .9 Door Push/Pulls:
 - .1 Where door pulls are scheduled on one side of door and push plates on other side issue installations instructions to ensure that the pull is secured through door from reverse side and countersunk flush with door installation of push plate. Locate push plate to cover fasteners for door pulls.
- .10 Door Stops:
 - .1 Wall stops shall not be installed on drywall partitions.
 - .2 Floor stops shall be installed so as not to create a tripping hazard and allows maximum opening of doors.
 - .3 Furnish door stops of height to engage doors.
- .11 Door Seals:
 - .1 Provide and install door seals, top door sweeps and astragals.
- .12 Electronic Hardware Items:
 - .1 Ensure electrical characteristics are compatible with card readers and related security systems provided by other Sections.
 - .2 Obtain electrical power and wiring characteristics from the Electrical Subcontractor and from the Electronic Security Subcontractor and provide the hardware to suit.
 - .3 Power Door Operators: Install operators by skilled trade persons who have been specifically trained in the installation and operation of these devices by a manufacturer's factory representative.
 - .4 All wiring shall be supplied and installed by Division 26 including conduit, boxes and other electrical appurtenances, including connection and termination.
 - .5 Be responsible for ensuring that all wiring work is performed at appropriate times to coordinate with installation of frames, doors and finish hardware. It is also responsible for ensuring that all electrical work is done in accordance with electronic hardware manufacturer's wiring diagrams and directions and that boxes, cut-outs, connections etc. are installed properly.
 - .6 Arrange for testing and commissioning of electronic finish hardware by manufacturer or system. Submit a copy of reports to Consultant.
- .13 Miscellaneous Accessories:
 - .1 All other items, not specifically described but required for complete and proper installation of finish hardware, shall be as selected by Hardware Supplier subject to approval of the Consultant.
- .14 Hardware Finish Codes:

	BHMA	Canadian Code	US Code	Description
.1	600	CP	USP	Primed for Paint
.2	602	C2C	US2C	Cadmium Plated
.3	603	C2G	US2G	Zinc Plated
.4	605	C3	US3	Brightened Brass, Clear Coated
.5	606	C4	US4	Satin Brass, Clear Coated

.6	612	C10	US10B	Satin Bronze, Clear Coated
.7	613	C10B	US10B	Oxidized Satin Bronze Oil Rub
.8	619	C15	US15	Satin Nickel Plate, Clear Coat
.9	625	C26	US26	Bright Chromium Plated
.10	626	C26D	US26D	Satin Chromium Plated
.11	627	C27	US27	Satin Aluminum Clear Coated
.12	628	C28	US28	Satin Aluminum Clear Anodize
.13	629	C32	US32	Polished Stainless Steel
.14	630	C32D	US32D	Satin Stainless Steel
.15	671	AL		Black Anodized
.16	689	SBL, AL	US28	Aluminum Paint
.17	690	DBL, STAT	US20	Dark Bronze Paint
.18	691	ES, SB		Bronze Lacquer
.19	692	TAN		Tan Lacquer
.20	693	KPD, BLACK		Black Lacquer
.21	696	EAB, SB		Satin Brass Lacquer
.15	Keying symbol/codes:			
.1	GMK			Grand Master Keyed
.2	MK			Master Keyed
.3	KA			Keyed Alike
.4	KD			Keyed Different
.5	SK			Separate Key (no masters)
.16	Hardware codes:			
.1	LH			Left Hand
.2	RH			Right Hand
.3	LHR			Left Hand Reverse
.4	RHR			Right Hand Reverse
.5	LHA			Left Hand Active
.6	RHA			Right Hand Active
.7	LHRA			Left Hand Reverse Active
.8	RHRA			Right Hand Reverse Active
.9	SGL,SGLE			Single
.10	PR			Pair
.11	D/A			Double Acting
.12	O/S			Opposite Swing
.13	D/E			Double Egress

.14	DR	Door
.15	FR	Frame
.16	HM	Hollow Metal
.17	AL	Aluminum
.18	PS	Pressed Steel
.19	P/LAM	Plastic Laminate
.20	KAL	Kalamein
.21	HMD	Hollow Metal Door
.22	HMF	Hollow Metal Frame
.23	CIF	Channel Iron Frame
.24	PSF	Pressed Steel Frame
.25	WD	Wood
.26	WD/DR	Wood Door
.27	WD/FR	Wood Frame
.28	CYL	Cylinder
.29	H/O	Hold Open
.30	O/H	Overhead
.31	U/C	Undercut
.32	B/S	Back Set
.33	NRP	Not Removable Pin
.34	TB	Thru Bolts
.35	CTB	Countersunk Thru Bolts
.36	TMS	Template Machine Screws
.37	MS	Machine Screws
.38	STS	Self Tapping Screws
.39	WS/LS	Wood Screws & Lead Shields
.40	TRR	Labeled for Temperature Rise Rating.
.41	A Label, 3 Hour Label or 180MFR	Labeled for 180 minutes (3 hour) Fire Protection Rating.
.42	B Label, 1-1/2 Hour Label or 90 MFR	Labeled for 90 minutes (1-1/2hour) Fire Protection Rating.
.43	C Label, 3/4 Hour Label or 45 MFR	Labeled for 45 minutes (3/4 hour) Fire Protection Rating.
.44	20 MIN Label or 20 MFR	Labeled for 20 minutes Fire Protection Rating.

PART - 3 EXECUTION
3.1 **EXAMINATION**

- .1 Verification of Conditions: Examine doors, frames, related items and conditions under which work of this section is to be performed and identify conditions detrimental to proper and timely completion.
 - .1 Do not proceed until unsatisfactory conditions have been corrected.
- .2 Confirm kickplate and threshold sizes before ordering.

3.2 **INSTALLATION**

- .1 Install hardware to standard hardware location dimensions in accordance with Canadian Metric Guide to Steel Doors and Frames (Modular Construction) prepared by Canadian Steel Door and Frame Manufacturers' Association, except as otherwise indicated in this Section and elsewhere in the Contract Document.
- .2 Do not install surface mounted items until finishes have been completed on the substrate. Set units level, plumb and true to line and location. Adjust and reinforce the attachment substrate as necessary for proper installation and operation.
- .3 Where door stop contacts door pulls, mount stop to strike bottom of pull.
- .4 Barrier Free Access: Mount all hardware in full conformity with authorities having jurisdiction. Confirm mounting heights with Consultant prior to commencement of frame and door preparation.
- .5 Install all miscellaneous hardware as shown on details and specified.
- .6 Do not use wall stops on gypsum board, demountable or moveable partitions.
- .7 Mineral core doors: Pre-drill 3 mm diameter pilot holes for all hardware items. Manually turn fasteners into pilot holes. If installer does not follow this method, it may void door manufacturer warranty.
- .8 Provide even margins between doors and jambs and doors and flooring and/or thresholds as follows:
 - .1 Hinge side: 1.6 mm.
 - .2 Latchside and head: 1.6 mm.
 - .3 Flooring and/or thresholds: 12 mm.
 - .4 Flooring, fire rated assemblies: 6 mm.

3.3 **HARDWARE MOUNTING HEIGHTS**

- .1 Install and mount hardware as follows:
 - .1 Door knobs and lever: 965 mm centre line from finish floor
 - .2 Deadlock cylinder: 1370 mm centre line from finish floor
 - .3 Deadlatch cylinders: 1370 mm centre line from finish floor
 - .4 Door pulls: 1069 mm centre line from finish floor
 - .5 Push plates: 1090 mm centre line from finish floor
 - .6 Push bars: 1069 mm centre line from finish floor
 - .7 Top hinges: 125 mm down from top of door to top of hinge
 - .8 Bottom hinges: 250 mm up from finish floor to bottom of hinge
 - .9 Intermediate hinges: equally spaced between top and bottom hinges
 - .10 Floor stops: maximum 150 mm from lock edge when door is in fully open position

- .11 Exit devices: to manufacturer's instructions
- .12 Kickplates: maximum 3 mm from bottom of door to bottom of kickplate

3.4 **ADJUSTING AND CLEANING**

- .1 Clean hardware with materials and methods as recommended by hardware manufacturer. Repair or replace defective hardware.
- .2 Remove protective material where present.
- .3 Adjust operable parts for correct function.
- .4 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

DOOR HARDWARE

08 71 00

PROJECT:



Sunnybrook Health Science Centre
K Wing Hematology
2075 Bayview Ave.
Toronto, ON

ARCHITECT:

NORR

175 Bloor Street East
North Tower, 15th Floor.
Toronto, ON

Prepared By: Chad Connors
Date: December 7, 2023
Revised: March 18, 2024

Architectural Hardware Finishes

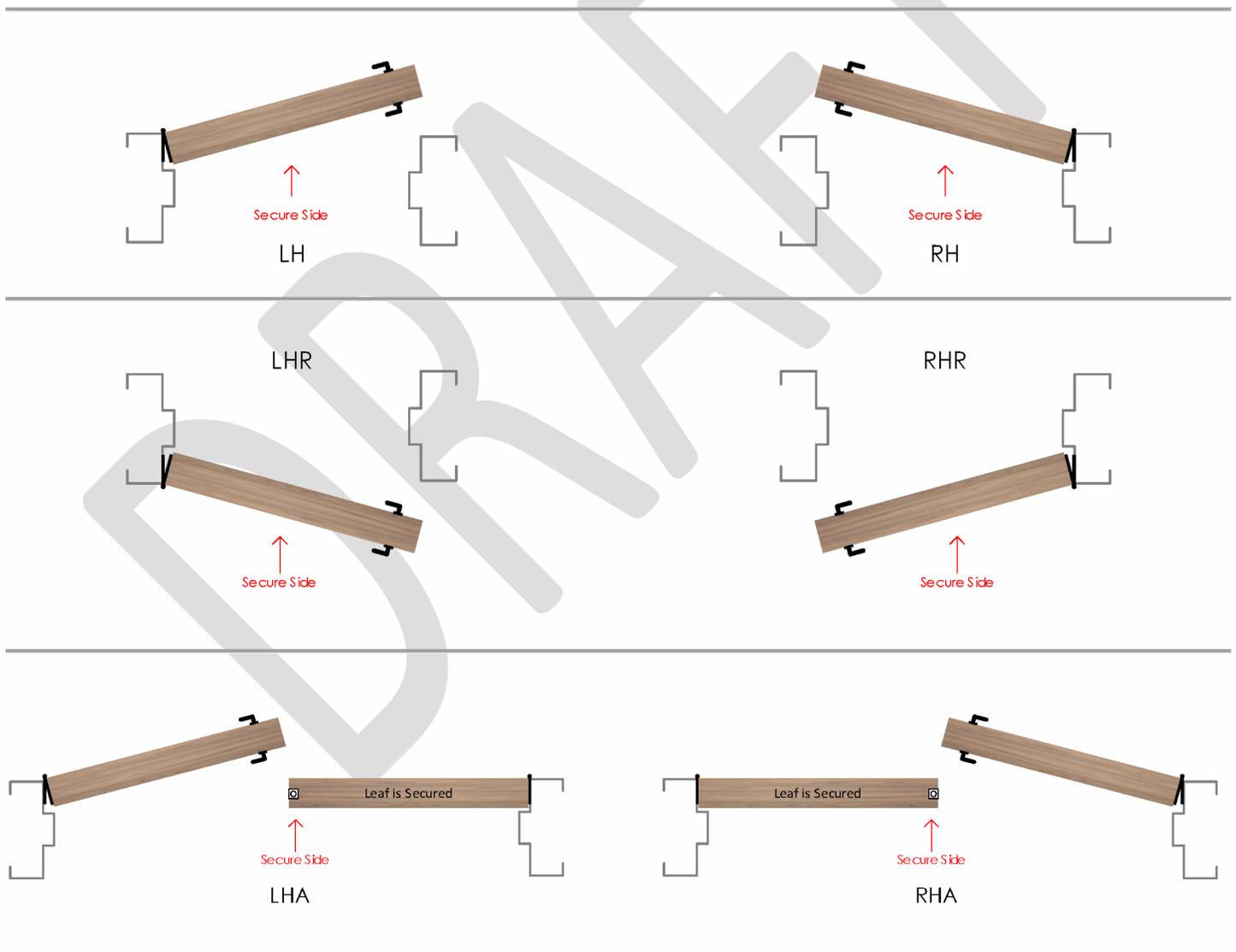
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Clear Anodized				628	689	US28
Satin Nickel	646		619	670		US15
Polished Nickel	645		618	669		US14
Satin Stainless Steel		630				US32D
Polished Stainless Steel		629				US32
Satin Chrome	652		626	702		US26D
Polished Chrome	651		625	672		US26
Satin Brass	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

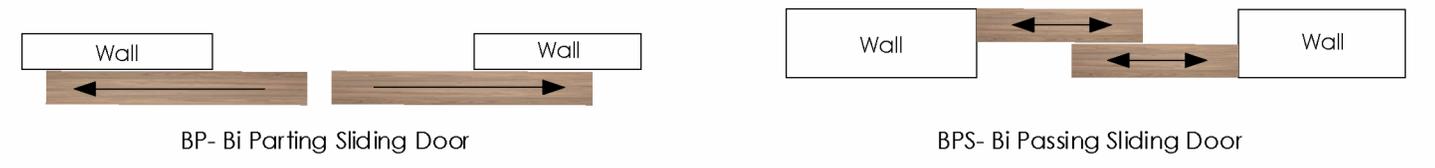
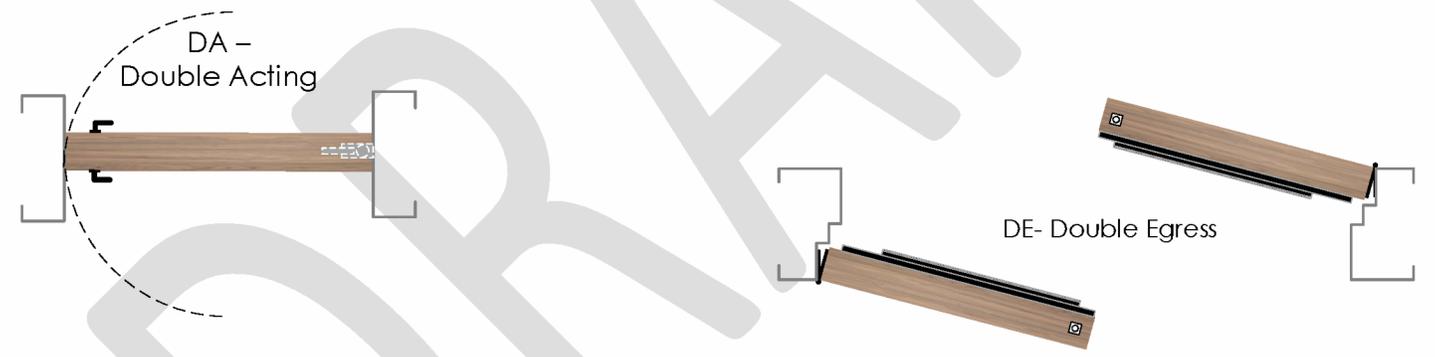
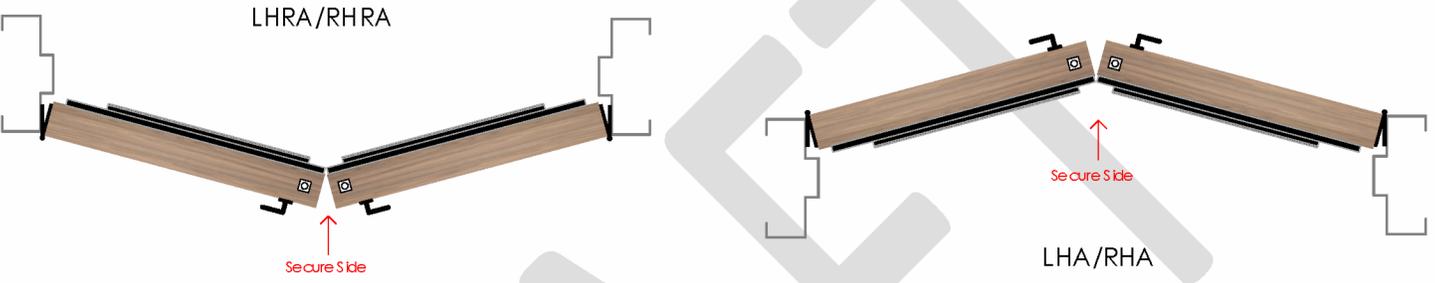
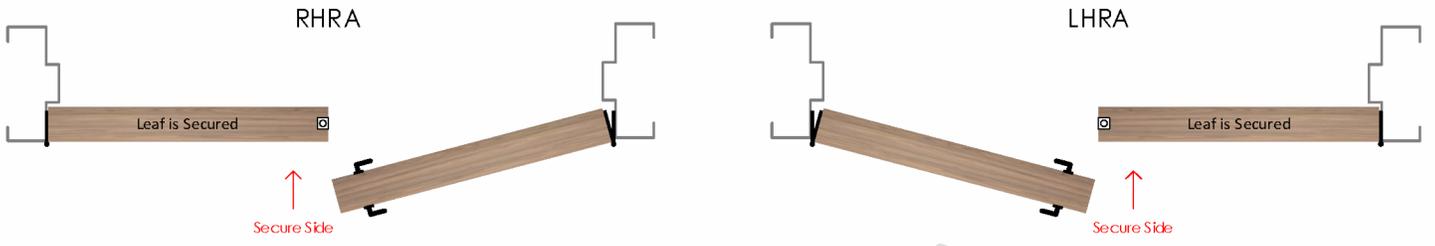
Door Handing's

Abbreviaions

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
Continuous Hinge	SL11HD	Select		
Power Transfer	EPT-10	Von Duprin		
Lockset	L9000 series	Schlage		
Door Closer	4011	LCN		
Electric Strike	1006	HES		
Overhead Stop	100 series	Glynn Johnson		
Auto Door operator	ED100 / ED250	Dormakaba		
Wave Actuator	CM-331	Camden		
Logic Relay	CX-33	Camden		
Restroom Control Kit	CX-WC16	Camden		
Emergency Call Kit	CX-WEC10K2	Camden		
Kickplate	K10A	Standard Metal		
Flush Bolt	F65UL	Standard Metal		
Smoke / Sound Seal	W-66	KN Crowder		
Door Bottom	CT-53	KN Crowder		

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
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
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
¼ 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:	3'2" x 7'0" x 1 1/4"	STC Rating	None
Door Material:	SCWD	Frame Material:	HMF	Fire Rating	None

1 Total Openings								
1	Door#	K3C00A. 1	Location:	Corridor	To	Reception K3C00A	Handing:	LH

Web Link
Site Verified

By Hardware Supplier

1	Continuous Hinge	SL11HD x 83" x TIPIT	628 / US28 / Clear Anodized	Select	Web Link	<input type="checkbox"/>
1	Storeroom Lockset	L9080BDC-03B	630 / US32D / Satin Stainless Steel	Schlage	Web Link	<input type="checkbox"/>
1	Electric Strike	1006CS	630 / US32D / Satin Stainless Steel	HES	Web Link	<input type="checkbox"/>
1	Overhead Stop	104S	630 / US32D / Satin Stainless Steel	Glynn Johnson	Web Link	<input type="checkbox"/>
1	Door Closer	4011 x ST-1544	689 / US28 / Painted Aluminum	LCN	Web Link	<input type="checkbox"/>
1	Mounting Plate	4010-18	689 / US28 / Painted Aluminum	LCN	Web Link	<input type="checkbox"/>
1	Kickplate	K10A 10" x 36 1/2"	630 / US32D / Satin Stainless Steel	Standard Metal	Web Link	<input type="checkbox"/>
1	Smoke / Sound Seal	W-66 x 17'2"	Black	KN Crowder	Web Link	<input type="checkbox"/>

By Security Supplier

1	Card Reader	By Security Supplier			Web Link	<input type="checkbox"/>
1	Door Contact	By Security Supplier			Web Link	<input type="checkbox"/>
1	Request to Exit	By Security Supplier			Web Link	<input type="checkbox"/>
1	Door Controller	By Security Supplier			Web Link	<input type="checkbox"/>
1	Power Supply	By Security Supplier			Web Link	<input type="checkbox"/>

By Owner

1	Permanent Cylinder	Best Coremax SFIC by Sunnybrook Locksmith	626 / US26D / Satin Chrome	Best		<input type="checkbox"/>
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Method of Operation:

Ingress: Valid card authorization releases the electric strike allowing ingress.

Egress: Rotating the lever allows egress, the request to exit sensor alerts security of an authorized exit.

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

DRAFT

Heading# 2

Opening Information					
Opening Type:	Single	Opening Size:	3'2" x 7'0" x 1 3/4"	STC Rating	STC 35
Door Material:	SCWD	Frame Material:	HMF	Fire Rating	None

3	Total Openings							
1	Door#	K3C00B. 1	Location:	Corridor	To	Staff Room K3C00B	Handing:	LH
1	Door#	K3C00C. 1	Location:	Corridor	To	Team Room K3C00C	Handing:	RH
1	Door#	K3C62.1	Location:	Corridor	To	Private Meeting Room K3C62	Handing:	LH

Web Link
Site Verified

By Hardware Supplier					
3	Continuous Hinge	SL11HD x 83" x TIPIT	628 / US28 / Clear Anodized	Select	<input type="checkbox"/>
3	Office Lockset	L9050BDC-03B	630 / US32D / Satin Stainless Steel	Schlage	<input type="checkbox"/>
3	Overhead Stop	104S	630 / US32D / Satin Stainless Steel	Glynn Johnson	<input type="checkbox"/>
3	Door Closer	4011 x ST-1544	689 / US28 / Painted Aluminum	LCN	<input type="checkbox"/>
3	Mounting Plate	4010-18	689 / US28 / Painted Aluminum	LCN	<input type="checkbox"/>
3	Kickplate	K10A 10" x 36 1/2"	630 / US32D / Satin Stainless Steel	Standard Metal	<input type="checkbox"/>
3	Smoke / Sound Seal	W-66 x 17'2"	Black	KN Crowder	<input type="checkbox"/>
3	Door Bottom	CT-53 x 38"	719 Milled Aluminum	KN Crowder	<input type="checkbox"/>
By Owner					
3	Permanent Cylinder	Best Coremax SFIC by Sunnybrook Locksmith	626 / US26D / Satin Chrome	Best	<input type="checkbox"/>

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

Opening Information					
Opening Type:	Single	Opening Size:	3'2" x 7'0" x 1 3/4"	STC Rating	STC 35
Door Material:	SCWD	Frame Material:	HMF	Fire Rating	None

4	Total Openings							
1	Door#	K3C00E. 1	Location:	Corridor	To	APN Office K3C00E	Handing:	RH
1	Door#	K3C00F. 1	Location:	Corridor	To	SW Office K3C00F	Handing:	RH
1	Door#	K3C00G. 1	Location:	Corridor	To	MD Office K3C00G	Handing:	RH
1	Door#	K3C00H. 1	Location:	Corridor	To	PCM Office K3C00HE	Handing:	LH

[Web Link](#)
[Site Verified](#)

By Hardware Supplier							
4	Continuous Hinge	SL11HD x 83" x TIPIT	628 / US28 / Clear Anodized	Select		<input type="checkbox"/>	
4	Office Lockset	L9050BDC-03B	630 / US32D / Satin Stainless Steel	Schlage		<input type="checkbox"/>	
4	Overhead Stop	104S	630 / US32D / Satin Stainless Steel	Glynn Johnson		<input type="checkbox"/>	
4	Smoke / Sound Seal	W-66 x 17'2"	Black	KN Crowder		<input type="checkbox"/>	
4	Door Bottom	CT-53 x 38"	719 Milled Aluminum	KN Crowder		<input type="checkbox"/>	
By Owner							
4	Permanent Cylinder	Best Coremax SFIC by Sunnybrook Locksmith	626 / US26D / Satin Chrome	Best		<input type="checkbox"/>	

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



Heading#

4

Opening Information

Opening Type:	Single	Opening Size:	4'0" x 7'0" x 1 3/4"	STC Rating	STC 45
Door Material:	HMD	Frame Material:	HMF	Fire Rating	None

2	Total Openings							
1	Door#	K3C21.1	Location:	Corridor 3200C	From	Patient Room K3C21	Handing:	LHR
1	Door#	K3C21A. 2	Location:	Exam Room K3C21A	From	Patient Room K3C21	Handing:	LHR

Web Link

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By Hardware Supplier

	Hinge	By STC Door Manufacturer				
						<input type="checkbox"/>
2	Passage Set	L9010-03B	630 / US32D / Satin Stainless Steel	Schlage		<input type="checkbox"/>
2	Electric Strike	1006CS	630 / US32D / Satin Stainless Steel	HES		<input type="checkbox"/>
2	Overhead Stop	106S	630 / US32D / Satin Stainless Steel	Glynn Johnson		<input type="checkbox"/>
4	Armour Plate	K10A 34" x 46 1/2"	630 / US32D / Satin Stainless Steel	Standard Metal		<input type="checkbox"/>
2	Sound Seal	By STC Door Manufacturer				<input type="checkbox"/>
2	Door Bottom	By STC Door Manufacturer				<input type="checkbox"/>

By Automatics Supplier

2	Auto Door Operator	ED250-4X6-SGL-PUSH-NH-CL 48-19	689 / US28 / Painted Aluminum	Dormakaba		<input type="checkbox"/>
4	Wave Actuator	CM-331/42-SWSGLR	630 / US32D / Satin Stainless Steel	Camden		<input type="checkbox"/>
2	Logic Relay	CX-33		Camden		<input type="checkbox"/>

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 and back boxes with pull cords are to be provided by the electrical contractor.
- Electrician to confirm wire locations with auto door operator supplier prior to pulling wires.

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



Heading#

5

Opening Information

Opening Type:	Pair	Opening Size:	1 – 4'0" & 1 – 2'0" x 7'0" x 1 3/4"	STC Rating	STC 45
Door Material:	HMD	Frame Material:	HMF	Fire Rating	None

1	Total Openings							
1	Door#	K3C21A. 1	Location:	Corridor 3200C	To	Exam Room K3C21A	Handing:	LHA

Web Link
Site Verified

By Hardware Supplier

	Hinge	By STC Door Manufacturer				<input type="checkbox"/>
2	Power Transfer	EPT-10	689 / US28 / Painted Aluminum	Von Duprin		<input type="checkbox"/>
1	Storeroom Lockset	RX-L9080BDC-03B	630 / US32D / Satin Stainless Steel	Schlage		<input type="checkbox"/>
1	Flush Bolt	F65UL	630 / US32D / Satin Stainless Steel	Standard Metal		<input type="checkbox"/>
1	Electric Strike	1006CS	630 / US32D / Satin Stainless Steel	HES		<input type="checkbox"/>
1	Overhead Stop	102S	630 / US32D / Satin Stainless Steel	Glynn Johnson		<input type="checkbox"/>
1	Overhead Stop	106S	630 / US32D / Satin Stainless Steel	Glynn Johnson		<input type="checkbox"/>
2	Armour Plate	K10A 34" x 22 1/2"	630 / US32D / Satin Stainless Steel	Standard Metal		<input type="checkbox"/>
2	Armour Plate	K10A 34" x 46 1/2"	630 / US32D / Satin Stainless Steel	Standard Metal		<input type="checkbox"/>
1	Sound Seal	By STC Door Manufacturer				<input type="checkbox"/>
1	Door Bottom	By STC Door Manufacturer				<input type="checkbox"/>

By Security Supplier

1	Card Reader	By Security Supplier				<input type="checkbox"/>
2	Door Contact	By Security Supplier				<input type="checkbox"/>
1	Request to Exit	Located in lockset wired by Security Supplier				<input type="checkbox"/>
1	Door Controller	By Security Supplier				<input type="checkbox"/>
1	Power Supply	By Security Supplier				<input type="checkbox"/>

By Automatics Supplier

1	Auto Door Operator	ED250-4X6-SGL-PULL-NH-CL 48-19	689 / US28 / Painted Aluminum	Dormakaba		<input type="checkbox"/>
2	Wave Actuator	CM-331/42-SWSGLR	630 / US32D / Satin Stainless Steel	Camden		<input type="checkbox"/>
1	Logic Relay	CX-33		Camden		<input type="checkbox"/>
By Owner						
1	Permanent Cylinder	Best Coremax SFIC by Sunnybrook Locksmith	626 / US26D / Satin Chrome	Best		<input type="checkbox"/>

Notes:

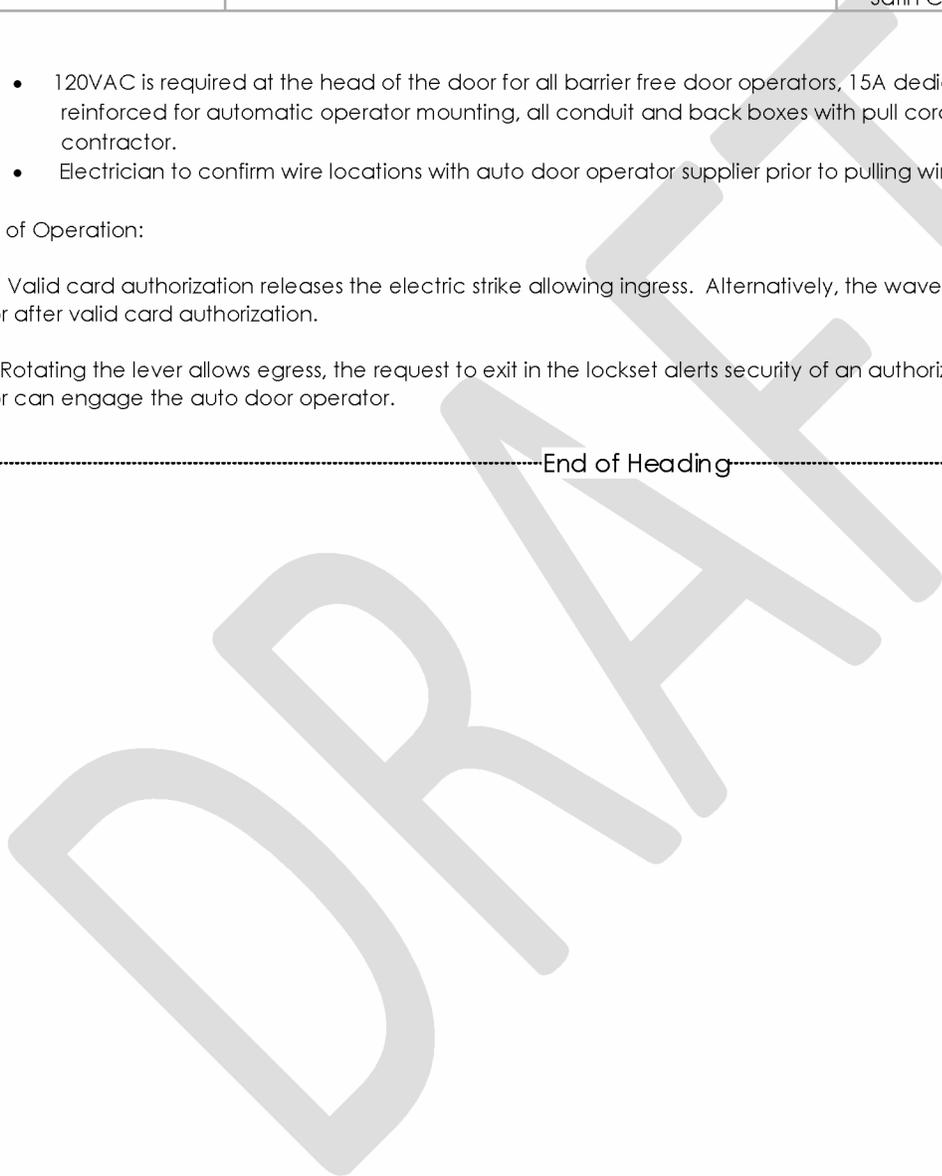
- 120VAC is required at the head of the door for all barrier free door operators, 15A dedicated circuit. Wall/Frame must be reinforced for automatic operator mounting, all conduit and back boxes with pull cords are to be provided by the electrical contractor.
- Electrician to confirm wire locations with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

Method of Operation:

Ingress: Valid card authorization releases the electric strike allowing ingress. Alternatively, the wave actuator can engage the auto door operator after valid card authorization.

Egress: Rotating the lever allows egress, the request to exit in the lockset alerts security of an authorized exit. Alternatively, the wave actuator can engage the auto door operator.

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





Heading#

6

Opening Information

Opening Type:	Single	Opening Size:	3'4" x 7'0" x 1 3/4" (Existing SCWD door and HMF frame)	STC Rating	None
Door Material:	Existing	Frame Material:	Existing	Fire Rating	None

1	Total Openings							
1	Door#	K3C23A.1	Location:	Patient Room	From	Washroom K3C23A	Handing:	RHR

Web Link
Site Verified

By Hardware Supplier

		Remainder of hardware to be re-used existing	628 / US28 / Clear Anodized	Select		<input type="checkbox"/>
1	Storeroom Lockset	L9080BDC-03B	630 / US32D / Satin Stainless Steel	Schlage		<input type="checkbox"/>
1	Electric Strike	1006CS (fail safe)	630 / US32D / Satin Stainless Steel	HES		<input type="checkbox"/>

By Automatics Supplier

1	Auto Door Operator	ED100-4X6-SGL-PULL-NH-CL 40-19	689 / US28 / Painted Aluminum	Dormakaba		<input type="checkbox"/>
1	Touchless Restroom Control Kit	CX-WC16	630 / US32D / Satin Stainless Steel	Camden		<input type="checkbox"/>
1	Emergency Call Kit	CX-WEC10K2	630 / US32D / Satin Stainless Steel	Camden		<input type="checkbox"/>

By Owner

1	Permanent Cylinder	Best Coremax SFIC by Sunnybrook Locksmith	626 / US26D / Satin Chrome	Best		<input type="checkbox"/>
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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 and back boxes with pull cords are to be provided by the electrical contractor.
- Electrician to confirm wire locations with auto door operator supplier prior to pulling wires.

Method of Operation:

Ingress: Manually pull the door for ingress. Alternatively, the touchless button engages the auto door operator. Once inside the washroom the touchless 'wave to lock' actuator locks the outside wall actuator and engages the electric strike. The outside actuator changes colour to indicate the washroom is in use. In the event of an emergency, push the emergency button and audible/visual signal will activate and the door will unlock for access, while sending a signal to the nurse station.

Egress: Rotate lever for manual egress, alternatively the actuator will engage the auto operator.

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

DRAFT



Heading# 7

Opening Information					
Opening Type:	Single	Opening Size:	3'2" x 7'0" x 1 1/4"	STC Rating	None
Door Material:	HMD	Frame Material:	HMF	Fire Rating	None

1 Total Openings								
1	Door#	K3C39.1	Location:	Corridor	To	Storage Room K3C39.1	Handing:	LH

Web Link
Site Verified

By Hardware Supplier						
1	Continuous Hinge	SL11HD x 83" x TIPIT	628 / US28 / Clear Anodized	Select		<input type="checkbox"/>
1	Storeroom Lockset	L9080BDC-03B	630 / US32D / Satin Stainless Steel	Schlage		<input type="checkbox"/>
1	Electric Strike	1006CS	630 / US32D / Satin Stainless Steel	HES		<input type="checkbox"/>
1	Overhead Stop	104S	630 / US32D / Satin Stainless Steel	Glynn Johnson		<input type="checkbox"/>
1	Door Closer	4011 x ST-1544	689 / US28 / Painted Aluminum	LCN		<input type="checkbox"/>
1	Mounting Plate	4010-18	689 / US28 / Painted Aluminum	LCN		<input type="checkbox"/>
1	Kickplate	K10A 10" x 36 1/2"	630 / US32D / Satin Stainless Steel	Standard Metal		<input type="checkbox"/>
1	Smoke / Sound Seal	W-66 x 17"2"	Black	KN Crowder		<input type="checkbox"/>
By Security Supplier						
1	Card Reader	By Security Supplier				<input type="checkbox"/>
1	Door Contact	By Security Supplier				<input type="checkbox"/>
1	Request to Exit	By Security Supplier				<input type="checkbox"/>
1	Door Controller	By Security Supplier				<input type="checkbox"/>
1	Power Supply	By Security Supplier				<input type="checkbox"/>
By Owner						
1	Permanent Cylinder	Best Coremax SFIC by Sunnybrook Locksmith	626 / US26D / Satin Chrome	Best		<input type="checkbox"/>

Method of Operation:

Ingress: Valid card authorization releases the electric strike allowing ingress.

Egress: Rotating the lever allows egress, the request to exit sensor alerts security of an authorized exit.

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

DRAFT



Heading#

8

Opening Information				
Opening Type:	Single	Opening Size:	3'2" x 7'0" x 1 1/4"	STC Rating STC 35
Door Material:	HMD	Frame Material:	HMF	Fire Rating None

1 Total Openings							
1	Door#	K3C00D. 1	Location:	Corridor	To	Locker Room K3C00D	Handing: RH

Web Link
Site Verified

By Hardware Supplier

1	Continuous Hinge	SL11HD x 83" x TIPIT	628 / US28 / Clear Anodized	Select		<input type="checkbox"/>
1	Storeroom Lockset	L9080BDC-03B	630 / US32D / Satin Stainless Steel	Schlage		<input type="checkbox"/>
1	Electric Strike	1006CS	630 / US32D / Satin Stainless Steel	HES		<input type="checkbox"/>
1	Overhead Stop	104S	630 / US32D / Satin Stainless Steel	Glynn Johnson		<input type="checkbox"/>
1	Door Closer	4011 x ST-1544	689 / US28 / Painted Aluminum	LCN		<input type="checkbox"/>
1	Mounting Plate	4010-18	689 / US28 / Painted Aluminum	LCN		<input type="checkbox"/>
1	Kickplate	K10A 10" x 36 1/2"	630 / US32D / Satin Stainless Steel	Standard Metal		<input type="checkbox"/>
1	Smoke / Sound Seal	W-66 x 17'2"	Black	KN Crowder		<input type="checkbox"/>
1	Door Bottom	CT-53 x 38"	719 Milled Aluminum	KN Crowder		<input type="checkbox"/>

By Security Supplier

1	Card Reader	By Security Supplier				<input type="checkbox"/>
1	Door Contact	By Security Supplier				<input type="checkbox"/>
1	Request to Exit	By Security Supplier				<input type="checkbox"/>
1	Door Controller	By Security Supplier				<input type="checkbox"/>
1	Power Supply	By Security Supplier				<input type="checkbox"/>

By Owner

1	Permanent Cylinder	Best Coremax SFIC by Sunnybrook Locksmith	626 / US26D / Satin Chrome	Best		<input type="checkbox"/>
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Method of Operation:

Ingress: Valid card authorization releases the electric strike allowing ingress.

Egress: Rotating the lever allows egress, the request to exit sensor alerts security of an authorized exit.

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

DRAFT

Heading#

9

Opening Information					
Opening Type:	Pair	Opening Size:	2 - 1'6" x 7'0" x 1 3/4"	STC Rating	STC 35
Door Material:	SCWD	Frame Material:	HMF	Fire Rating	None

1	Total Openings							
1	Door#	K3C00C. 2	Location:	Team Room K3C00C	From	AV Closet	Handing:	RHRA

Web Link
Site Verified

By Hardware Supplier							
2	Continuous Hinge		SL11HD x 83" x TIPIT	628 / US28 / Clear Anodized	Select		<input type="checkbox"/>
1	Flush Bolt		F65UL	630 / US32D / Satin Stainless Steel	Standard Metal		<input type="checkbox"/>
1	Storeroom Lockset		L9080BDC-03B	630 / US32D / Satin Stainless Steel	Schlage		<input type="checkbox"/>
2	Overhead Stop		1026	630 / US32D / Satin Stainless Steel	ABH		<input type="checkbox"/>
1	Smoke / Sound Seal		W-66 x 15'6"	Black	KN Crowder		<input type="checkbox"/>
1	Astragal Set		W-25 x 2/7"	628 / US28 / Clear Anodized	KN Crowder		<input type="checkbox"/>
2	Door Bottom		CT-53 x 18"	719 Milled Aluminum	KN Crowder		<input type="checkbox"/>
By Owner							
1	Permanent Cylinder		Best Coremax SFIC by Sunnybrook Locksmith	626 / US26D / Satin Chrome	Best		<input type="checkbox"/>

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

End of Door Hardware Schedule

PART - 1 GENERAL

1.1 SUMMARY

- .1 Section Includes:
 - .1 Labour, Products, equipment and services necessary to complete the work of this Section.
 - .2 This Section includes glazing work not specified in other Sections. Refer to other Sections for other glazing.
- .2 Related Requirements
 - .1 Comply with Conditions of the Contract and Division 01 - General Requirements.

1.2 SUBMITTALS

- .1 Shop drawings:
 - .1 Submit shop drawings indicating manufacturing and installation details.
- .2 Product Data: Submit manufacturer's product specifications, including the PVB interlayer products. Include documentation of compliance with specified requirements, referenced tests, and compatibility of all products in contact with glazing.
 - .1 Provide Installer signed letter listing all products to be used, with signed letters from each glass, sealant, glazing tape, and blocking manufacturer certifying their compatibility.
 - .2 Provide a sample warranty and instructions for handling, storing, installing, cleaning and protecting each type of glass and glazing material.
- .3 Samples:
 - .1 Submit samples for each type of glass and of glazing materials identifying quality and type of glass if required by the Consultant before commencing work.
 - .2 Submit samples for each type of film.
 - .3 Ensure samples are clearly labelled with manufacturer's name and type.
- .4 Certificates:
 - .1 Submit manufacturer's certification compatibility of glass and glazing materials.
- .5 Test Results:
 - .1 Provide test results in accordance with ASTM C1087 and ASTM C794 showing compatibility of applied sealants with accessories used in butt-joint glazing systems and also determine strength, ability of cured sealant to maintain a bond to substrate under severe conditions and characteristics of peel properties of a cured-in-place elastomeric joint sealants for use in butt-joint glazing. Provide a statement and test data confirming sealant used in design indicated to accommodate design load requirements without failure.
- .6 Operations and Maintenance Manual: Information on cleaning, maintenance and replacement of all types of glass or glazing products shall be included in the Operations and Maintenance Manual.

1.3 QUALITY ASSURANCE

- .1 Installer Qualifications: Glazier shall have minimum five (5) years' experience in the successful installation of glazing products similar to those specified for this Project.

- .2 Glazing Installation Standard: Comply with recommendations of the GANA (Glass Association of North America), "Glazing Manual" and "Glazing Sealing Systems Manual" except where more stringent requirements are called for by manufacturers or these specifications. Refer to GANA for definitions of glass and glazing terms not otherwise defined.
- .3 Safety Glazing Standard: Where safety glass is indicated or required by authorities having jurisdiction, provide type of products indicated which comply with OBC, ANSI Z97.1, and requirements of CPSC 16 CFR Part 1201 for category II materials.
- .4 Single Source Responsibility: Provide materials obtained from one source for each type of glass and glazing product indicated, and for visually related areas.
- .5 Pre-installation Conference: at least two weeks prior to commencing work of this Section, arrange for manufacturer's technical representative to visit the site and review preparatory and installation procedures to be followed, conditions under which the work will be done, and inspect the surfaces to receive the work of this Section. Advise the Consultant of the date and time of the meeting.
- .6 Manufacturer's site inspection: Have the manufacturer's technical representative inspect the Work at suitable intervals during application and at conclusion of the work of this Section, to ensure the Work is correctly installed. When requested, submit manufacturer's inspection reports and verification that the work of this Section is correctly installed.
- .7 Mock-Up: Provide a mock-up of film application for evaluation of surface preparation techniques, application workmanship, and to confirm pattern.
 - .1 Finish areas designated by the Consultant.
 - .2 Do not proceed with remaining work until workmanship is reviewed by the Consultant.

1.4 **DELIVERY, STORAGE AND HANDLING**

- .1 Handle and store materials and products in accordance with manufacturer's recommendations. Deliver and store packaged materials and products in original, undamaged containers with manufacturer's labels and seals intact.

1.5 **WARRANTY**

- .1 Laminated glass products: Provide written 5-year warranty from date of manufacture for laminated glass. 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 Double glazed units: Provide written 10-year warranty against defects in the insulating glass units and warrant them to be free from material obstruction of vision as a result of dust or film formation on the internal glass surfaces by any cause, under design conditions, other than extrinsic glass breakage, but including breakage due to thermal shock and temperature differential due to inherent glass faults.
- .3 Warrant mirrors against defects in materials and workmanship for a period of 5 years against silver deterioration and for a period of two years against loosening the metal frames or fastening, and against cracking of the mirrors.

PART - 2 PRODUCTS

2.1 **GENERAL**

- .1 Glass: Each unit bearing manufacturer's label indicating quality and thickness.

- .2 Thickness of glass: Glass thicknesses indicated or scheduled in the Contract Documents are minimums required. Exact thickness of glass to be engineered to account for size of glass and application, to satisfy building code requirements and requirements of authorities having jurisdiction.

2.2 **GLASS**

- .1 Float glass (GL-F): CAN/CGSB-12.3, glazing quality polished.
- .2 Tempered Safety Glass (GL-T):
 - .1 ASTM C1048, Kind FT (fully tempered), Condition A (uncoated surfaces), Type I (transparent glass, flat), Class 1 (clear), Quality q3 (glazing select), and meeting requirements of ANSI Z97.1, tong and roller marks free, minimum thickness 6 mm.
 - .2 Ensure surface compression is equal to or greater than 68.9 MPa (10 000 psi)
 - .3 Tempered glass material to come from one tempering furnace and be tempered to minimize distortion variance.
 - .1 Roller-wave distortion not to exceed 0.127 mm (0.005") from peak to valley.
 - .2 Maximum peak to valley roller-wave 0.8 mm (0.003") in the central area and 0.20 mm (0.008") within 267 mm (10.5") of the leading and trailing edge.
 - .3 Maximum bow and warp 0.79 mm per lineal 305 mm (1/32" per lineal foot).
- .3 Fire-Rated Glass: laminated fire-rated and impact safety-rated to ANSI Z97.1, FireLite Plus Visually Clear by Technical Glass Products or approved equivalent.
- .4 Translucent film: Polycarbonate film, 3 mils thick, velvet texture finish, Crystal Matte by Convenience Group or other approved equivalents.

2.3 **GLAZING MATERIALS**

- .1 General - Glazing materials (fire-rated and non-fire-rated): 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 Shims, spacers and setting blocks: 45, 70 and 90 Durometer A hardness plus/minus 5 respectively, neoprene rubber, resistant to oxidation and permanent deformation under load.
- .3 Glazing gaskets: Extruded neoprene or EPDM of approved profile. Tensile strength of 7300 kPa; Durometer A hardness of 50 plus/minus 5; 25% maximum permanent set; 300 % minimum elongation at break; and resistant to ozone, showing no cracks.
- .4 All glazing materials, products, primers and cleaning solvents: Mutually compatible.
- .5 Colours for glazing materials: As selected later and not necessarily standard colours. (*to match colour of entrance and screen frames*).

2.4 **FABRICATION**

- .1 Accurately size glass to fit openings allowing clearances recommended by the Flat Glass Marketing Association. Cut glass clean and free of nicks and damaged edges. Grind smooth and polish exposed glass edges. Do not cut or abrade tempered, heat treated, or coated glass.
- .2 Take field measurements and levels required to verify and supplement those shown on the Drawings for the proper layout and installation of the work. Co-ordinate dimensional tolerances in adjacent building elements and confirm prior to commencement of work.

PART - 3 EXECUTION

3.1 **INSPECTION**

- .1 Verify dimensions at the site before proceeding with fabrication or glazing units.
- .2 Ensure that openings are free from distortion, and that surfaces are free from protrusions that will obstruct face and edge clearances.
- .3 Ensure that wood is sealed; ferrous metals are painted or zinc coated; and that surfaces are suitable for adhesion of the glazing materials.
- .4 Ensure that movable units to be glazed are adjusted for proper operation.
- .5 Ensure that surfaces to receive mirrors are sealed.
- .6 Ensure that ambient and surface temperatures are above 5 degree C.

3.2 **PREPARATION**

- .1 Inspect hollow metal and other glass framing for compliance with manufacturing and installation tolerances, including those for size, squareness, offsets at corners, existence of minimum required face or edge clearances, and effective sealing of joinery.
- .2 Provide written report listing conditions detrimental to performance of glazing work.
- .3 Do not perform glazing work prior to correction of unsatisfactory conditions. Commencement of installation indicates Installer's acceptance of substrate.
- .4 Ensure rabbets, stops and glass edges are free of dust, dirt, moisture, oil and other foreign matter detrimental to, or, obstructing the glazing material.
- .5 Clean contact surfaces with solvent and apply primers to surfaces to receive tapes and sealants in accordance with the manufacturer's instructions. Ensure surfaces are free of moisture and frost.
- .6 Immediately before glazing clean glazing channels and other framing members to receive glass.
 - .1 Remove coatings which are not firmly bonded to substrates.
 - .2 Promptly complete glazing both sides of a lite once started, to prevent re-entry of dust and dirt in glazing channels.
- .7 Clean surfaces thoroughly prior to installation of films. Prepare surfaces using the methods recommended by the film's manufacturer for achieving the best result for the substrate under the project conditions

3.3 **INSTALLATION - GENERAL**

- .1 Handle and install glass in accordance with manufacturer's directions. Prevent nicks, abrasions and other damage likely to develop stress on edges.
- .2 Remove and replace glazing stops in original locations, using original fasteners, securely set and undamaged.
- .3 Use setting blocks and spacers as required to properly support the glass, centred in place in the glazing space independent of the materials and to uniformly distribute its load.
- .4 Use a minimum of 2 setting blocks, located at the quarter points. Locate spacers at jamb edges of glass, uniformly spaced at 600 mm o.c. maximum, and 300 mm maximum from top and bottom.
- .5 Assess coloured glass units for colour uniformity and arrange to avoid abrupt variation in appearance.
- .6 Set glass properly centred with uniform bite and face and edge clearance, free from twist, warp or other distortion likely to develop stress.
- .7 Leave labels on glass until it has been set and inspected and approved. Leave glass whole and without cracks, scratches or other defects and with setting in perfect condition at completion, to the approval of the Consultant.
- .8 Remove rejected, broken or damaged glass due to defective materials or improper setting and replace with perfect materials. Units producing distorted vision will be rejected and replaced at the reasonable discretion of the Consultant.
- .9 Apply translucent film to glazing where indicated, free of wrinkles, air bubbles and other defects.

3.4 **INTERIOR GLAZING**

- .1 Unless otherwise specified, all interior glazing shall be dry glazing.
- .2 Provide glazing gasket around entire perimeter of glass. Make tight butt joint at corners of lights. Place setting blocks at sill and spacers at both jambs as required to centre the unit in the frame. Place the unit into the frames and apply the stops against the gaskets. Tighten the screws or clips to obtain positive uniform pressure avoiding excessive pressure.
- .3 Ensure rattle-free cushioning.
- .4 Install fire-rated glazing materials in accord with manufacturer's product data complying with specified fire testing standard. Use specified fire-rated glazing sealant for installation of fire tested glass materials.
- .5 Remove non-permanent labels promptly after installation and promptly clean adhesive and other residue from both surfaces of all glass.

3.5 **PROTECTION AND CLEANING**

- .1 Protect glass from contact with contaminating substances resulting from construction operations or cleaning of adjacent materials.
- .2 Remove and replace glass which is broken, chipped, cracked, abraded, scratched or damaged in other ways during the construction period, including natural causes, accidents and vandalism.
- .3 Clean glass on both faces not more than 4 days prior to date scheduled for inspections intended to establish date of Substantial Performance in each area of project. Clean glass by method recommended by glass manufacturer.

- .4 Clean and make good to the approval of the Consultant, surfaces soiled or otherwise damaged in connection with the work of this Section. Pay the cost of replacing finishes or materials that cannot be satisfactorily cleaned.
- .5 Upon completion of the work, remove all debris, equipment and excess material resulting from the work of this Section from the site.

END OF SECTION

PART - 1 GENERAL

1.1 SUMMARY

- .1 Section Includes: Labour, Products, equipment and services necessary to complete the work of this Section.

1.2 RELATED REQUIREMENTS

- .1 Read and comply with Conditions of the Contract and Division 01 - General Requirements.

1.3 ACTION SUBMITTALS

- .1 Product Data: Submit product data for each type of product.
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for gypsum board assemblies and include product characteristics, performance criteria, physical size, finish and limitations.
- .2 Fire-rated assembly listings:
 - .1 Submit fire-rated assembly listings for each required fire resistance rated assembly for work of this section.
- .3 Samples: For the following products:
 - .1 Trim Accessories: Full size sample in 300 mm long length for each trim accessory indicated.
- .4 Engineered Shop drawings:
 - .1 Submit engineered shop drawings and associated design calculations bearing the stamp and signature of the registered professional engineer, licensed to practice in the Province of Ontario, responsible for the design of this Section.
 - .2 Engineered submittals shall include associated design calculations and load diagrams, complete with references to codes and standards used in such calculations, supporting the proposed design represented by the submittal. Prepare calculations in a clear and comprehensive manner so that they can be properly reviewed.
 - .3 Submit Engineered Shop drawings including but not limited to the following elements:
 - .1 Interior metal support systems;
 - .2 Horizontal framing of ceilings and bulkheads;
- .5 Shop Drawings for cove base/solid surface and wall base: Submit the shop drawings indicating the following:
 - .1 Special conditions affecting installation;
 - .2 Locations of transitions and intersections between different materials;
 - .3 Widths, details, and locations of joints in finished surfaces;
 - .4 Locations and configuration of inserts and edging details.

1.4 **ADMINISTRATIVE REQUIREMENTS**

- .1 Pre-installation meeting:
 - .1 Two (2) weeks prior to commencing work of this Section, arrange for manufacturer's technical representative to visit the site and review preparatory and installation procedures to be followed, conditions under which the work will be done, and inspect the surfaces to receive the work of this Section.
 - .2 Establish a procedure to maintain optimum working conditions and to coordinate this work with related and adjacent work.
 - .3 Review products, conditions, and other performance requirements.
 - .4 Advise the Consultant of the date and time of the meeting.

1.5 **QUALITY ASSURANCE**

- .1 Installer Qualifications: Subcontractor executing the work of this section shall have a minimum of 10 years continuous experience in successful installation of work of type and quality indicated and specified.
- .2 Install work level to tolerance of 3 mm in 3000 mm.
- .3 Select studs with maximum deflection of L/360 at lateral force of 240 Pa for maximum heights indicated.
- .4 Fire test response characteristics: For gypsum board assemblies with fire-resistance ratings, provide materials and construction identical to those tested in assembly indicated according to ASTM E119 by an independent testing and inspecting agency acceptable to authorities having jurisdiction.
- .5 Sound transmission characteristics: For gypsum board assemblies with STC ratings, provide materials and construction identical to those tested in assembly indicated according to ASTM E90 and classified according to ASTM E413 by a qualified independent testing agency.

1.6 **ENVIRONMENTAL REQUIREMENTS**

- .1 When the outdoor temperature is less than 13°C ensure that heat is introduced in sufficient time, before work commences, to bring surrounding materials up to these temperatures; and maintained until materials installed by this Section have cured.
- .2 Do not install paper-faced gypsum panels until installation areas are fully enclosed and conditioned.
- .3 Maintain temperature between 10 degree C and 21 degree C both day and night, 24 hours before, during and after entire gypsum board joint finishing and until the permanent heating system is in operation or the building is occupied.
- .4 Do not install work in any area unless satisfied that work in place has dried out, and that no further installation of damp materials is contemplated.
- .5 Do not install panels that are wet, those that are moisture damaged, and those that are mold damaged.
 - .1 Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
 - .2 Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

1.7 **DELIVERY, STORAGE, AND HANDLING**

- .1 Deliver materials in original packages, containers, or bundles bearing brand name and identification of manufacturer or supplier.
- .2 Store materials on the job site in their original packaging until ready for actual use.
- .3 Store materials inside under cover and keep them dry and protected against damage from weather, direct sunlight, surface contamination, corrosion, construction traffic, and other causes. Stack gypsum panels flat to prevent sagging.
- .4 Handle gypsum products with care to avoid damage.
- .5 Do not store joint compounds for extended periods, as they are subject to aging.

PART - 2 PRODUCTS

2.1 **PERFORMANCE/DESIGN CRITERIA**

- .1 Single source responsibility: Obtain gypsum board products from a single manufacturer, or from manufacturers recommended by the prime manufacturer of gypsum boards.
- .2 Fire resistance rating: Where gypsum board systems with fire resistance ratings are indicated or required, provide materials and installations that are identical with those of applicable assemblies tested by fire testing laboratories acceptable to authorities having jurisdiction.
- .3 Follow applicable requirements of ASTM C754 for installation of steel framing.
- .4 Design system members to withstand own dead load, super-imposed dead loads, to maximum allowable deflection of L/240, without permanent deformation.
- .5 Seismic Bracing: Provide in accordance with OBC requirements for the project location and building Importance Category.
- .6 Sheet metal thicknesses indicated herein pertains to the “minimum base steel thickness exclusive of coating”.

2.2 **MATERIALS**

- .1 Gypsum board: ASTM C1396/C1396M, paper faced, regular and fire rated Type X core, 1200 mm wide x maximum practical length, ends square cut, square edged base layer and taper edged face layer, thickness as indicated.
- .2 Moisture Resistant (Water/mold resistant) Gypsum Board:
 - .1 High-performance interior panels, with non-combustible water and mould-resistant core encased in a moisture-resistant fiberglass mat on both sides, with tapered long edges, Regular and Type X as required, mould-resistant with a rating of 10 when tested in accordance with ASTM D3273, thickness as indicated
 - .2 Product: CGC Sheetrock Brand Glass-Mat Panels Mold Tough, Regular and Type X as required, or equivalent.
- .3 Steel studs: ASTM C645, minimum 20 gauge studs (0.792 mm design thickness) base metal, hot-dipped galvanized to ASTM A653/A653M G60 (Z180) zinc coating, roll formed, widths as indicated, with knock-out holes for mechanical and electrical services.
- .4 Steel studs at door jambs and where indicated: 1.720 mm (0.0677”) minimum thickness.

- .5 Floor and ceiling tracks (runners): ASTM C645, metal thickness to match studs, hot-dipped galvanized to ASTM A653/A653M G60 (Z180) zinc coating, roll formed, width to suit studs.
 - .1 For openings wider than 914 mm (36"), provide 0.836 mm (0.0329") minimum thickness for header.
- .6 Runner fasteners:
 - .1 To metal concrete inserts: Use 10 mm (3/8") Type S-12 Pan Head screws.
 - .2 To suspended ceilings: Use prefinished clips to match ceiling grid, as manufactured by CGC or approved equivalent.
- .7 Furring runners and channels: ASTM C645, minimum 0.46 mm base metal thickness, hot-dipped galvanized to ASTM A653/A653M G60 (Z180) zinc coating, roll formed.
- .8 Resilient steel furring channels: ASTM C645, 12.7 mm x 65 mm, 0.46 mm base metal thickness, hot-dipped galvanized to ASTM A653/A653M G60 (Z180) zinc coating, roll formed; Hat shaped resilient furring channel for direct wall furring where resilient channels are indicated.
- .9 Fasteners for furring members: Type and size recommended by furring manufacturer for substrate and application indicated.
- .10 Channel bridging: 1.37 mm bare steel thickness, 38 mm deep with minimum 12.7 mm wide flange.
- .11 Backing plate: Galvanized steel sheet for blocking and bracing in length and width indicated, minimum base metal 0.7 mm thick.
 - .1 Elimination of backer plates or direct attachment of accessories or equipment to studs will not be permitted.
- .12 Attachment clips: Sized to suit acoustical ceiling grid members, complete with screws and other fastening system, Revoe Clips by Revoe Manufacturing Ltd.
- .13 Hangers, tie wires, inserts, anchors: Manufacturer's standard.
- .14 Insulating strip: Rubberized, moisture resistant 3 mm thick foam strip, 12 mm wide, with self-sticking adhesive on one face, lengths as required.
- .15 Casing beads, corner beads: 0.48 mm hot dipped galvanized steel, perforated flanges, designed to be concealed with joint compound; one piece length per location.
- .16 Reveal trims: Extruded 6063-T5 aluminum, designed to be concealed with joint compound, maximum lengths, reveal width and depth as indicated, Final Forms I 500 Series by Gordon Inc. or other approved equivalents.
- .17 Sealants: as specified in Section 07 92 00.
- .18 Joint and laminating compounds: to ASTM C475, as recommended by gypsum board and tile backer board manufacturer, high bond, low shrinkage and asbestos-free.
- .19 Joint tape: 50 mm wide reinforced tape.
- .20 Acoustical insulation (Sound Attenuation Batts): CAN/ULC-S702, mineral (glass and rock wool) fibre, flame spread and smoke developed in conformance with OBC requirements and other authorities having jurisdiction in accordance with CAN/ULC-S102. Non-combustible in accordance with requirements of CAN/ULC-S114. Sufficient thickness to meet required STC rating for sound-rated partitions and of width to suit metal framing spacing and other miscellaneous spacings.

- .21 Acoustic putty pads: asbestos free gypsum based synthetic rubber moldable putty pad, 177.8 mm x 177.8 mm x 3 mm, non-conductive, of 1.6 kg/l density, tested to UL 263, in red colour, to match Hilti CP 617L Firestop Putty Pad by Hilti (Canada) Corp., for covering electrical boxes in acoustic partitions.
- .22 Access Doors and Panels:
 - .1 Product: supplied under Mechanical and Electrical Divisions' specification.
 - .2 Installation: under this section 09 21 16.
- .23 Adjustable partition closure: spring loaded aluminum closure of extruded alloy 6063 T5, in clear anodized finish; Mullion/Mate Partition Closure by Gordon Interior Specialties Division, in required sizes for openings indicated.

PART - 3 EXECUTION

3.1 EXAMINATION

- .1 Examine areas and substrates including welded hollow-metal frames and framing for compliance with requirements and other conditions affecting performance.
- .2 Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged. Remove rejected panels from site and replace with undamaged panels at no additional cost to the Owner.
- .3 Do not proceed with installation until the building is completely enclosed and protected from exposure to the elements.
- .4 Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION - GENERAL

- .1 Comply with ASTM C754 and ASTM C840, Standard Specification for Application and Finishing of Gypsum Board.

3.3 INSTALLATION - PARTITION AND WALL FRAMING

- .1 Align partition top and bottom tracks and secure by screws at 600 mm o.c. maximum.
- .2 Place studs vertically at 400 mm oc, unless otherwise noted, and not more than 50 mm from abutting walls, and at each side of openings and corners. Position studs in top and bottom tracks.
- .3 Screw attach end studs to top and bottom tracks. Screw attach intermediate studs to bottom tracks. Secure intermediate studs to top tracks by crimping or by other means of fastening acceptable to Consultant.
- .4 Continuously cross brace steel studs at 1500 mm on center to provide rigid installation to manufacturer's instructions.
- .5 Maintain clearance under beams and structural slabs to avoid transmission of structural loads to studs.
- .6 Provide two studs extending from floor to ceiling at each side of openings wider than stud centres specified. Secure studs together, 50 mm apart using clips or other approved means of fastening placed alongside frame anchor clips.
- .7 Erect track at head of door/window openings and sills of sidelight/window openings to accommodate intermediate studs. Secure track to studs at each end, in accordance with manufacturer's instructions. Install intermediate studs above and below openings in same manner and spacing as wall studs.

- .8 Frame openings and around built-in equipment, cabinets, access panels, on four sides. Extend framing into reveals. Check clearances with equipment suppliers.
- .9 Provide stud, furring channel, and backing plates secured between studs for attachment of fixtures, electrical boxes, grab bars, washroom accessories, and other items. Comply with details indicated and with stud and gypsum board manufacturers' written recommendations.
- .10 Terminate partitions at ceiling height except where indicated otherwise.
- .11 Install continuous insulating strips to isolate studs from exterior window framing.
- .12 Furr duct shafts, beams, columns, pipes and exposed services where indicated.
- .13 Apply two continuous beads of acoustical sealant at junctions of metal framing and structure, including bottom and top tracks, where partitions abut fixed building components. Fill junction completely and continuously from floor to ceiling, or to structure for full height partitions.
- .14 Acoustic putty pads: Apply acoustic putty pads to the exterior of electrical boxes in acoustic partitions, completely sealing pads against the stud within the stud cavity and fitting around conduit and cables, in accordance with manufacturer's recommendations.
- .15 Frame for gypsum board faced vertical bulkheads within and at termination of ceilings.
- .16 Secure light lens support trims to substrate at 300 mm centers. Loose lay light lens on support trims.
- .17 Mechanically fasten resilient channels perpendicular to wall framing starting at 50 mm up from floor and end with 150 mm to the underside of structure at no more than 610 mm o.c. Install where indicated.

3.4 **INSTALLATION – ATTACHMENT CLIPS**

- .1 Place attachment clips over acoustic ceiling main/cross tee from top. Line up pre-drilled hole on clip with hole on main/cross tee and screw clip to main/cross tee with 12.7 mm wafer screw.
- .2 Screw through pre-drilled holes in attachment clip into top track of stud partition. Do not screw through ceiling grid.
- .3 Do not damage ceiling grid system during installation of these clips.

3.5 **INSTALLATION - WALL FURRING**

- .1 Space wall furring runners vertically at 600 mm o.c., and secure through alternate flanges of runners. Shim runners as required to present a true, plumb line for application of gypsum board.
- .2 Locate furrings not more than 50 mm away from all openings, interior corners, intersections, frames, jambs, control joints and the like.
- .3 At windows, doors or similar openings having returns, and around corners, install lengths of mitred and bent pieces of furring horizontally spaced approximately 600 mm o.c. Form mitres by cutting the flanges and bending the web. Do not cut web to form corners.
- .4 Mechanically fasten resilient channel perpendicular to wall framing starting at 50 mm up from floor and end within 150 mm to the underside of structure, at no more than 600 mm o.c. Install where indicated.

3.6 **INSTALLATION - SUSPENDED CEILING FRAMING**

- .1 Erect hangers and runner channels for suspended gypsum board ceilings in accordance with ASTM C840 and in accordance with the engineered shop drawings.

- .2 Provide additional ceiling suspension hangers within 150 mm of each corner and at maximum 600 mm around perimeter of light fixtures and diffusers.
- .3 Furr above suspended ceilings for gypsum board fire and sound stops and to form plenum areas as indicated.

3.7 **INSTALLATION - GYPSUM PANELS**

- .1 Do not apply gypsum panels until bucks, anchors, blocking, electrical and mechanical work are approved.
- .2 Apply gypsum panels to furring or framing using screw fasteners, at 300 mm oc., and at closer spacings as required for fire resistance rated assemblies. Space fasteners in tile baker boards a maximum of 200 mm o.c.
- .3 Install ceiling board panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in the central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.
- .4 Install gypsum panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1.6 mm of open space between panels. Do not force into place.
- .5 Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.
- .6 Attach gypsum panels to framing provided at openings and cutouts.
- .7 Control Joints
 - .1 Prior to installation review exact locations of control joints with the Consultant. Install purpose made control joint metal trim at following locations:
 - .1 Where partition, wall, or ceiling traverses a construction joint (expansion, seismic, or building control element) in the base building structure.
 - .2 Furring or partition abuts a structural element or dissimilar wall or ceiling.
 - .3 Ceiling abuts a structural element, column or dissimilar wall, partition, or other vertical penetration.
 - .4 Construction changes within a partition or ceiling.
 - .5 Partition or furring runs exceeding 9100 mm and total area between control joints exceeding 84 m²
 - .6 Partition and ceiling runs on column lines or at joints in ceiling runs.
 - .7 In interior ceilings without perimeter relief exceeding 9100 mm in either direction and total area between control joints exceeding 84 m²
 - .8 In interior ceilings with perimeter relief exceeding 15000 mm and total area between control joints exceeding 230 m²
 - .9 In exterior ceilings or soffits exceeding 9100 mm in either direction and total area between control joints exceeding 84 m²
 - .2 Install control joints full height floor to ceiling or door header to ceiling in partitions and furring runs.
 - .3 Install control joints from wall to wall in ceiling areas.

- .8 Cover both faces of steel stud partition framing with gypsum panels in concealed spaces.
 - .1 Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than 0.7 sq.m. in area.
 - .2 Fit gypsum panels around ducts, pipes, and conduits.
 - .3 Where partitions intersect open joists and other structural members projecting below underside of slabs and decks, cut gypsum panels to fit profile formed by joists and other structural members; allow 6 mm to 10 mm wide joints to install sealant.
- .9 Gypsum board single layer application:
 - .1 On ceilings, apply gypsum panels before wall/partition board application to the greatest extent possible and at right angles to framing, unless otherwise indicated.
 - .2 On partitions and walls, apply gypsum panels parallel to framing, unless otherwise indicated or required by fire resistance rated assembly, and minimize end joints.
 - .3 Stagger abutting end joints not less than one framing member in alternate courses of board.
- .10 Gypsum board multilayer application - ceilings: Apply gypsum board indicated for base layers before applying base layers on partitions and walls; apply face layers in same sequence. Apply base layers at right angles to framing members and offset face layer joints one framing member, 400 mm minimum, from parallel base layer joints, unless otherwise indicated or required by fire resistance rated assembly.
- .11 Gypsum board multilayer application – partitions and walls: Apply gypsum board indicated for base layers and face layers parallel to framing with joints of base layers located over stud or furring member and face-layer joints offset at least one stud or furring member with base-layer joints, unless otherwise indicated or required by fire-resistance-rated assembly. Stagger joints on opposite sides of partitions.
 - .1 Furring members: Apply base layer parallel to framing and face layer either vertically parallel or perpendicular to framing with vertical joints offset at least one furring member. Locate edge joints of base layer over furring members.
- .12 Single layer fastening method: Fasten gypsum panels to supports with steel drill screws.
- .13 Multilayer fastening method: Fasten base layers with screws; fasten face layers with adhesive and supplementary fasteners, unless otherwise indicated or required by fire resistance rated assembly.
- .14 Laminating to substrate: Where gypsum panels are indicated as directly adhered to a substrate, comply with gypsum board manufacturer's written recommendations and temporarily brace or fasten gypsum panels until fastening adhesive has set.

3.8 **INSTALLATION - ACOUSTICAL INSULATION**

- .1 Install acoustical insulation to partitions indicated. Provide continuous coverage between studs and run continuously from floor to ceiling, or to structure for full height partitions, over door frames and openings and around corners.
- .2 Install acoustical insulation within induction units where partitions meet window mullions.
- .3 Pack acoustical insulation around cut openings in gypsum board, behind outlet boxes around plumbing, heating or structural items passing through the system and at abutting walls.

- .4 Secure acoustical insulation to one interior face of gypsum board with adhesive or mechanical fasteners or by other approved means.
- .5 For partitions receiving acoustical insulation, 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. Comply with ASTM C919, Standard Practice for Use of Sealants in Acoustical Applications, and with manufacturer's written recommendations for locating edge trim and closing off sound-flanking paths around or through assemblies, including sealing partitions above acoustical ceilings

3.9 **INSTALLATION - FIRE RATED ASSEMBLIES**

- .1 Construct fire rated assemblies where indicated, to requirements of authorities having jurisdiction.

3.10 **INSTALLATION - ACCESSORIES**

- .1 Erect casing beads, corner beads straight, plumb or level, rigid and at proper plane. Use full length pieces where practical. Make joints tight, accurately aligned and rigidly secured by screw fasteners. Fit corners accurately, free from rough edges.
- .2 Provide corner beads at external corners of gypsum board partitions and where indicated.
- .3 Provide casing beads at gypsum board terminations, at gypsum board wall/ceiling junctions, where gypsum board butts against surfaces having no trim concealing junction and where indicated.
- .4 Construct control joints of two back-to-back casing beads set in gypsum board facing and supported independently on both sides of joint. Provide continuous polyethylene dust barrier behind and across control joints.

3.11 **INSTALLATION - ACCESS PANELS**

- .1 Install access doors to electrical and mechanical fixtures specified in respective Sections.
- .2 Rigidly secure frames to furring or framing systems.

3.12 **INSTALLATION - TAPING AND FILLING**

- .1 Fill joints, casing beads, corner beads, screwholes and depressions on gypsum board surfaces exposed to view to provide smooth seamless surfaces and square neat corners.
- .2 Apply joint compounds and reinforcing tapes in accordance with manufacturer's specifications.
- .3 Fill joints and apply joint compounds by three-coat method. Apply cover coat 175 mm wide, level coat 250 mm wide, and skim coat 300 mm wide.
- .4 Embed reinforcing tape in a cover coat of joint compound. Apply level coat of joint compound when cover coat has dried. Apply skim coat of compound when level coat has dried.
- .5 Feather edges of compounds into surfaces of gypsum boards. After skim coat has dried for at least 24 hours sand to leave smooth for decoration. Do not sand paper face of gypsum board.
- .6 At internal corners: First fill gaps between boards with joint compound. Embed creased reinforcing tape into a thin coat of joint compound applied 50 mm wide at each side of corner. Apply cover coat. Apply skim coat to one side of joint, and when dry apply skim coat to other side.
- .7 At external corners: Fill to nose of corner bead with joint compound and sand smooth.

- .8 At screwheads and nailheads: Fill holes and depressions with a two coat application of joint compound and sand smooth.
- .9 Finish gypsum board joints above finished ceiling with tape and first coat of joint compound.

3.13 **EXISTING BASE BUILDING GYPSUM WALL PARTITIONS**

- .1 All existing Base Building gypsum wall partitions must be repaired, patched, taped, filled and sanded prior to receive new finishes.
- .2 Patching and Repair:
 - .1 Gypsum panel product patch must be mechanically secured; attachment with joint compound material only is not acceptable. The patching material should be cut from gypsum panel product of a type and thickness equal to the original materials so that the patching material is in the same geometric shape as, but slightly larger than, the damaged area. The damaged area is then further enlarged to match exactly the size of the patching material. Restore thermal insulation, if present.
 - .2 Metal runner track is secured to the inside edges of the damaged area. The patching material is screw attached to the exposed face of the runner track with fasteners a maximum of 8 in. (200 mm) apart. The patch should be treated with tape and joint compound to restore appearance to Level 5 gypsum board finish, fire resistance qualities, and acoustical performance.
 - .1 Apply skim coat of topping or all-purpose drying-type compound over the entire wall where patching and repair was performed.

3.14 **FINISHING**

- .1 Provide levels of gypsum board finish for locations as follows, in accordance with GA-214.
 - .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 where flat paints, light textures, or wallcoverings are to be applied.
 - .4 Level 5: Exposed gypsum board surfaces where paint Gloss Level 3 or higher is specified, indicated, scheduled, or required, for all glass scrim (fiberglass mat) interior gypsum boards, and for areas where critical lighting exists, including wall and ceiling areas abutting glazed assemblies, long hallways, and areas with large surface areas flooded with artificial or natural lighting.
- .2 Refer to Section 09 91 00 for paint Gloss Levels.

3.15 **INSTALLATION TOLERANCES**

- .1 Provide and 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.
 - .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.

- .2 Suspended and furred ceilings:
 - .1 Level cross furring channels to maximum tolerance of 3 mm in 3 m (1/8" in 10 ft).
- .3 Installation tolerances gypsum board panels:
 - .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.
- .4 Installation tolerances accessories:
 - .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").

3.16 **PROTECTION**

- .1 Protect adjacent surfaces from drywall compound and promptly remove from floors and other non-drywall surfaces. Repair surfaces stained, marred, or otherwise damaged during drywall application.
- .2 Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.
- .3 Remove and replace panels that are wet, moisture damaged, and mold damaged at no additional cost to the Owner.
 - .1 Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
 - .2 Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION

PART - 1 GENERAL

1.1 SUMMARY

- .1 Section Includes:
 - .1 Labour, Products, equipment and services necessary to complete the work of this Section.

1.2 QUALITY ASSURANCE

- .1 Installer: Trained and approved by the manufacturer and having a minimum three years experience in the installation of the work described in this Section and can show evidence of satisfactory completion of projects of similar size, scope and type. If requested, provide letter of certification from manufacturer stating that installer is certified applicator of its products, and is familiar with proper procedures and installation requirements required by the manufacturer.
- .2 Finish ceiling system: Square with adjoining walls and level within 1:1000, in true plane, free from distorted, warped, soiled or damaged panels or grid.
- .3 Comply with ASTM C635/C635M Intermediate Duty and C636/C636M except as otherwise specified herein.
- .4 Maximum deflection of completed ceiling system: 1/360 of span.
- .5 Design suspended ceiling system for adequate support of electrical fixtures as required by Electrical Safety Authority.
- .6 Maintenance seminars: Provide, to the Owner, training seminars and recommendations on Product maintenance procedures.
- .7 Pre-installation meeting: Two weeks prior to commencing work of this Section, arrange for manufacturer's technical representative to visit the site and review preparatory and installation procedures to be followed, conditions under which the work will be done, and inspect the surfaces to receive the work of this Section. Advise the Consultant of the date and time of the meeting.
- .8 Manufacturer's site inspection: Have the manufacturer's technical representative inspect the Work at suitable intervals during application and at conclusion of the work of this Section, to ensure the Work is correctly installed. When requested, submit manufacturer's inspection reports and verification that the work of this Section is correctly installed.

1.3 SAMPLE INSTALLATION

- .1 Construct on site a 10 m x 10 m minimum sample installation of each type acoustical ceiling. Accepted sample installation may become part of finished work.

1.4 SUBMITTALS

- .1 Samples: Duplicate full size samples of each type acoustical units and 300 mm long grid members.

1.5 ENVIRONMENTAL CONDITIONS

- .1 Permit wet work to dry before commencement of installation.
- .2 Maintain uniform minimum temperature of 15°C and humidity of 20 - 40% before and during installation.
- .3 Store materials in work area 48 hours prior to installation.

1.6 **EXTRA STOCK**

- .1 Provide two percent of each pattern and type of acoustical units. Store where directed. Extra stock to be same production run as installed materials.

PART - 2 PRODUCTS

2.1 **MATERIALS**

- .1 Basis of Design – Acoustic Tile Products: Refer to Section 00 01 30 List of Materials for complete list of acoustic tile products, designations, manufacturers, sizes and colours.
- .2 Exposed main tee: Hot dipped galvanized steel to ASTM A653/A653M minimum Z90 coating designation, 24 mm exposed face and 38 mm high bulb tee design with double web and separate exposed cap piece, maximum length, with reversible and integral splice. Prefinish tee in baked enamel, standard colour.
- .3 Exposed cross tee: Hot dipped galvanized steel to ASTM A653/A653M minimum Z90 coating designation, exposed face to match main tees, 38 mm high bulb tee design of same fabrication as main tee, with override stepped ends to allow cross tee flange to sit on main tee flange providing flush exposed faces, and with positive interlock to main tee, grid module to suit acoustical panels. Finish to match main tees.
- .4 Main tee splices: Designed to lock lengths of main tees together so that joined lengths of tee function structurally as a single unit with tee faces at joint perfectly aligned and presenting a tight seam.
- .5 Hangers and wires: Galvanized hangers and 2.6 mm minimum galvanized steel wire.
- .6 Hold-down clips: Spring steel clips by the grid system manufacturer.
- .7 Wall moulding: Prefinished galvanized steel, nominal 25 mm x 25 mm with nominal 25 mm exposed face, hemmed edges. Finish to match main tees.
- .8 Shadow wall moulding: Prefinished galvanized steel, 19 mm x 19 mm reveal with nominal 25 mm exposed face, hemmed edges. Finish to match main tees.
- .9 Adhesive: Recommended by acoustic unit manufacturer.

PART - 3 EXECUTION

3.1 **INSTALLATION - GENERAL**

- .1 Install work in accordance with ASTM C636/C636M and to manufacturer's instructions except where specified otherwise.
- .2 Do not commence installation until work above ceiling has been inspected by Consultant.
- .3 Lay out system in accordance with reflected ceiling plans.
- .4 Ensure work is co-ordinated with location of related components.

3.2 **INSTALLATION - GRID SYSTEM**

- .1 Centre acoustical ceiling suspension systems on room axis; install equal border pieces, unless otherwise indicated.
- .2 Install hangers spaced at maximum 1200 mm centres and within 150 mm from ends of main tees.

- .3 Install supplemental suspension system where ducts or other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support suspension system members. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards and publications.
- .4 Install hanger wires plumb and securely anchored to the building structural framing, independent of walls, pipes, ducts, and metal deck; install additional framing and hangers to bridge interference items.
- .5 Do not bend or twist hangers as a means of levelling. Form double loops tightly and lock to prevent vertical movement or rotation within the loop.
- .6 Install wall moulding at intersection of ceiling and vertical surfaces to provide correct ceiling height.
- .7 Provide additional ceiling suspension hangers within 150 mm of each corner and at maximum 600 mm around perimeter of light fixtures and diffusers.
- .8 Use longest practical lengths of tees, furring and running channels to minimize joints. Make joints square, tight, flush and reinforced with concealed splines. Assemble framework to form a rigid and interlocking system.
- .9 Run main tees at right angles to length of light fixtures.
- .10 Interlock cross tees to main tees to provide rigid assembly.
- .11 Frame at openings for light fixtures, air diffusers, speakers and at changes in ceiling heights.

3.3 **INSTALLATION - ACOUSTICAL PANELS**

- .1 Neatly cut acoustic units for mechanical and electrical and other services.
- .2 Carefully fit acoustic units in place; no broken edges permitted.
- .3 Scribe acoustic units to fit adjacent work. Butt joints tight, terminate edges with moulding.
- .4 Provide hold-down clips at acoustical system to hold units tight to grid system within 6000mm of an exterior door and an operable window.
- .5 Install adhesive bonded acoustic units to clean, dry and firm substrate.

END OF SECTION

PART - 1 GENERAL

1.1 SUMMARY

.1 Section Includes:

.1 Labour, Products, equipment and services necessary to complete the work of this Section.

1.2 QUALITY ASSURANCE

.1 Install work of this Section straight and level to variation of 1:1000.

.2 Maintenance seminars: Provide, to the Owner, training seminars and recommendations on Product maintenance procedures.

.3 Pre-installation meeting: Two weeks prior to commencing work of this Section, arrange for manufacturer's technical representative to visit the site and review preparatory and installation procedures to be followed, conditions under which the work will be done, and inspect the surfaces to receive the work of this Section. Advise the Consultant of the date and time of the meeting.

.4 Manufacturer's site inspection: Have the manufacturer's technical representative inspect the Work at suitable intervals during application and at conclusion of the work of this Section, to ensure the Work is correctly installed. When requested, submit manufacturer's inspection reports and verification that the work of this Section is correctly installed.

.5 Products: Provide like Products from same production run. Install Products in sequence from sequentially numbered dye lots.

.6 Testing of concrete floors: Test floors that have been cured for minimum 28 days, and after preparation for Product installation is complete and patching or levelling compound is fully cured. Conduct testing simultaneously on floors free of sealer, curing compounds, oil, grease and other agents detrimental to the test and the Product performance, and in strict conformance with test kit manufacturer's written instructions. Locate test sites to cover representative installation areas. Do not proceed with work when the test results do not conform to the specified allowable.

.1 Moisture vapour emission: Maximum 3 lbs of moisture per 1000 sq.ft. per 24 hour for vinyl and rubber sheet flooring and 5 lbs of moisture per 1000 sq.ft. for vinyl composite tile. Test floors to ASTM F1869 using anhydrous calcium chloride method. Provide 3 test sites for floor area up to 1000 sq.ft., add one test site for each additional 1000 sq.ft. or fraction thereof.

.2 Alkalinity: Acceptable range of 5 to 9 on the pH scale. Test floors using distilled water and pH paper. Provide 2 tests for every moisture vapour emission test.

1.3 SUBMITTALS

.1 Samples: Duplicate full size 300 mm x 300 mm sheet flooring.

.2 Maintenance data: Incorporation in project record manual.

1.4 EXTRA STOCK

.1 Provide 2% of each type and colour of materials installed. Store the extra materials at locations as directed by the Owner. Extra stock shall be of same production run as installed materials. Include cost of extra stock in the Contract Price.

1.5 ENVIRONMENTAL REQUIREMENTS

.1 Maintain air temperature and structural base temperature at flooring installation area above 20 degree C for 48 hours before, during and for 48 hours after installation.

PART - 2 PRODUCTS

2.1 MATERIALS

- .1 Basis of Design – Resilient Flooring Products: Refer to Section 00 01 30, List of Materials for complete list of products, designations, manufacturers, and colours.
 - .1 Products by other manufacturers similar in function, design, performance, and construction complying with requirements of this Section may be incorporated into the Work subject to Consultant's acceptance.
- .2 Integral flash cove base: Provide integral flash cove base by extending sheet flooring 150mm up the vertical surfaces using adhesive, welding rod, and accessories recommended and approved by the flooring manufacturer.
 - .1 Provide a fillet support strip for integral cove base with a minimum radius of 2.54cm of wood or plastic.
- .3 Welding rod: Compatible with resilient sheet flooring and recommended by the flooring manufacturer, colour as indicated.
- .4 Primers and adhesives: Nontoxic, odourless, waterproof type, recommended by flooring manufacturer for specific material on applicable substrate, above, at or below grade.
- .5 Sub-floor filler and leveller: White premix latex requiring water only to produce cementitious paste.
- .6 Metal edge strips: Extruded aluminum, smooth, polished with lip to extend under floor finish, shoulder flush with top of adjacent floor finish.
- .7 Sealer and polish: As recommended by flooring manufacturer.

PART - 3 EXECUTION

3.1 PREPARATION

- .1 Prepare subfloor smooth, level, true, sound and free of cracks, holes and other defects, in accordance with flooring manufacturers' recommendation.

3.2 INSTALLATION - RESILIENT SHEET FLOORING

- .1 Apply adhesive uniformly using recommended trowel. Do not spread more adhesive than can be covered by flooring before initial set takes place.
- .2 Lay flooring to produce a minimum number of seams. Locate seams acceptable to the Consultant. Run sheets in direction of traffic.
- .3 Continuously machine weld seams with welding rods using methods and equipment in accordance with manufacturer's printed instructions.
- .4 As installation progresses, and after installation, roll flooring with 45 kg minimum roller to ensure full adhesion.
- .5 Cut flooring neatly around fixed objects.
- .6 Continue flooring over areas which will be under built-in furniture.
- .7 Continue flooring through areas to receive movable type partitions without interrupting floor pattern.
- .8 Terminate flooring at centreline of door in openings where adjacent floor finish or colour is dissimilar.
- .9 Install metal edge strips at unprotected or exposed edges where flooring terminates.

- .10 Provide carpet/flooring adapter at interface of carpet and work of this Section, straight and true. Where carpet/resilient flooring interface occurs at doorway, locate adapter underneath door in its closed position.
- 3.3 **INSTALLATION - BASE**
- 3.4 Provide integral flash cove wall base, including cove fillet support strip and top edge cove cap moulding. Construct flash cove base in accordance with the flooring manufacturer's instructions. Treat all seams in the flash cove area the same as seams throughout the rest of the installation.
- 3.5 Securely adhered cove cap mouldings to the wall utilizing the manufacturer's recommended adhesive. Roll cove cap mouldings with a J-hand roller after installation, to ensure proper bonding.
- 3.6 **CLEANING**
 - .1 Remove excess adhesive from floor, base and wall surfaces without damage.
 - .2 Clean, seal and polish floor to flooring manufacturer's instructions.
- 3.7 **PROTECTION**
 - .1 Protect flooring from damage until final inspection.
 - .2 Prohibit traffic on floor for 48 hours after installation.

END OF SECTION

PART - 1 GENERAL

1.1 SUMMARY

.1 Section Includes:

.1 Labour, Products, equipment and services necessary to complete the work of this Section.

1.2 QUALITY ASSURANCE

.1 Applicator experience: Having minimum of five years proven satisfactory experience. When requested, provide a list of the last three comparable projects including, name and location, consultant, start and completion dates, and value of the painting work.

.2 Applicator qualification: Qualified journeypersons, painters, as defined by local jurisdiction shall be engaged in painting and decorating work. Apprentices may be employed provided they work under the direct supervision of a qualified journeyperson in accordance with trade regulations.

.3 Materials, preparation and quality of work: In conformance with requirements of the latest edition of the Architectural Painting Specification Manual by the Master Painters Institute, referred to as the MPI Painting Manual in this Section, issued by the local MPI Accredited Quality Assurance Association having jurisdiction.

.4 Manufacturers and products: Listed under the Approved Product List section of the MPI Painting Manual.

.5 Maintenance seminars: Provide, to the Owner, training seminars and recommendations on Product maintenance procedures.

.6 Pre-installation meeting: Two weeks prior to commencing work of this Section, arrange for manufacturer's technical representative to visit the site and review preparatory and installation procedures to be followed, conditions under which the work will be done, and inspect the surfaces to receive the work of this Section. Advise the Consultant of the date and time of the meeting.

.7 Manufacturer's site inspection: Have the manufacturer's technical representative inspect the Work at suitable intervals during application and at conclusion of the work of this Section, to ensure the Work is correctly installed. When requested, submit manufacturer's inspection reports and verification that the work of this Section is correctly installed.

.8 All surfaces requiring painting shall be inspected by the Consultant who shall notify the Consultant and General Contractor in writing of any defects or problems, prior to commencing painting work, or after the prime coat shows defects in the substrate.

.9 Ensure written confirmation is received from steel fabricators of the specific surface preparation procedures and primers used for steel work to ascertain appropriate and compatible finish materials.

1.3 SAMPLES AND MOCK-UPS

.1 Samples: Provide duplicate minimum 300 mm square samples of surfaces or acceptable facsimiles requested painted with specified paint or coating in colours, gloss, sheen and textures required to MPI Painting Manual standards for review. When approved, samples become acceptable standard of quality for appropriate on-site surface with one of each sample retained on-site.

- .2 Sample installations: When requested by the Consultant, prepare and paint designated surface, area, room or item in each colour scheme to requirements specified, with specified paint or coating showing selected colours, gloss, sheen, textures and quality of work to MPI Painting Manual standards for review and approval. When approved, surface, area, room and items become acceptable standard of finish quality and workmanship for similar on-site work.

1.4 **SUBMITTALS**

- .1 List of painting materials: Submit duplicate copy of list of painting materials for review prior to ordering materials. If requested, provide an invoice list of all paint materials ordered for project work to Consultant indicating manufacturer, types and quantities for verification and compliance with specification and design requirements.
- .2 Material Safety Data Sheets (MSDS): Submit duplicate copies prior to commencement of work for review and for posting at job site as required.
- .3 Project Data Manual: At project completion provide an itemized list complete with manufacturers' application instructions, paint type and colour coding for all colours used for Owner's later use in maintenance.

1.5 **PRODUCT DELIVERY, STORAGE AND HANDLING**

- .1 Deliver all 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.
- .2 Store all paint materials in original labelled containers in a lockable, dry, heated and well ventilated single designated area meeting the minimum requirements of both paint manufacturer and authorities having jurisdiction and at a minimum ambient temperature of 7 degree C. Only material used on this project to be stored on site.
- .3 Where toxic, volatile, explosive, flammable materials are being used, provide adequate fireproof storage lockers and take all necessary precautions and post adequate warnings such as no smoking signs as required.
- .4 Take necessary precautionary and safety measures to prevent fire hazards and spontaneous combustion and to protect the environment from hazard spills. Store materials that constitute a fire hazard in suitable closed and rated containers and removed from the site on a daily basis.
- .5 Comply with requirements of authorities having jurisdiction, in regard to the use, handling, storage and disposal of hazardous materials.

1.6 **SCHEDULING**

- .1 Schedule painting operations to prevent disruption of and by other Sections.
- .2 Schedule painting operations in occupied facilities to prevent disruption of occupants in and about the building. Perform painting after facility working hours in accordance with Owner's operating requirements. Schedule work such that painted surfaces will have dried before occupants are affected. Obtain written authorization from Consultant for changes in work schedule.

1.7 **PROJECT CONDITIONS**

- .1 Unless specifically pre-approved by the Consultant, and the product manufacturer, do not perform work when the ambient air and substrate temperatures are below 10 degree C for interior work.
- .2 Do not perform interior work unless adequate continuous ventilation and sufficient heating facilities are in place to maintain ambient air and substrate temperatures above minimum requirements for 24 hours before, during and 48 hours after work is complete, unless required otherwise by manufacturer's instructions. Provide supplemental ventilating and heating equipment if ventilation and heating from existing system is inadequate to meet minimum requirements.
- .3 Do not perform work when the relative humidity is above 85% or when the substrate temperature is less than 3 degree C above the measured dew point.
- .4 Do not perform work when the maximum moisture content of the substrate exceeds:
 - .1 12 % for concrete and masonry.
 - .2 15% for wood.
 - .3 12 % for plaster and gypsum board.
- .5 Conduct all moisture tests using a properly calibrated electronic Moisture Meter, except test concrete floors for moisture using a simple cover patch test.
- .6 Test concrete, masonry and plaster surfaces for alkalinity as required.
- .7 Apply work only to dry, clean, properly cured and adequately prepared surfaces in areas where dust is no longer generated by construction activities such that airborne particles will not affect the quality of finished surfaces.
- .8 Do not perform work unless a minimum lighting level of 323 Lux is provided on surfaces to be painted or decorated.

1.8 **EXTRA STOCK**

- .1 At project completion provide 4 liters of each type and colour of paint from same production run used in unopened cans, properly labelled and identified for Owner's later use in maintenance. Store where directed.

1.9 **WASTE MANAGEMENT AND DISPOSAL**

- .1 Paint, stain and wood preservative finishes and related materials such as thinners, solvents are regarded as hazardous products and are subject to regulations for disposal. Obtain information on these controls from applicable authorities having jurisdiction.
- .2 Separate and recycle waste materials. Where paint recycling is available, collect waste paint by type and provide for delivery to recycling or collection facility. Materials that cannot be reused must be treated as hazardous waste and disposed of in an appropriate manner.
- .3 Place materials defined as hazardous or toxic waste, including used sealant and adhesive tubes and containers, in containers or areas designated for hazardous waste.
- .4 Strictly adhere to the following procedures to reduce the amount of contaminants entering waterways, sanitary and storm drain systems or into the ground:
 - .1 Retain cleaning water for water-based materials to allow sediments to be filtered out. In no case shall equipment be cleaned using free draining water.

- .2 Retain cleaners, thinners, solvents and excess paint and place in designated containers and ensure proper disposal.
 - .3 Return solvent and oil soaked rags used during painting operations for contaminant recovery, proper disposal, or appropriate cleaning and laundering.
 - .4 Dispose of contaminants in an approved legal manner in accordance with hazardous waste regulations.
 - .5 Empty paint cans are to be dry prior to disposal or recycling (where available).
 - .6 Close and seal tightly partly used cans of materials including sealant and adhesive containers and store protected in well ventilated fire-safe area at moderate temperature.
- .5 Set aside and protect surplus and uncontaminated finish materials not required by the Owner and deliver or arrange collection for verifiable re-use or re-manufacturing.

PART - 2 PRODUCTS

2.1 MATERIALS

- .1 Only materials listed in the latest edition of the MPI Approved Product List (APL) are acceptable for use on this project. Provide material from a single manufacturer for each system used.
- .2 Other materials not listed in the APL shall be the highest quality product of an MPI listed manufacturer and shall be compatible with paint materials being used as required.
- .3 All materials used shall be lead and mercury free and shall have low VOC content where possible.
- .4 Where required, use only materials having a minimum MPI Environmentally Friendly E2 or E3 rating based on VOC (EPA Method 24) content levels.
- .5 Where indoor air quality is an issue, use only MPI listed materials having a minimum E2 or E3 rating.
- .6 Provide materials having good flowing and brushing properties and capable to dry or cure free of blemishes, sags, air entrapment.
- .7 Where required, paints and coatings shall meet flame spread and smoke developed ratings to code requirements and authorities having jurisdiction.

2.2 EQUIPMENT

- .1 Painting and Decorating Equipment: to best trade standards for type of product and application.
- .2 Spray Painting Equipment: of ample capacity, suited to the type and consistency of paint or coating being applied and kept clean and in good working order at all times.

2.3 MIXING AND TINTING

- .1 Unless otherwise specified or pre-approved, provide materials ready-mixed and pre-tinted. Re-mix materials in containers prior to and during application to ensure break-up of lumps, complete dispersion of settled pigment, and color and gloss uniformity.

- .2 Mix paste, powder or catalyzed materials in strict accordance with manufacturer's written instructions.
- .3 Do not exceed amount of thinner beyond manufacturer's recommendations. Do not use kerosene or organic solvents to thin water-based materials.
- .4 If required, thin paint for spraying according in strict accordance with paint manufacturer's instructions. If directions are not on container, obtain instructions in writing from manufacturer and provide copy of instructions to Consultant.

2.4 FINISH AND COLORS

- .1 The Consultant will select colours from a manufacturer's full range of colours. Refer to Section 00 01 30 List of Materials for identification and location of colours.
- .2 Where required by authorities having jurisdiction, finish exit and vestibule doors in contrasting colour to walls and a different colour than any other door in the same area.
- .3 Access doors, prime coated butts and other prime painted hardware, registers, radiators and covers, exposed piping and electrical panels: To match adjacent surfaces, unless otherwise noted or where pre-finished.
- .4 Where other applied finishes and nosing are not specified at stairs, ramps and landings providing access and exit for persons with visual impairment, provide colour contrast slip resistant finish and warning strips at treads and landings.

2.5 GLOSS AND SHEEN RATINGS

- .1 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	Max. 5	Max. 10
G2	Velvet finish	Max. 10	10 to 35
G3	Eggshell finish	10 to 25	10 to 35
G4	Satin finish	20 to 35	Min. 35
G5	Semi-Gloss finish	35 to 70	
G6	Gloss finish	70 to 85	
G7	High-Gloss finish	More than 85	

PART - 3 EXECUTION

3.1 CONDITION OF SURFACES

- .1 Prior to commencement of work thoroughly examine and test as required conditions and surfaces scheduled to be painted. Do not commence work until adverse conditions and defects have been corrected and surfaces and conditions are acceptable to the Consultant.

3.2 SURFACE PREPARATION

- .1 Prepare all surfaces in accordance with MPI requirements.
- .2 Sand, clean, dry, etch, neutralize and test surfaces under adequate illumination, ventilation and temperature requirements.

- .3 Remove and securely store miscellaneous hardware, surface fittings and fastenings such as electrical plates, mechanical louvers, door and window hardware, hinges, knobs, locks, trim, frame stops, removable rating/hazard/instruction labels, washroom accessories, light fixture trim, from wall and ceiling surfaces, doors and frames, prior to commencement of work. Carefully clean and replace items upon completion of work in each area. Do not use solvent or reactive cleaning agents on items that will mar or remove finishes. Remove doors to finish bottom and top edges and re-hang doors when work is complete.
- .4 Protect all adjacent interior surfaces and areas, including rating/hazard/instruction labels on doors, frames, equipment, piping, from painting operations and damage using drop cloths, shields, masking, templates, or other suitable protective means and make good damages caused by failure to provide such protection.
- .5 Make good substrate defects and sand ready for finishing particularly after the first coat is applied. Start of finishing on defective surfaces indicates acceptance of substrate and any costs of making good defects shall be borne by this Section including re-painting of entire defective surface.
- .6 Confirm preparation and primer used with fabricator of steel items.

3.3 **APPLICATION**

- .1 Do not perform work unless substrates are acceptable and until heating, ventilation, lighting and completion of work of other Sections are acceptable for applications of products.
- .2 Apply materials in accordance with MPI Painting Manual Premium Grade finish and manufacturers' requirements.
- .3 Work specified is intended to cover surfaces satisfactorily when applied at proper consistency and in accordance with manufacturer's recommendations.
- .4 Tint each coat of finish progressively lighter to enable confirmation of number of coats.
- .5 Unless otherwise approved by the Consultant, apply a minimum of four coats of paint where deep or bright colors are used to achieve satisfactory results.
- .6 Sand between each coat to provide an anchor for next coat and to remove defects visible from a distance up to 1000 mm.
- .7 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.
- .8 Prime coat of stain or varnish finishes may be reduced in accordance with manufacturer's directions.
- .9 Paint finish shall continue through behind all wall-mounted items.
- .10 Unless noted otherwise, field-apply finish paint to all structural steel work, which will remain exposed and subject to normal view by pedestrians or occupants on the completed exterior or interior of the building.

3.4 **INTERIOR FINISHING SYSTEMS**

- .1 Finish interior surfaces in accordance with MPI Painting Manual requirements:
- .2 Galvanized Metal: Doors, frames, railings, misc. steel, pipes, overhead decking, ducts.
 - .1 INT 5.3M: High performance architectural latex G5 finish.

- .3 Plaster and Gypsum Board:
 - .1 INT 9.2B: High performance architectural latex G5 finish.
 - .2 INT 9.2F: Waterborne epoxy (tile-like) finish.

3.5 **MECHANICAL, ELECTRICAL EQUIPMENT AND RELATED SURFACES**

- .1 Unless otherwise specified or noted, finish all unfinished conduits, piping, hangers, ductwork and other mechanical and electrical equipment with color and texture to match adjacent surfaces, in the following areas:
 - .1 Where exposed-to-view.
 - .2 In interior high humidity interior areas.
 - .3 In boiler room, mechanical and electrical rooms.
- .2 In unfinished areas leave exposed conduits, piping, hangers, ductwork and other mechanical and electrical equipment in original finish and touch up scratches and marks.
- .3 Touch up scratches and marks on factory finished equipment with products compatible with factory finish.
- .4 Do not paint over nameplates.
- .5 Paint the inside of all ductwork where visible behind louvers, grilles and diffusers for a minimum of 450 mm or beyond sight line, whichever is greater, with primer and one coat of flat black paint.
- .6 Paint the inside of light valances gloss white.
- .7 Paint disconnect switches for fire alarm system and exit light systems in red enamel.
- .8 Paint or band all fire protection piping and sprinkler lines in accordance with mechanical specification requirements. Keep sprinkler heads free of paint.
- .9 Paint or band all natural gas piping in accordance with mechanical specification requirements.
- .10 Back prime and paint face and edges of plywood service panels for telephone and electrical equipment before installation to match adjacent wall surface. Leave equipment in original finish except for touch-up as required, and paint conduits, mounting accessories and other unfinished items.

3.6 **FIELD QUALITY CONTROL AND STANDARD OF ACCEPTANCE**

- .1 Painted interior surfaces will be considered to lack uniformity and soundness if any of the following defects are apparent to the Consultant:
 - .1 Brush and 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 the weather.
 - .5 Damage and/or contamination of paint due to blown contaminants (dust, spray paint, etc.).
 - .2 Make good painted surfaces rejected by the Consultant and at the no extra cost to the Owner. Touch up small affected areas. Repaint large affected areas or areas without sufficient material dry film thickness. Remove runs, sags of damaged paint by scraper or by sanding prior to application of paint.
- 3.7 **PROTECTION**
- .1 Protect interior surfaces and areas, equipment and any labels and signage from painting operations and damage by drop cloths, shields, masking, templates, or other suitable protective means and make good any damage caused by failure to provide such protection.
 - .2 Erect barriers or screens and post signs to warn of or limit or direct traffic away or around work area as required.
- 3.8 **CLEAN-UP**
- .1 Remove paint where spilled, splashed, splattered or sprayed as work progresses using means and materials that are not detrimental to affected surfaces.
 - .2 Keep work area free from an unnecessary accumulation of tools, equipment, surplus materials and debris.
 - .3 Remove combustible rubbish materials and empty paint cans each day and safely dispose of same in accordance with requirements of authorities having jurisdiction.
 - .4 Clean equipment and dispose of wash water / solvents as well as all other cleaning and protective materials (e.g. rags, drop cloths, masking papers, etc.), paints, thinners, paint removers / strippers in accordance with the safety requirements of authorities having jurisdiction.
- 3.9 **EXISTING SURFACES**
- .1 Finish or refinish existing surfaces of items or rooms where noted, including new work which has been incorporated into the existing work and existing work which has been damaged, altered or otherwise disturbed during renovation operations.
 - .2 Refinish surfaces or rooms adjacent to rooms where alterations or renovations have been carried out and which have been damaged or otherwise disturbed by the alterations or renovations. Where such damages occur, refinish completely.
 - .3 Remove from existing surfaces rust, scale, oil grease, mildew, chemicals and other foreign matters.
 - .4 If coatings on existing surfaces have failed so as to affect the proper performance or appearance of materials to be applied, or if such coatings can be easily removed, remove them and prepare the substrates properly. Dull hard or glossy surfaces by sanding, sandblasting or by other abrasive methods prior to finishing.

- .5 Refinish surfaces entirely between changes of planes which have been incorporated into the existing work and existing work which has been damaged, altered or otherwise disturbed during renovation operations.

END OF SECTION

PART - 1 GENERAL

1.1 SUMMARY

- .1 Section Includes:
 - .1 Labour, Products, equipment and services necessary to complete the work of this Section.

1.2 SUBMITTALS

- .1 Provide Shop Drawings showing the finished appearance, construction details, bracing materials, finishes, connections and fastenings of each item.
- .2 Underline, ring or otherwise point out any deviation from the Specification or Drawings.
- .3 When requested by the Consultant submit samples of materials, colour and finish, and if required include the complete item.
 - .1 Submit manufacturer's operation and maintenance data and instructions for inclusion in the operation and maintenance manuals.

1.3 QUALITY ASSURANCE

- .1 Electrical Components, Devices and Accessories:
 - .1 Use CSA approved, listed and labelled by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.4 SCHEDULES AND DRAWINGS

- .1 Refer to Schedules and Drawings for the location and details of the various items of manufactured specialties.

1.5 WARRANTY

- .1 Warrant work of this Section against defects and deficiencies in materials and workmanship for a period of two (2) years from the Date of Substantial Performance.
- .2 Promptly make good defects and deficiencies which become apparent within the warranty period by replacing defective work at no expense to the Owner.

PART - 2 PRODUCTS

2.1 INTERNAL PATIENT BLINDS

- .1 Acceptable Manufacturer – Basis of Design: Unichel Architectural.
 - .1 Product: VIULITE SL20P
 - .2 Substitutions: Comply with provisions of Section 01 25 13 Product Substitution Procedures.
- .2 Product Requirements:
 - .1 Slats: Aluminium, AA 6011-T8. 12.5 mm wide, 0.2 mm thick. High-resistance polyester paint with special treatment designed to eliminate possible emissions of chemical products inside the insulated glass units, when exposed to ultraviolet and heat radiation. Colour to be selected by Consultant.
 - .2 Internal Cords: Thermo-fixed 100% polyester with internal core.
 - .3 Function: Tilt.
 - .4 Operator: Corridor side, slider.

2.2 WHITEBOARD

- .1 Product (WB-1): EganAero Hover by Egan Visual or approved equivalent.
 - .1 Dimensions: 1980 mm x 1220 mm (78" x 48"), landscape orientation.
 - .2 Colour: White.
 - .3 Aluminum trims and accessories: Perimeter frames, marker tray and three sets of marking pens in each of the 4 standard colours for each markerboard.

PART - 3 EXECUTION

3.1 EXAMINATION

- .1 Verify all site dimensions prior to commencing installation.
- .2 Examine surfaces to receive the work of this Section for compliance with manufacturer's recommendations.
- .3 Verify that structural supports are ready to receive work and dimensions are as indicated on Shop Drawings.
- .4 Do not commence work until all unsatisfactory conditions have been corrected and surfaces and conditions are acceptable.

3.2 ELECTRICAL COORDINATION

- .1 Employ licensed electrician to wire and interconnect all operational and safety components for the work.
- .2 Perform wiring in strict conformity with the Electrical Code and Division 26 requirements.
- .3 The wall control switches, junction box and power to the control switches and junction box shall be supplied and installed under Division 26.
- .4 Wiring and connection at and from the control switch and junction box to motors, starters, switches, controls, safety devices and other items requiring power from the control switch/junction box shall be the responsibility of this Section.
- .5 Terminate wiring required for connection to control circuitry and power at EEMAC enclosures. Ground all control wiring.

3.3 FABRICATION

- .1 Fabricate the work true to dimensions, square, plumb and level. Fit joints and intersecting members accurately with adequate fastenings, as shown on reviewed Shop Drawings.
- .2 Finished work shall be free from distortion and defects detrimental to appearance and performance.

3.4 INSTALLATION

- .1 Install work true to dimensions, square, plumb and level. Accurately secure joints and intersecting members with adequate fastening.
- .2 Install work of this Section in strict accordance with the manufacturer's instructions, and as shown on reviewed Shop Drawings.
- .3 Refer to Drawings for location and details of various items of manufactured specialties.
- .4 Supply templates, components and instructions for items built into work of other sections.

- .5 Install privacy system tracks secure, rigid, and true to ceiling line. Slide carriers onto tracks, install end caps or other stop devices.

END OF SECTION

PART - 1 GENERAL

1.1 SUMMARY

- .1 Section Includes:
 - .1 Labour, Products, equipment and services necessary to complete the work of this Section including but not limited to the following:
 - .1 Manually operated, continuously hinged folding sliding glass partitions.
 - .2 Related Sections include the following:
 - .1 Division 05 Sections for primary structural support, including pre-punching of support members by structural steel supplier per glass operable partition supplier's template.
 - .2 Division 06 Sections for wood framing and supports and all blocking at head and jambs as required.
 - .3 Division 09 Sections for wall and ceiling framing at head and jambs.

1.2 REFERENCE STANDARDS

- .1 ASTM International
 - .1 ASTM E557 Standard Practice for Architectural Application and Installation of Operable Partitions.
 - .2 ASTM C1036 - Standard Specification for Flat Glass.
 - .3 ASTM C1048 - Heat-Treated Flat Glass—Kind HS, Kind FT Coated and Uncoated Glass.
 - .4 ASTM E84 - Surface Burning Characteristics of Building Materials.

1.3 SUBMITTALS

- .1 Product Data: Material descriptions, construction details, finishes, installation details, and operating instructions for each type of operable glass panel partition, component, and accessory specified.
- .2 Shop Drawings: Show location and extent of operable glass panel partitions. Include plans, elevations, sections, details, attachments to other construction, and accessories. Indicate dimensions, weights, conditions at openings and at storage areas, and required installation, storage, and operating clearances. Indicate location and installation requirements for hardware and track including floor tolerances required and direction of travel. Indicate blocking to be provided by others.
- .3 Setting Drawings: Show imbedded items and cutouts required in other work, including support beam punching template.
- .4 Samples: Color samples demonstrating full range of finishes available for selection by Consultant. Verification samples will be available in same thickness and material indicated for the work.
- .5 Reports: Provide a complete and unedited written sound test report indicating test specimen matches product as submitted.

1.4 QUALITY ASSURANCE

- .1 Installer Qualifications: An experienced installer who is certified in writing by the glass operable partition manufacturer, as qualified to install the manufacturer's partition systems for work similar in material, design, and extent to that indicated for this Project.

- .2 Preparation of the opening shall conform to the criteria set forth per ASTM E557 “Standard Practice for Architectural Application and Installation of Operable Partitions.”
- .3 The movable glass wall must be manufactured by a certified ISO-9001 company or an equivalent quality control system.

1.5 **DELIVERY, STORAGE, AND HANDLING**

- .1 Clearly mark packages and panels with numbering systems used on Shop Drawings. Do not use permanent markings on panels.
- .2 Protect panel and glazing materials during delivery, storage, and handling to comply with manufacturer’s direction and as required to prevent damage to the glass and hardware.

1.6 **WARRANTY**

- .1 Manufacturer’s Special Project Warranty on Glass Panels: Provide written warranty signed by the manufacturer of glass operable partitions agreeing to replace those panels with manufacturing defects.
 - .1 Manufacturing defects are defined as any defect materially obstructing vision through the glass, and mechanical failure of hardware which prevents the proper operation of the panels after appropriate installation.

PART - 2 PRODUCTS

2.1 **MANUFACTURERS**

- .1 Basis of Design System: Modernfold Acousti-Clear by Modernfold Inc.

2.2 **SYSTEM DESCRIPTION**

- .1 Operable Partition consisting of a series of continuously hinged folding glass panels, manually operated and top-supported with pivot door panel. Panels use two-piece, clamp-on top and bottom rails that fasten together from alternating sides.

2.3 **CONSTRUCTION**

- .1 Provide top reinforcement as required to support panel from suspension components and provide reinforcement for hardware attachment. Fabricate panels with concealed fasteners. Finished in-place partition shall be rigid, level, plumb, aligned with uniform joints and appearance, free of bow, warp, twist, deformation, and surface and finish irregularities.
- .2 Dimensions: Fabricate operable glass panel partitions with manufacturer’s standard panel sizes to form an assembled system of dimensions indicated on Drawings and verified by field measurements.
 - .1 Maximum panel width: 39-inches (991 mm)
 - .2 Standard rail thickness: 1-9/16-inches (40 mm)
- .3 Top and Bottom Rails: Continuous two-piece assemblies with removable end caps. Rails fasten together from alternate sides of partition allowing for field adjustment to job site conditions. Snap-on covers are furnished to facilitate installation.
- .4 Horizontal Top and Bottom Seals: Continuous contact vinyl seals without the need for mechanically operated parts.
- .5 Bottom Rail Locking System: Engage floor by use of thumb turn operated floor bolts to stabilize panels from movement in all directions.
 - .1 Equip lead panel with mortised cylinder with key and thumb turn operated floor bolt. Round bolt engages eccentric bushing floor strike for security.
 - .2 Intermediate panels to have a thumb turn operated floor bolt.

- .3 Pivot panels to have mortised cylinder with key and thumb turn.
- .6 Hinges for panels shall be:
 - .1 Butt hinges attached to top and bottom rail
- .7 Acoustical ratings of panels: Sound Transmission Class of minimum 15 STC when tested in accordance with ASTM E90 and classified in accordance with ASTM E413.

2.4 **MATERIALS**

- .1 Aluminum: Alloy and temper recommended by aluminum producer and finisher for type of use, corrosion resistance, and finish indicated; ASTM B221 (ASTM B221M) for extrusions; manufacturer's standard strengths and thicknesses for type of use.
 - .1 Finish: Clear anodized
- .2 Glass: Refer to Section 08 80 00, Glazing for glass requirements.

2.5 **SUSPENSION SYSTEM**

- .1 G-330 Suspension System "Smart Track"
 - .1 Suspension Tracks: Extruded aluminum with a minimum wall thickness of 0.235 inches (6 mm). Incorporate cast aluminum or mitered intersections, switches, and curves in stacking area. Provide alignment pins for track, intersections, switches and curves insuring both fit and roller surface integrity.
 - .1 Exposed track soffit: Factory-finished aluminum with white powder coat.
 - .2 Carriers: Two stainless steel trolleys with vinyl roller surfaces. Trolley design incorporates eight (8) wheels of varying dimensions. Automatic indexing of panels into stack area is provided by pre-programmed switches and trolleys without electrical, pneumatic, or mechanical activation.
 - .3 Warranty period: Two (2) years.

PART - 3 EXECUTION

3.1 **INSTALLATION**

- .1 General: Comply with ASTM E557, operable glass partition manufacturer's written installation instructions, Drawings, and approved Shop Drawings.
- .2 Install operable glass partitions and accessories after other finishing operations, including painting, have been completed.
- .3 Match operable glass partitions by installing panels from marked packages in numbered sequence indicated on Shop Drawings.
- .4 Broken, cracked, chipped, deformed, or unmatched panels are not acceptable.

3.2 **CLEANING AND PROTECTION**

- .1 Clean metal and glass surfaces upon completing installation of operable glass partitions to remove dust, loose fibers, fingerprints, adhesives, and other foreign materials according to manufacturer's written instructions.
- .2 Provide final protection and maintain conditions in a manner acceptable to manufacturer and Installer that ensure operable glass partitions are without damage or deterioration at time of Substantial Completion.

3.3 **ADJUSTING**

- .1 Adjust operable glass partition to operate smoothly, easily, and quietly, free from binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Lubricate hardware and other moving parts.

3.4 **EXAMINATION**

- .1 Examine flooring, structural support, and opening, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of operable glass partitions. Proceed with installation only after unsatisfactory conditions have been corrected.
 - .1 Ensure finished floor under operable glass partition is level \pm 0.13-inch (3 mm) in ten (10) feet (3048 mm) non-cumulative.

3.5 **DEMONSTRATION**

- .1 Demonstrate proper operation and maintenance procedures to Owner's representative.
- .2 Provide Operation and Maintenance Manual to Owner's representative.

END OF SECTION

PART - 1 GENERAL

1.1 SUMMARY

.1 Section Includes:

.1 Labour, Products, equipment and services necessary to complete the work of this Section, including but not limited to:

- .1 Wall coverings (PWC)
- .2 Corner guards (CG)
- .3 Handrail/Bumper Rails (CRL)

1.2 QUALITY ASSURANCE

.1 Installer: Trained and approved by the manufacturer and having a minimum three years experience in the installation of the work described in this Section and can show evidence of satisfactory completion of projects of similar size, scope and type. If requested, provide letter of certification from manufacturer stating that installer is certified applicator of its products, and is familiar with proper procedures and installation requirements required by the manufacturer.

.2 Maintenance seminars: Provide, to the Owner, training seminars and recommendations on Product maintenance procedures.

.3 Pre-installation meeting: Two weeks prior to commencing work of this Section, arrange for manufacturer's technical representative to visit the site and review preparatory and installation procedures to be followed, conditions under which the work will be done, and inspect the surfaces to receive the work of this Section. Advise the Consultant of the date and time of the meeting.

.4 Source limitations: Obtain each type of product from a single manufacturer.

.5 Products: Provide like Products from same production run. Install Products in sequence from sequentially numbered dye lots.

1.3 SUBMITTALS

.1 Samples: Three 300 mm x 300 mm samples of each wall covering material and three 300 mm long samples of handrail and bumper rail.

.2 Maintenance data: Printed manufacturer's maintenance instructions giving specific warnings of maintenance practices of substances, which may stain or otherwise damage the wall coverings or handrails/bumper rails.

1.4 SAMPLE INSTALLATION

.1 Apply each type of covering to a sample area on the project and obtain the approval of the Consultant of such applications before proceeding. Locations of sample areas shall be as directed by the Consultant.

.2 Sample areas of wall covering shall be full height, as indicated on Drawings, and include one outside corner and one covering material joint.

.3 Sample areas of rail shall be full length, and include one outside corner, and one end cap.

- .4 Promptly revise or replace coverings on sample areas at no additional cost to the Owner until approval of the Consultant is obtained. The approved sample area installations shall be the standard for acceptance of the remaining work.

1.5 **STORAGE**

- .1 Store materials with manufacturer's seals and labels intact. Store materials flat in clean, dry storage area at temperatures over 10 deg C and normal humidity.

1.6 **PROJECT CONDITIONS**

- .1 Environmental Limitations: Do not commence work until spaces are enclosed and weatherproof, wet work in spaces is complete and dry, work above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
- .2 Lighting: Do not commence work until a lighting level of not less than 160 lux is provided on the surfaces to receive wall covering.
- .3 Ventilation: Provide continuous ventilation during installation and for not less than the time recommended by wall covering manufacturer for full drying or curing.

1.7 **EXTRA STOCK**

- .1 Provide minimum 5% of each type and colour of wall covering and handrail/bumper rail material in unopened packages, and accessories installed. Store the extra materials at locations as directed by the Owner. Extra stock shall be of same production run as installed materials.

PART - 2 PRODUCTS

2.1 **MATERIALS**

- .1 Basis of Design: Refer to Section 00 01 30 List of Materials, for complete list of corner guards and protective wall covering products, designations, manufacturers, sizes, finishes and colours.
- .2 Aluminum Retainers: Extruded aluminum retainers 6063-T6 alloy, nominal 0.62" thick. Minimum strength and durability properties as per ASTM B221. Supplied by manufacturer.
- .3 Fasteners: non corrosive and compatible with aluminium retainers supplied by manufacturer.
- .4 Adhesive: Mildew resistant, nonstaining, strippable adhesive, for use with specific wall covering and substrate application, as recommended in writing by wall covering manufacturer.
- .5 Primer/Sealer: Mildew resistant primer/sealer, and recommended in writing by wall covering manufacturer for intended substrate.
- .6 Sealant: antimicrobial, 100% silicone sealant.

2.2 ACCESSORIES

- .1 Wall covering and rails manufacture to supply a packaged system, containing all materials needed to complete wall covering and rails design.
- .2 Supply all primers and adhesive required to install wall coverings, as per manufacturer's recommendations.

PART - 3 EXECUTION

3.1 INSPECTION

- .1 Examine areas, which are to receive the work of this Section and proceed only if conditions are satisfactory. Verify adequacy of support at substrate. Report unsuitable substrates. Commencement of work shall imply acceptance of conditions.
- .2 Substrates shall be smooth, dry, free of dust and dirt.

3.2 PREPARATION

- .1 Remove materials from packaging and acclimatize materials in the installation areas not less than 24 hours before installation.
- .2 Test surfaces for moisture and alkali content prior to application of materials. Moisture content shall be less than 4%. Neutralize and seal surfaces in accordance with manufacturer's directions.
- .3 Where substrate has been painted, apply a thin coat of adhesive over substrate and allow drying for one hour.
- .4 Comply with manufacturer's written instructions for surface preparation.
- .5 Clean substrates of substances that could impair wall covering's bond, including mold, mildew, oil, grease, incompatible primers, dirt, and dust.
- .6 Prepare substrates to achieve a smooth, dry, clean, structurally sound surface free of flaking, unsound coatings, cracks, and defects.
- .7 Remove hardware and hardware accessories, electrical plates and covers, light fixture trims, and similar items.

3.3 INSTALLATION – WALL COVERINGS

- .1 Apply materials in strict accordance with manufacturer's instructions and as specified; report discrepancies immediately to Consultant.
- .2 Install materials free from tears, ripples or air pockets. Horizontal joints in wall covering are not permitted except upon specific, written approval of the Consultant.
- .3 Take special care to prevent plaster particles, grit, dirt, or other extraneous matter from being imbedded beneath the wall covering.
- .4 Spread adhesive in a uniform coat to back of material and apply material to wall within time recommended by adhesive manufacturer. Thoroughly wash excessive adhesive off material and adjacent surfaces as application progresses.
- .5 On gypsum board construction, avoid scoring gypsum board face by using a metal strip cutting base.

- .6 Neatly and carefully trim around fixtures, door frames and the like, as indicated on Drawings.
- .7 Match adjacent panels for colour, pattern, texture and direction of nap where applicable. All panels shall be uniform in colour and texture. Remove material, which fails to match when applied, and replace with matching material.
- .8 Reinstall hardware and hardware accessories, electrical plates and covers, light fixture trims, and similar items.

3.4 INSTALLATION – RAILS

- .1 Apply materials in accordance with manufacturer's instructions.
- .2 Install aluminum rail retainer to platform bracket base with fasteners, supplied by the manufacturer.
- .3 Snap on rail cover overtop of retainer.
- .4 Install end caps and corners where required, and as shown on Drawings.
- .5 All covers shall be uniform in colour and texture. Remove material, which fails to match when applied, and replace with matching material.
- .6 Reinstall hardware and hardware accessories, electrical plates and covers, light fixture trims, and similar items, if removed to install handrail.

3.5 INSTALLATION – CORNER GUARDS

- .1 Install work in accordance with manufacturer's written installation instructions and as shown on drawings.

3.6 PATCHING

- .1 Perform cutting, fitting and patching of wall covering material as required to accommodate fixtures, railing brackets and other appurtenances occurring in surfaces to receive coverings. Maintain covering pattern regardless of position of appurtenances.

3.7 CLEANING

- .1 Immediately upon completion of installation, clean wall covering and accessories in accordance with manufacturers recommended cleaning method.
- .2 Remove surplus materials, and debris upon completion of work.

END OF SECTION

PART - 1 GENERAL

1.1 SUMMARY

.1 Section Includes:

.1 Labour, Products, equipment and services necessary to complete the work of this Section in accordance with the Contract Documents. The work of this Section includes but is not limited to:

.1 Washroom accessories

1.2 QUALITY ASSURANCE

.1 Source Limitations: Provide like products of same manufacturer unless otherwise approved by Consultant.

1.3 SUBMITTALS

.1 Shop Drawings: Indicate materials, products and finishes and showing in large scale detail the construction, reinforcing, anchorage and, where permitted, the location of exposed fastenings.

.1 Submit engineered shop drawings

.2 Maintenance data: Three copies of a list of the accessories requiring supplies together with names and addresses of local distributors of the supplies.

.3 Samples for Verification: Full size, for each accessory item to verify design, operation, and finish requirements. Approved full-size Samples will be returned and may be used in the Work.

.4 Product Schedule: Indicating types, quantities, sizes, and installation locations by room of each accessory required.

.1 Identify locations using room designations indicated on Drawings.

.2 Identify products using designations indicated on Drawings.

1.4 CLOSEOUT SUBMITTALS

.1 Operation and Maintenance Data: Provide maintenance data for toilet and bath accessories for incorporation into manual.

1.5 MAINTENANCE MATERIAL SUBMITTALS

.1 Tools

.1 Provide special tools required for assembly, disassembly or removal for toilet and bath accessories.

.2 Deliver special tools to Contracting Authority.

1.6 DELIVERY, STORAGE AND HANDLING

.1 Carefully wrap accessories ensuring protection during shipping and storage.

.2 Store accessories inside the building in the location directed, and so that their identification is readily visible, and in the general order in which they will be required for installation.

1.7 **COORDINATION**

- .1 Coordinate accessory locations with other work to prevent interference with clearances required for access by people with disabilities, and for proper installation, adjustment, operation, cleaning, and servicing of accessories.
- .2 Deliver inserts and anchoring devices set into concrete or masonry as required to prevent delaying the Work.

PART - 2 PRODUCTS

2.1 **ACCEPTABLE MANUFACTURERS**

- .1 Basis of Design: Refer to Section 00 01 30, List of Materials for complete list of washroom accessory products, designations, manufacturers, sizes and colours.
 - .1 Products by other manufacturers similar in function, design, performance, and construction complying with requirements of this Section may be incorporated into the Work subject to Consultant's acceptance, in accordance with Section 01 25 13, Product Substitution Procedures.
- .2 Provide accessories for the Work from one manufacturer.

2.2 **MATERIALS**

- .1 Sheet steel: To ASTM A653/A653M-11 with ZF001 designation zinc coating.
- .2 Stainless steel: ASTM A167-99 (2009), type 304, with BA finish.
- .3 Stainless Steel Tubing: Type 304, commercial grade, seamless welded, 1.2 mm wall thickness.
- .4 Supply for installation under other Sections, mounting devices and reinforcement required to be built-in for support of grab bars and imposed loads. Be responsible for giving proper notice to other Sections and supplying such reinforcement when required by other Sections for building in.
- .5 Concealed screws and bolts hot dip galvanized, exposed fasteners to match face of unit. Expansion shields fibre, lead or rubber as recommended by accessory manufacturer for component and its intended use.
- .6 For mental health areas use tamper resistant fasteners, hexalobular conforming to ISO 10664 or other tamper resistant fastener design as accepted by Consultant.

2.3 **FABRICATION**

- .1 Fabricate accessories true, square, rigid, free from distortion and from defects detrimental to appearance and performance.
- .2 Butt visible joints straight and accurate. Mitre corner joints.
- .3 Except as otherwise specified, fabricate accessories for concealed mounting by non-corrosive metal, expansion type, toggle type or other approved type of positive, mechanical anchors to suit the construction to which the accessory is to be mounted.

- .4 Exposed fasteners, where permitted, shall be finished to match the adjacent accessory surface, and shall be countersunk. Where accessories are to be mounted to sheet metal, provide a 3 mm thick minimum full-size metal back-up plate drilled and tapped to receive machine screws and finished to match the adjacent sheet metal surface.
- .5 Where specified as frameless, provide accessories in one piece fronts with 90 degree formed returns at their edges and openings. Continuously weld returns and ground smooth at the corners.
- .6 Where accessory fronts are framed, frame edges, both inside and outside, shall have 90 degree formed returns continuously welded and ground smooth at the corners. Doors shall also have 90 degree formed returns as specified.
- .7 Provide full length concealed stainless steel piano hinges. Hinged elements shall have concealed, mechanically-retained, rubber bumpers for silent closing, and shall close flush with faces of fronts or frames.
- .8 Unless otherwise specified, portions of sheet metal accessory interiors which are visible in the completed work shall be stainless steel. Changes in plane shall be formed or continuously welded and ground smooth.
- .9 Sheet metal accessory parts concealed in the finished installation shall be galvanized sheet steel.
- .10 Hem edges of sheet metal accessible by users or maintenance personnel.
- .11 Accessories for flange-type mounting shall have forged brass, full flanges drilled and countersunk for three mounting fasteners. Fix flanges to tubes using solid silver soldering.
- .12 Back paint components where contact is made with building finishes to prevent electrolysis.
- .13 Shop assemble components and package complete with anchors and fittings.
- .14 Deliver inserts and rough-in frames to job site at appropriate time for building-in. Provide templates, details and instructions for building in anchors and inserts.
- .15 Provide steel anchor plates and components for installation on studding and building framing.
- .16 Engrave lettering on accessories to a depth of minimum 0.254 mm. Size, location and type face of lettering to selection by Consultant. Maintain engraving edges straight and sharp.

2.4 **FINISHES**

- .1 Where steel is specified as having a chrome plated finish, pretreat including mechanical removal of imperfections and buffing, degreasing, removal of degreaser, electrolytic cleaning, intermediate treatments of acid washes and cold water rinses in preparation for and to suit plating, nickel plating pretreatment, nickel plating, hard chromium plating with a final hot water rinse.
- .2 Finish stainless steel to a standard No. 4 mechanical finish. Where possible, arrange sheet stainless steel so that the grain of the finish runs vertically in the finished installation.
- .3 Manufacturer's or brand names on face of units not acceptable.

PART - 3 EXECUTION

3.1 INSTALLATION

- .1 Install and secure accessories rigidly in place.
- .2 Stud walls: Provide steel back-plate to stud prior to gypsum board finish. Provide plate with threaded studs or plugs.
- .3 Hollow masonry units or existing gypsum board: Use toggle bolts drilled into cell/wall cavity.
- .4 Install grab bars on built-in anchors provided by manufacturer.
- .5 Fill units full with necessary supplies shortly before Substantial Performance.

END OF SECTION

PART - 1 GENERAL

1.1 SUMMARY

- .1 Section Includes: Labour, Products, equipment and services necessary to complete the work of this Section.

1.2 SUBMITTALS

- .1 Shop drawings: Indicate the materials being supplied and all connections, attachments, reinforcing, anchorage and location of exposed fastenings.
- .2 Samples: Submit if requested, one full size sample of locker, complete in all respects with this specification including the selected colours.

PART - 2 PRODUCTS

2.1 MATERIALS

- .1 Locker type: Prefinished, Z-Type 450 mm wide x 450 mm deep x 1800 mm high, double tier, complete with sloping tops and 100 mm high recessed base, by Hadrian Manufacturing Inc.
- .2 Bodies: Minimum 24 gauge stretcher levelled cold rolled steel sheets, carefully formed and factory punched to provide necessary assembly holes. Bolts and nuts shall be complete with lock washers and nut cover, and cadmium plated. Welded construction will be accepted provided surfaces welded together are prime coated before assembly and prefinished.
- .3 Panels and trims: Same material, construction and finish as locker bodies.
- .4 Frames: Formed channel section of 1.6 mm thick stretcher levelled cold rolled steel, corners notched and neatly welded. Provide two rubber door silencers per door on lock side of frame, 38 mm from top and bottom of door. Incorporate ventilation slots at top and bottom.
- .5 Doors: Minimum 20 gauge thick stretcher levelled cold rolled steel, fully enclosed panel and reinforced with internal 24 gauge thick stiffeners, running full length and width of door. Secure components by spot welding and/or special type fasteners to provide a rigid and whip free door. Door frames shall be 16 gauge thick cold rolled steel of box channel shape. Hang doors on two heavy duty tamperproof hinges welded to door and designed to allow full 180 deg. swing.
- .6 Latching: Heavy duty hasp and plunger arrangement, minimum 3.5 mm thick for padlocking and friction catch.
- .7 Handles: Fully recessed, chrome plated and fitted for padlock use. Padlocks will be supplied by the Owner. Provide stainless steel or chrome plated inserts for the recessed handle area. Door shall be held closed with friction catch.
- .8 Number plates: Semi-recessed plates of anodized aluminum, numbered and lettered with die embossed numerals painted black as directed by the Consultant.
- .9 Hooks: Equip each locker with three die-cast zinc wall hooks.

- .10 Finish: Remove grease and extraneous matter, pre-treat, prime and finish with two coats of baked enamel or electrostatic powder coat, colour to be selected by Consultant from manufacturer's standard and premium colour set.
- .11 Locker Bench (FB-1): Phenolic resin locker bench with stainless steel pedestals, size 240 mm x 1525 mm x 440 mm (9 1/2"x 60" x 17 1/4"). Manufacturer to provide complete package required to install product including hardware.

2.2 **FABRICATION**

- .1 Fabricate work true to dimensions, square, plumb, level and free from distortion and defects detrimental to appearance and performance. Accurately fit members with hairline joints. Secure intersecting members with adequate fastenings.
- .2 Weld connections where possible; where not possible bolt connections or secure in an approved manner. Countersink exposed fastenings and cut off bolts flush with nuts, and make as inconspicuous as possible.

PART - 3 EXECUTION

3.1 **INSTALLATION**

- .1 Examine surfaces to receive the work of this Section and proceed only if conditions are satisfactory.
- .2 Install work true to dimensions, square, plumb and level. Accurately secure joints and intersecting members with adequate fastening.
- .3 Provide maximum number of lockers to fill completely the spaces indicated or as called for on the Drawings.
- .4 Provide cover strips, trim, false fronts and panels to complete banks of lockers.

END OF SECTION

PART - 1 GENERAL

1.1 SUMMARY

- .1 This Section includes requirements for supply and installation of patient bed head walls (HU) forming a complete system comprised of the following:
 - .1 Medical gas service piping manifold ready for final connection to building services at single point connection drop
 - .2 Equi-potential ground bus, wiring, grounding, lights, low voltage raceways and communications wiring harness ready for final connection to building services at single point connection drop
 - .3 Recess mounted service console.
 - .4 Accessories, integrated equipment accessory rails and other components required for a complete and functioning installation.

1.2 REFERENCE STANDARDS

- .1 Aluminum Association (AA):
 - .1 Welding Aluminum: Theory and Practice
- .2 American Architectural Manufacturer's Association (AAMA):
 - .1 AAMA 611, Voluntary Specification for Anodized Architectural Aluminum
 - .2 AAMA AFPA, Anodic Finishes/Painted Aluminum
- .3 American National Standards Institute (ANSI):
 - .1 ANSI/AWS A5.8M, Specification for Filler Metals for Brazing and Braze Welding
 - .2 ANSI/AWS D10.13M, Recommended Practices for the Brazing of Copper Pipe and Tubing for Medical Gas Systems
- .4 American Society of Mechanical Engineers (ASME):
 - .1 ASME B16.18, Cast Copper Alloy Solder Joint Pressure Fittings
 - .2 ASME B16.22, Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
- .5 American Society for Testing and Materials (ASTM):
 - .1 ASTM A167, Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet and Strip
 - .2 ASTM A269, Stainless and Welded Austenitic Stainless Steel Tubing for General Service
 - .3 ASTM A403/A403M, Wrought Austenitic Stainless Steel Piping Fittings
 - .4 ASTM A653/A653M, Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc Iron Alloy Coated (Galvannealed) by the Hot Dip Process.
 - .5 ASTM A666, Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate and Flat Bar
 - .6 ASTM B32, Solder Metal
 - .7 ASTM B88, Standard Specification for Seamless Copper Water Tube
 - .8 ASTM B209/209M, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate

- .9 ASTM B221, Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
- .10 ASTM B280, Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service
- .11 ASTM B819, Standard Specification for Seamless Copper Tube for Medical Gas Systems
- .12 ASTM D1785, Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
- .13 ASTM D2466, Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings
- .14 ASTM D2564, Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings
- .6 Canadian Standards Association (CSA):
 - .1 CSA Z305.1, Non-Flammable Medical Gas Piping Systems
 - .2 CSA Z305.2-M88, Low-Pressure Connecting Assemblies for Medical Gas Systems
 - .3 CAN3 Z305.4-M85, Qualification Requirements for Agencies Testing Nonflammable Medical Gas Piping Systems
 - .4 CSA Z318.6, Commissioning of Medical Gas Systems in Health Care Facilities
 - .5 CSA Z7396.1, Medical Gas Pipeline Systems – Part 1: Pipelines for Medical Gases and Vacuum
 - .6 CAN/CSA Z9170-1, Terminal Units for Medical Gas Pipeline Systems - Part 1: Terminal Units for Use with Compressed Medical Gases and Vacuum
 - .7 CAN/CSA Z10524-1, Pressure Regulators and Pressure Regulators with Flow-Metering Devices for Medical Gas Systems
 - .8 CAN/CSA Z15002, Flow-Metering Devices for Connection to Terminal Units of Medical Gas Pipeline Systems
- .7 Canadian General Standards Board (CGSB):
 - .1 CAN/CGSB 24.2-M86, Identification of Medical Gas Containers, Pipelines and Valves
- .8 Compressed Gas Association (CGA):
 - .1 CGA G-7, Compressed Air for Human Respiration
 - .2 CGA G-7.1, Commodity Specification for Air
 - .3 CGA V-5, Diameter Indexing Safety System (Noninterchangeable Low Pressure Connections for Medical Gas Applications)
 - .4 CGA E-7, American National and CGA Standard for Medical Gas Regulators and Flowmeters
- .9 National Fire Protections Association (NFPA):
 - .1 NFPA 99, Health Care Facilities
- 1.3 **ADMINISTRATIVE REQUIREMENTS**
 - .1 Coordination: Coordinate work of this section with work of other sections for the following:
 - .1 Connection of HU medical gas piping manifold to building services.

- .2 Connection of HU electrical, communications and cable television wiring harness to building services.
 - .3 Dimensions and roughing in requirements required for preparation of shop drawings.
 - .4 Manufacturers of all equipment forming part of HU's and wall assemblies and compatibility of those components specified in other related requirements.
 - .5 Placement and installation of communication wiring and devices that do not form a part of the work of this section such as nurse call, television cable, code blue, telephone and monitor jacks, and similar components.
 - .6 Location and timing of site constructed mock-ups described later in this section.
 - .7 Site Quality Assurance testing by manufacturer, installer and Owner's Site Quality Control testing required for certification and final acceptance of installed systems.
- .2 Pre-installation meeting: Two weeks prior to commencing work of this Section, arrange for manufacturer's technical representative to visit the site and review preparatory and installation procedures to be followed, conditions under which the work will be done, and inspect the surfaces to receive the work of this Section. Advise the Consultant of the date and time of the meeting.

1.4

SUBMITTALS

- .1 Action Submittals: Provide the following submittals before starting any work of this Section:
- .1 Product Data: Submit product data, manufacturer's literature and illustrations indicating size, dimensions and configuration of all components forming a part of HU's including the following:
 - .1 Connection stub outs or termination points to tie in medical gas supply lines.
 - .2 Connection stub outs or termination points to tie in electrical service.
 - .3 Indicate relationship of services including medical gas piping, gas outlets, raceways and wires, outlets, circuiting and grounding, and fixtures.
 - .4 Indicate openings required for coordination of medical and electrical services, connections, access panels, and exposed fasteners.
 - .5 Indicate materials, thicknesses, and dimensions.
 - .6 Include detailed list of information required for integration of related work.
 - .7 Include specific details, model numbers and manufacturer's product literature for electrical devices including switches, receptacles, and terminal blocks.
 - .2 Shop Drawings: Submit shop drawings indicating general assembly of components, mounting and installation details, and general layout of HU's.
- .2 Informational Submittals: Provide the following submittals before starting any work of this Section as follows:
- .1 Certificates: Submit certification indicating compliance to codes and standards referenced in this Section and required by the Authorities Having Jurisdiction; installing personnel must hold current certification or license indicating that they are skilled in the installation of medical gas systems; submit evidence of certification to Consultant prior to any work being performed on the medical gas systems.
 - .2 Manufacturer's Instructions: Submit manufacturer's written installation instructions indicating requirements for equipment and systems including the following:
 - .1 Equipment dimensions and performance
 - .2 Wiring and controls

1.5 **PROJECT CLOSEOUT SUBMISSIONS**

- .1 Operation and Maintenance Data: Submit manufacturer's written instructions for repair and cleaning procedures; include name of original installer and contact information; including the following information:
 - .1 Equipment list identifying components used in each HU including installation instructions and assembly views
 - .2 Equipment manufacturer's names and addresses.
 - .3 Equipment maintenance data including maintenance and inspection data, replacement part numbers and availability, and service depot location and telephone numbers.
 - .4 Wiring diagrams of electrical components.
 - .5 Detailed drawings of equipment and components
 - .6 Manufacturers service manuals for equipment
 - .7 Completed test result report form from independent testing agency verifying that systems are complete, zone valves are installed, alarm systems are functional, and pressure and cross connections tests have been performed.

1.6 **QUALITY ASSURANCE**

- .1 Regulatory Requirements: Conform to listed referenced standards and codes, and requirements of the Authority Having Jurisdiction for supply and installation of medical gas systems.
 - .1 Comply with the requirements of the Canadian Electric Code Part 1 (CEC), applicable Canadian Standards Association and National Fire Protection Association (NFPA) publications, and with all applicable local, provincial, and federal codes.
 - .2 Perform work in accordance with NFPA 99, other referenced codes and standards, and requirements of this Section; maintain one copy of each document referenced in this section on site.
 - .3 Specific reference to a phrase or component within a particular Code or Standard in this specification is made to emphasize and clarify the intent of the Section; compliance with these individual points does not constitute or relieve installer or testing agency from complying with the remaining applicable sections of the reference Codes and Standards.
- .2 Qualifications: Provide proof of qualifications when requested by Consultant:
 - .1 Manufacturer: Use a manufacturer specializing in manufacturing products specified in this Section having experience with projects of similar complexity and extent.
 - .2 Materials: Materials provided by this Section shall be complete in every respect and ready to be put in operation at completion of the work and as follows:
 - .1 Material shall be new and of the best grade and quality obtainable.
 - .2 Materials shall comply with relevant standards and codes listed in this section and as required by the Authorities Having Jurisdiction.
 - .3 Equipment shall be CSA Approved and bear a CSA Label indicating compliance with specified standards and be acceptable to cULus requirements.

- .4 Materials used for work of this section shall be supplied by one manufacturer; manufacturer shall supply the medical-gas system(s) equipment, including the sources of supply.
- .5 Manufacturer shall have a trained agent available to periodically check with the Subcontractor during initial installation of the medical gas pipeline systems equipment, who has the authority to recommend and document changes to the installation arising from site conditions.
- .3 Installer: Use only installers that specialize at performing the work of this Section having experience with specified materials and projects of similar complexity and extent, and certified or licensed to perform the work of this Section.
- .4 Testing Agency: Use a testing laboratory for Subcontractor quality assurance and verification that specializes in performing the testing of medical gas systems to perform the following testing before Owner conducts their own third party testing of the completed installation:
 - .1 Subcontractor is required to confirm that installation of medical gas systems specified in this Section is complete and ready for purity and cross-contamination testing specified in Part 3 below for formalized quality assurance procedures.

1.7 **MOCK-UPS**

- .1 Install mock-up of typical medical gas system components demonstrating interface with other materials including brazing techniques, connection to electrical components and penetrations through wall assemblies.
- .2 Allow 3 working days for review of mock-up by Consultant.
- .3 Make revisions to mock-ups or perform additional work as directed by Consultant.

1.8 **PROJECT CONDITIONS**

- .1 Site Measurements: Verify dimensions by site measurements before fabrication and indicate measurements on Shop Drawings where HU's are indicated to fit between walls and other construction; coordinate fabrication schedule with construction progress to avoid delaying the Work.
- .2 Established Dimensions: Establish dimensions and proceed with fabricating metal fabrications without site measurements where site measurements cannot be made without delaying the Work; coordinate construction to ensure that actual dimensions correspond to established dimensions; allow for trimming and fitting.

1.9 **DELIVERY, STORAGE AND HANDLING**

- .1 Deliver materials to site in manufacturer's original undamaged containers or wrapping with seals and labels intact.
- .2 Damaged components shall not be installed but shall be replaced with new components.
- .3 Notify the Consultant for clarification prior to closing of Bids where differences occur between this Section and other referenced sections.

PART - 2 PRODUCTS

2.1 MANUFACTURERS

- .1 Basis-of-Design Manufacturer: Amico Corporation, refer to Section 00 01 30 List of Materials attached to this Section for model, size and other requirements.
 - .1 Manufacturer's name is stated in the Specification to establish a basis for tender submission and to clearly describe the quality of system required for the work. Equipment by other manufacturers, equal or better in design, performance and construction complying with requirements of this section may be incorporated into the work subject to Consultant's approval.

2.2 MATERIALS

- .1 Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated, and as follows:
 - .1 Sheet and Plate: ASTM B209
 - .2 Extruded Bars, Rods, Shapes, and Tubes: ASTM B221
 - .3 Extruded Structural Pipe and Tubes: ASTM B 429
 - .4 Welding Rods and Bare Electrodes: CSA W59.2
- .2 Stainless Steel Sheet or Bar: In accordance with ASTM A167 or A666 as appropriate for material thickness required, Type 304.
- .3 Medical Gas Piping, Fittings and Joints: Following applies to distribution system piping, stubbed out ready for connection to building services located in ceiling:
 - .1 Tube: ASTM B819, Type K or L:
 - .1 Use Type K for systems having an operating pressure of 1380 kPa or greater.
 - .2 Concealed Piping: Soft Temper
 - .3 Exposed Piping: Hard Temper
 - .2 Service Rating: Suitable for oxygen service, permanently labelled and delivered plugged, capped, or otherwise sealed to prevent contamination of internal surfaces.
 - .3 Plugs, caps, or other seals shall remain in place until final assembly.
 - .4 Copper Tubing: Type K seamless copper cleaned and degreased in accordance with ASTM B819.
 - .5 Protective Caps: Cap open ends of piping to prevent contamination of system until fixtures or fittings are attached.
 - .6 Fittings: ASME B16.22, cleaned for oxygen service:
 - .1 Deliver fixtures plugged, capped, bagged, or otherwise sealed to prevent contamination of internal surfaces.
 - .2 Keep plugs, caps, bags, or other seals in place until final assembly.
 - .7 Joints: Brazed using an AWS A5.8 BCuP Series filler metal and flux recommended for medical gas piping systems for interior installations.
- .4 Medical Vacuum Piping, Fittings and Joints:
 - .1 Exposed Locations: Hard Temper ASTM B88 Type L or Type M, ASTM B280 Type ACR, or ASTM B819 Type L

- .2 Concealed Locations: Soft Temper ASTM B88 Type L, or ASTM B280 Type ACR, soft temper for underground or concealed locations
- .3 Fittings: ASME B16.22
- .4 Joints: Brazed using an AWS A5.8 BCuP Series filler metal and flux recommended for vacuum systems for interior installations
- .5 Gas Connectors: Diameter Index Safety System (DISS) Connectors to suit site standard, and as follows:
 - .1 CGA V-5 brass connections with automatic valve, and secondary check valves as required.
 - .2 Provide each outlet connector with a positive acting metal or plastic cap secured with chain to the faceplate.
 - .3 Provide connectors as required, colour code in accordance with CGSB 24.2:
 - .4 Clean medical gas piping in accordance with ASTM B819, and securely cap and identify each service prior to shipping.
 - .5 Protect copper tubing from contact with dissimilar metals to prevent galvanic degradation.
- .6 Electrical: Provide electrical services harness and connections stubbed out ready for connection to building services located in ceiling:
 - .1 Line Voltage Wiring: ULC and CSA listed and acceptable wiring, wiring and connection devices meeting requirements of CEC.
 - .2 Low Voltage Wiring: ULC and CSA listed and acceptable wiring, wiring and connection devices contained within barrier compartments and back boxes.
 - .3 Communication Wiring: Provide empty back boxes and barrier compartments ready for installation of communication wiring and devices.
 - .4 Devices: Factory installed duplex receptacles and line voltage switches and as follows:
 - .1 Duplex Receptacles: 15 Amp 120 V Hospital Grade
 - .2 Electrical Back Boxes: Hubbell MBS 1K to 3K
- .7 Equipment Mounting Tracks: Profiled tracks meeting infection control standards and as follows:
 - .1 Extruded aluminum, capable of supporting medical equipment loads in configurations as indicated.
 - .2 Tracks that require adapters attached through specific openings will not be acceptable.
 - .3 Finish: Clear anodized finish.
- .8 Brackets and Reinforcements:
 - .1 Provide structure complete with fasteners, studs, nailers, anchoring plates, electrical plates, and bases.
 - .2 Manufacturer's standard steel wall plates with knockouts for building service connections.
 - .3 Coordinate supply of mounting brackets for early delivery in advance of fabricated assemblies for pre-installation of electrical and mechanical services and furnished with required instructions.

- .9 Fasteners and Accessories: Manufacturer's standard corrosion-resistant, non-staining fasteners and accessories compatible with adjacent materials; concealed mounting in all instances and as follows:
- .10 Finishes: Use materials that are durable, cleanable, and compatible with facility infection control measures, and as follows:
 - .1 Clear Anodized Finish: Class II Finish: AA-M12 Mechanical Finish; C22 Non-Specular; A31 Chemical Finish, etched, medium matte anodic coating; Architectural Class II, clear coating 0.010 mm or thicker in accordance with AAMA 611.
 - .2 Stainless Steel: Number 4 bright directional satin finish; remove tool and die marks and stretch lines or blend into finish; grind and polish surfaces to produce uniform, directionally textured, polished finish indicated, free of cross scratches; run grain with long dimension of each piece; passivate and rinse surfaces after polishing; remove embedded foreign matter and leave surfaces chemically clean.

2.3 **FABRICATIONS**

- .1 Console Assemblies: Fabricated as follows:
 - .1 Console Back Boxes: Nominal 1.5 mm thick galvanized steel or 2.4 mm thick extruded aluminum at manufacturer's choice.
 - .2 Fascia Covers: 2.4 mm thick extruded aluminum.
 - .3 Compartments: Compartmentalize electrical components of different voltages within console assembly with metal barrier plates; construct consoles so that barrier plates can be added or relocated to facilitate future electrical system modifications.
 - .4 Trims: Trim electrical devices and medical gas outlets with anodized aluminum sub-face plate.
 - .5 Exterior Cover: Incorporate a series of rectangular openings to reveal components and conceal fasteners in fascia assembly.
 - .6 Radius inside corners and ease edges of openings to facilitate sterilization and hospital cleaning requirements.
 - .7 Length: as indicated on drawings.
 - .8 Finishes: Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes, and as follows:
 - .1 Finish: Clear anodized finish.

PART - 3 EXECUTION

3.1 **EXAMINATION**

- .1 Verification of Conditions: Verify that wall blocking and supports are adequately installed and that building services are located as indicated on submitted shop drawings and as coordinated in advance during pre-construction meetings.
 - .1 Installation of products specified in this Section will denote acceptance of site conditions.

3.2 **INSTALLATION**

- .1 Secure HU assemblies fixing through gypsum board into mounting brackets; installed in accordance with manufacturer's written instructions, plumb, true, level, and rigid.

- .2 HU equipment manufacturer's representative is responsible to periodically monitor installation and coordinate with Contractor during initial installation and assist in final check to verify that installation is operating in accordance with manufacturer's requirements.
- .3 Verify that HU assemblies are installed correctly and operate proper.

3.3 **SITE QUALITY CONTROL**

- .1 Preparation for Testing: Provide signage indicating that HU's shall not be used until the above documentation has been certified complete and a copy has been accepted and identify the following before starting any site quality control activities:
 - .1 All piping and outlets
 - .2 Medical gas systems
 - .3 Confirm that all specified items are completed
- .2 Subcontractor's Quality Assurance Site Testing and Certification:
 - .1 Certify equipment and fixtures forming a part of HU's and connections up to junction boxes and medical gas stub ups are in accordance with referenced standards and requirements of the Authorities Having Jurisdiction.
 - .2 Certify pressure tests in accordance with NFPA 56F.
 - .3 Verify that installation has been completed properly and that all equipment within the assemblies function in a proper manner; test in accordance with NFPA 99 and CSA Z305.1 and as follows:
 - .1 Test individual HU system component for conformance to specifications and make any necessary adjustments required for a complete and working system is provided.
 - .2 Make adjustments or corrections as required for a working HU prior to the Owner's final testing program.
 - .4 Cooperate, assist and coordinate with Owner's Quality Control testing agency to ensure that Owner obtains a fully operational medical gas delivery system.
- .3 Quality Control Testing and Commissioning: Hire and pay for the services of a certified quality control and commissioning agency to conduct testing in accordance with CSA Z305.4 for medical gas purity and cross-contamination as follows:
 - .1 Subcontractor responsible for work of this section shall include costs for quality assurance testing listed above; and certification requirements required by the Authorities Having Jurisdiction.
 - .2 Agency shall confirm that systems are complete in all respects; that systems are functional as represented by the manufacturer's quality assurance testing.
 - .3 Subcontractor shall include costs associated with coordination and assistance required during purity testing of medical gas systems, and for performing any adjustments required to correct non-conforming items identified by the testing agency. Subcontractor will also be responsible for paying for failed purity tests where failure is a result of installed materials or workmanship.

3.4 **CLEANING**

- .1 Remove fingerprints and smudges from exposed surfaces with a clean damp cloth after installation and testing of HU's is complete.

END OF SECTION

PART - 1 GENERAL

1.1 SUMMARY

- .1 Section Includes: Labour, Products, equipment and services necessary to complete the work of this Section in accordance with the Contract Documents.

1.2 REFERENCES

- .1 National Fire Protection Association (NFPA):
 - .1 NFPA 701-23: Standard Methods of Fire Tests for Flame Propagation of Textiles and Films.

1.3 SUBMITTALS

- .1 Shop Drawings: Show shade arrangements, layout, location within window framing, controls, fixing devices and method of installation.
- .2 Sample: One 300 x 300 mm sample of each shade fabric specified.
- .3 Operation and Maintenance Data: Submit data for inclusion in Operation and Maintenance Manual.
- .4 Warranty Documentation: Submit warranty documentation for inclusion in the Operation and Maintenance Manual.

1.4 QUALITY ASSURANCE

- .1 Conform to applicable fire code for fire performance requirements of shade fabric; material flame-resistance rating as per NFPA 701 as tested by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
- .2 Qualifications:
 - .1 Manufacturer: Company specializing in manufacturing products specified in this Section with minimum five years documented experience.
 - .2 Installer: Company specializing in performing the work of this Section with minimum five years documented experience and approved by the manufacturer.
- .3 Source Limitations: Obtain roller shade system through one source from a single manufacturer. Obtain shade fabric from Manufacturer of roller shade system or from source approved in writing by Manufacturer of roller shade system.

1.5 PROJECT CONDITIONS

- .1 Do not install roller shades until finish work, including painting, is complete and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

1.6 WARRANTY

- .1 Warrant work of this Section against defects and deficiencies as follows. Promptly make good defects and deficiencies which become apparent within warranty period to satisfaction of, and at no expense, to Owner.
 - .1 Warrant roller shade system for a period of one (1) year.
 - .2 Warrant shade fabric for a period of one (1) year.

PART - 2 PRODUCTS

2.1 DESCRIPTION

- .1 Manual chain and roller operated shade systems with fascia or extruded pocket, incorporating an adjustable slip clutch to control rate of fall; single and double as indicated on Drawings.
 - .1 Upper and lower stop limits to prevent overwinding and unrolling to ensure alignment and air clearance at sill.
 - .2 Removable and replaceable shade and spline assembly without disassembling the hardware.
 - .3 Mounting to permit free flow of air over top of shade with a minimum of 12 sq.in./lin.ft.

2.2 COMPONENTS

- .1 Chain: Heavy duty continuous loop stainless steel ball chain, capable of resisting 40 kg. pull.
- .2 Bracket operating assembly: 3 mm steel bracket and injection moulded delrin components assembled on 11 mm diameter welded steel shaft. Provide Wall, jamb or ceiling mounting and centre brackets as required. Reversible for left-hand or right-hand operation.
- .3 Roller tube: Extruded 6063 T6 aluminum tube, sized to suit operating system with asymmetrically shaped mounting channels to which a matching snap-in vinyl spline can be mounted.
- .4 Shade spline: Extruded vinyl with asymmetrical insertion locking channels and embossed shade guide.
- .5 Tube and plug-and-pin assembly tapered to assure alignment and shade edge protection. Pin laterally adjustable 8 mm.
- .6 Mounting hardware: Manufacturer's standard heavy duty steel bracket constructed to support full weight of shade; integrated levelling device; locking mechanism on bracket adapter.
- .7 Roller shade pocket: Extruded aluminum alloy U shape housing for recessed mounting in acoustical tile or drywall ceilings; with snap on endplates and bottom closure; colour to be selected by Consultant from Manufacturer's standard range.
- .8 Fabric: Heat seal, non-ravelling, anti-static, anti-microbial, fade and stain resistant, 0.8 mm single thickness, vinyl fabric woven from 0.5 mm diameter extruded vinyl yarn of polyester and reinforced vinyl; bi-directional.
 - .1 Refer to Section 00 01 30 for Product, manufacturer and other requirements.
- .9 Hem bar: Manufacturer's standard; single length for each shade panel; exposed type with end caps. Colour and finish to be selected by Consultant from manufacturer's standard range.

2.3 FABRICATION

- .1 Square with shade spline for fastening directly to shade roller.
- .2 Seal single length mill finished aluminum flat hembar within hem.
- .3 Reinforce fabric with heat sealed spring tempered stainless steel batten stiffeners at 900 mm centres.

2.4 **FINISHES**

- .1 All exposed aluminum parts shall have clear anodized finish.
- .2 Steel parts shall be either nickel plated, satin finish, or bonderized prior to painting with baked enamel finish. Colour to be selected by Consultant.

PART - 3 EXECUTION

3.1 **EXAMINATION**

- .1 Verify conditions for installation, mounting surfaces, and all site dimensions prior to commencing installation.

3.2 **INSTALLATION**

- .1 Install shades as per Manufacturer's written instructions.
- .2 Install shades, secure, accurately aligned and free of sag.
- .3 Tolerances:
 - .1 Maximum variation of gap at window opening perimeter: 6 mm per 2.4 m of shade height.
 - .2 Maximum offset from level: 3 mm.
 - .3 Use manufacturer's edge clearance requirements for shades where width-to-height ratio exceeds 1:3.

3.3 **ADJUSTING**

- .1 Adjust units for smooth and quiet operation.
- .2 Adjust shade and shade fabric to hang flat without waves, folds, or distortion.
- .3 Replace defective shade and/or shade components.

END OF SECTION



**Mechanical
Specification**
FOR

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END OF SECTION

MECHANICAL GENERAL REQUIREMENTS 20 01 01

1 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.

1.9 Product Substitutions

- .1 The use of a substitute article or material which the manufacturer 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

2.1 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.

3 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 48 hours 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 A security escort will be required for any work being done in secured areas, e.g. raised floor, computer room and mechanical/electrical rooms.
- .17 If Building Operations deems that work on a particular system requires security escort, allow 48 hours to make appropriate arrangements.
- .18 For any open flame work, provide fire extinguishers and security fire watch.
- .19 Obtain the approval of the Building Manager for the storage of materials on site.
- .20 Perform a daily cleanup prior to leaving the site.
- .21 Secure oxygen and acetylene cylinders at all times and capped nightly.
- .22 Restore operating and redundant systems to their normal condition at the end of each work day unless otherwise approved by the Owner
- .23 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

4.1 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.
- .9 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 5% 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 Order will be issued to delete this work element and the amount from the Contract Price. If coordination drawings are not provided, all interferences will be resolved at the contractor's cost.

- .10 For each SOV, include a line item "As-Built & Operating Manuals" and includes a value that is the greater of:
- .1 the value of the work or,
 - .2 2% 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 will be issued to delete this work element and the amount from the Contract Price.

5 CONSTRUCTION CHANGES

5.1 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 journeyman labour that directly performs the work nor labour that directly supervises journeyman(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 journeymen.
- .8 **Journeyman** – a person working in a skilled construction trade which may be prescribed by regulation, and includes apprentices.
- .9 **Labour Unit** – the number of journeyman 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 journeyman 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 journeyman 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:

.1 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,

.2 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),

.3 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 overheat and profit.

6 SUBMITTALS

6.1 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);
 - .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

8.1 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 Provision for Future

- .1 Where space is indicated as reserved for future equipment or for future extension to building, leave such space clear and install piping, raceways and equipment so that connections can be made to future apparatus or building.
- .2 Identify provisions and service terminations for future on Record Drawings.

8.7 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.

8.8 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

9.1 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.

10 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

- .1 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 Ferroscan

- .1 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,

- .2 Based on the preceding results, provide two-dimensional ground penetrating radar scans to locate concrete reinforcement, conduits and other embedments. 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

- .1 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

- .1 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

14.1 General

- .1 Comply with 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. Route pipes, ducts, conduits and other services to avoid interference with existing installation.
- .4 Perform core drilling after-hours or on weekends 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

16.1 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

17.1 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

18.1 Record Drawings

- .1 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, Revit, 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 or Revit 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

- .1 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:

<p>AS-BUILT DRAWINGS. This drawing has been revised to show systems as installed (Signature of Contractor) (Date).</p>
--

- .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 removable mass storage device or 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

19.1 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

- .1 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.
- .6 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, convertors, 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 of Integrated Life Safety and Fire Protections Systems

- .1 Conduct testing of integrated life safety and fire protection systems in accordance with specification Section 20 08 11 *Testing of Integrated Electrical Life Safety and Fire Protection Systems*.

21.3 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 chlorin 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.

21.4 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 natural gas system in accordance with CSA B149.1 *Natural Gas and Propane Piping Code*.
- .3 Test fuel oil systems in accordance with CSA B139 *Installation Code for Oil Burning Equipment*.
- .4 Test drainage, waste and vent piping for tightness and grade as required by the plumbing code in effect at the location of the Work.
- .5 Test special service piping as detailed in other sections of Divisions 21, 22 and 23.

21.5 Testing - Ventilation

- .1 Pressure test ductwork in accordance with section 23 31 13 *Ductwork*, or other applicable sections of Division 23.

21.6 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.

22 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 set of mechanical seals for one pump of each model size,
 - .2 one pump casing joint gasket for each model size,
 - .3 one head gasket for each shell-and-tube heat exchanger with removable heads,
 - .4 one glass for each gauge glass,
 - .5 one set of V-belts for each drive of the same model size,
 - .6 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 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 Contractor's 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 Concealed Space Digital Image Records

- .1 Where services are to be concealed behind walls, ceilings, or buried, the Contractor shall make a digital photo or digitally scanned record of the Work, and assemble these digital records in a logical file structure, organized by floor or department, with each record filename including the room number, so as to form a comprehensive documentation of the completed services.
- .2 The digital files and folders are to be turned over to the Consultant for review prior to the Consultant's reviews for partial- occupancy or substantial performance.
- .3 As part of the request for substantial performance of the Work, submit two (2) copies of the digital record on separate removable storage devices to the Owner for their use. These records are in addition to other construction records including as-built documentation.

26.3 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-yyyy

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%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%
X.X	As-built documents and operating manuals	15,000.00	1.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%
CO.1	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%
	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%
	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%
	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:

- | | | | |
|--|-------------------------------------|--|---|
| <input type="checkbox"/> Architectural | <input type="checkbox"/> Structural | <input type="checkbox"/> Conveying Equipment | <input type="checkbox"/> User Equipment |
| <input type="checkbox"/> Mechanical | <input type="checkbox"/> Electrical | <input type="checkbox"/> Telecommunications | <input type="checkbox"/> Civil |
| <input type="checkbox"/> Other | | | |

If this is a resubmission, check here:

Previous submission HHA reference no.:

hhangus.com



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.

- .2 Contractors performing work on liquid or gaseous fuel piping systems and related equipment shall hold certificates of authorization made under O.Reg. 215/01 *Fuel Industry Certificates* to perform work within the scope of the following regulations;
- .1 Gaseous Fuels, O.Reg. 212/01
 - .2 Propane Storage and Handling, O.Reg. 211/01
 - .3 Fuel Oil, O.Reg. 213/01
 - .4 Compressed Natural Gas, O.Reg. 214/01

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 Electrical work performed under Division 20 to 25, and
 - .3 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 [Refer to specification section 01 14 00 *Work Restrictions*.]
- .2 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 hidden conduit in slabs and walls

- .4 availability of existing documentation

3 INTERFERENCE CO-ORDINATION DRAWINGS

3.1 General

- .1 Take information involving accurate measurements from dimensioned Architectural Drawings or at building.
- .2 Install services and equipment which are to be concealed, close to building structure so that furring is kept to minimum dimensions. Provide necessary offsets in ducts, piping etc. to change elevation and direction as required to coordinate services in the ceiling space.
- .3 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.
- .4 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.
- .5 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.
- .6 Include incidental material and equipment not specifically shown but which is needed to complete the work as an operating installation.
- .7 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.
- .3 Mechanical contractor shall make arrangements with the Owner to access the site and ceiling spaces immediately after award of contract to start survey and preparation of coordination drawings so drawings are coordinated before services are installed. Reasonable time for survey and coordination drawings must be included in the schedule. 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.
- .4 Conduct weekly meetings to discuss and resolve interference issues discovered during interference drawing production.
- .5 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, preferably in 3D AutoCad MEP or Revit format, and keep a set of drawings on site for Consultant's general review.
- .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 Superimpose all services (piping and conduits larger than 2" diameter) on one drawing to be installed in ceiling space or mechanical rooms from information gathered from all subcontractors on site. 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 lbsf).
- .2 The above requirements do not apply to control devices that are solely located and used by the building operations staff.

3 ACCESS 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	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 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 NFPT ends with thermobaked epoxy coating, and Teflon shoulder gasket,
 - .4 head-piece with integral O-ring, with threaded or sweat 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 carbon steel piping.

- .2 Ductile iron flanges, Class 125 to ANSI B16.42.
- .3 Copper tailpiece for soldered joint,
- .4 NFPT 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 2-1/2 to NPS 4;
 - .1 For connecting copper to carbon steel piping.
 - .2 Van Stone style carbon steel flange with copper tailpiece with flared 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.

Standard of Acceptance

- CTS Flange Canada - fig. CTS Copper Flange Adaptor

- .4 Dielectric Insulating gaskets for flanges NPS 6 and over:
 - .1 for use with ASME Class 150 and 300 dimensional flanges.
 - .2 suitable for connecting dissimilar piping materials, including carbon steel/copper, carbon steel/stainless steel, and copper/stainless steel,
 - .3 compatible with pressure and temperature service,
 - .4 BUNA-N or EPDM gasket seals compatible with potable water
 - .5 flange bolts run in insulating sleeves with insulating washers under nuts.

Standard of Acceptance

- Advance Products and Systems

- .5 Provide dielectric isolation between pipes of dissimilar metals with suitable insulating dielectric unions, insulating flanges, or insulating gaskets between flanges;
 - .1 place dielectric isolation between steel piping and bronze or brass valves.
 - .2 do not use bronze or brass valves as dielectric fittings.

◦

5 DRAIN VALVES

- .1 Provide drain points with drain valves at low points of piping systems and at section isolating valves.
- .2 Drain valves: minimum NPS 2 straight pattern bronze with hose end male thread, cap and chain.

6 V-BELT DRIVES

6.1 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 Sheaves for motors greater than 7.5 kW (10 hp) or drives with three or more belts:
 - .1 cast iron or steel with split tapered bushing and keyway.
 - .2 fixed pitch.
- .4 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.
- .5 Motor slide rails:
 - .1 adjustment plates for centre line alignment
 - .2 belt tension adjusting screws.

6.2 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.

7 DRIVE AND COUPLING GUARDS

7.1 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 ($\frac{3}{4}$ in) galvanized wire mesh or expanded metal screen with net free area of guard not less than 80% of fan opening.

7.2 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.

8 SLEEVES

8.1 General

- .1 Sleeve pipes, ducts and conduits passing through masonry walls, concrete floors, and fire rated gypsum board ceilings and partitions.
- .2 Maintain fire rating integrity where pipes and ducts pass through fire rated walls, floors and partitions.

8.2 Floor and Wall Sleeves

- .1 Sleeves in fire separations:
 - .1 sized to suit fire stopping methods employed for bare pipes, conduits, insulated pipes, and bare and insulated ducts without fire dampers, and
 - .2 sized to suit conditions of approval given in manufacturers installation instructions for fire and smoke dampers.
- .2 Sleeves in other construction:
 - .1 sized to clear insulated pipes and ducts by 13 mm ($\frac{1}{2}$ in) all round, and
 - .2 sized to clear conduits, bare pipes, and bare ducts by 6 mm ($\frac{1}{4}$ in) all round.
- .3 Sleeves for pipes, conduits and ducts smaller than 0.4 m² (4 sq ft) through solid walls and floors:
 - .1 Schedule 40 steel pipe or 1 mm (20 ga) (minimum) sheet metal, lapped and spot welded.
 - .2 Sleeves for pipes, conduits and ducts smaller than 0.4 m² (4 sq ft) through gypsum board partitions:
 - (a) 1 mm (20 ga) minimum sheet metal, lapped and spot welded with 20 mm ($\frac{3}{4}$ in) lip flange at one end.
- .4 Sleeves for ducts 0.4 m² (4 sq ft) and larger through walls and floors:
 - .1 1.6 mm (16 ga) minimum sheet metal, lapped and spot welded with 20 mm ($\frac{3}{4}$ in) lip flange at one end.
- .5 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

8.3 Waterproof Sleeves - Indoors

- .1 Applications:
 - .1 where pipes and ducts pass through floors in areas subject to water, in mechanical rooms, in kitchens, in washing areas and in slabs over electric and telephone rooms.
- .2 Waterproof sleeves for pipes and conduits:
 - .1 Schedule 40 pipe, with 75 mm (3 in) wide annular water bar continuously welded at midpoint, hot dip galvanized to ASTM A123 after fabrication.
- .3 Waterproof sleeves for ducts less than 0.4 m² (4 sq ft):
 - .1 1 mm (20 ga) galvanized steel, with 40 mm (1½ in) flange at midpoint.
- .4 Waterproof sleeves for ducts 0.4 m² (4 sq ft) and larger and openings with multiple ducts:
 - .1 1.6 mm (16 ga) galvanized steel, with 40 mm (1½ in) flange at midpoint, or,
 - .2 form opening with wood (removed after concrete is set) and trim opening with welded steel angle frame 75 mm (3 in) high, bolted to slab and caulked, or,
 - .3 trim opening with 75 mm x 75 mm (3 in x 3 in) continuous concrete curb doweled to slab.
- .5 Modifications for existing construction:
 - .1 annular fins and flanges attached to sleeve at point equivalent to surrounding floor level or curb.

8.4 Installation

- .1 Place and secure sleeves in concrete form work.
- .2 Supply sleeves to be set in concrete and masonry walls with installation detail drawings.
- .3 Regular sleeves;
 - .1 terminate flush with surfaces of concrete and masonry walls.
- .4 Waterproof sleeves in new construction;
 - .1 extend 75 mm (3 in) above finished floor.
 - .2 with flange embedded within concrete floor.
- .5 Sleeves in existing concrete and masonry walls and floors;
 - .1 installed in neatly cut or drilled holes in existing construction,
 - .2 cutting and drilling of structural elements, such as floors, slabs, walls, columns, or beams to be carried out in accordance with procedure set out in Article "Cutting and Patching" below.
 - .3 terminate sleeves flush with surfaces of concrete and masonry walls,
 - .4 extend waterproof sleeves 75 mm (3 in) above finished floor with flange, countersunk, and bolted down flush into floor surface,
 - .5 fill opening between sleeve and wall or floor with 2 hour fire rated fire-stopping sealant with water barrier.
- .6 Roof sleeves for pipe and conduit:
 - .1 install manufactured roof flashing sleeves in accordance with manufacturer instructions, specifically in accordance with requirements applicable to the type of roofing membrane requirements,

- .2 where limestone ballast is used, apply asphalt or similar protective coating onto flashing sleeve to a height of 50 mm (2 in) above ballast layer,
- .7 Fill future-use sleeves with weak concrete, gypsum plaster or similar material.
- .8 Coat exposed exterior surfaces of un-galvanized ferrous sleeves with heavy application of zinc rich paint
- .9 At fire separations and smoke separations, pack and seal void between sleeve and pipe, duct without fire damper, conduit, or insulation in accordance with Article "Fire Stopping and Smoke Seals" in this Section.
- .10 At other locations, pack void between sleeve and pipe, conduit, duct or insulation for full depth of sleeve, with mineral wool and seal with silicone-free caulking compound.
- .11 Install fire dampers in accordance with conditions of approval given in manufacturer's instructions.

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 to form ULC listed or cUL listed/classified assemblies.

Standard of Acceptance

- Hilti Firestop Systems
 - 3M
 - Nelson Firestop Products
 - Eastern Wire + Conduit (Royal Quickstop)
- .2 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.

11 PIPE SUPPORTS, EQUIPMENT SUPPORTS, AND TRENCH COVERS

11.1 General

- .1 Design and fabricate supplementary supporting steel for piping, ductwork and equipment supports 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:
 - .1 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 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 (½ 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.

12 HOUSEKEEPING PADS AND CURBS

12.1 Materials

- .1 Concrete: 20 MPa (3000 psi),

12.2 Concrete Housekeeping Pads

- .1 Construct housekeeping pads using plywood form-work and site-poured concrete, and run pads continuously beneath the equipment.
- .2 Structurally-connect the housekeeping pads to the concrete floor slab with dowels, consisting of not less than 13 mm (½ in) diameter steel rods. For existing concrete floors, floors are to be drilled and dowels secured in the holes with chemically-hardening adhesive.
- .3 Provide anchorage, dowels, anchor clips, bar anchors, expansion bolts and shields, and toggles.
- .4 Refer to Specification section 20 05 49 *Seismic Restraint for Mechanical Systems* for additional requirements for housekeeping pads where equipment is to be seismically restrained.
- .5 Finish exposed surfaces to make them flat, level, and smooth.
- .6 Chamfer corners 25 mm (1 in).
- .7 Housekeeping pad plan dimensions:
 - .1 extending 75 mm (3 in) larger all around than the base of apparatus for non-seismic applications,
 - .2 minimum 200 mm (8 in) larger all around than equipment-base anchor attachment points for seismically restrained equipment.
- .8 Except for air handling units with condensate drains, provide housekeeping pads of the following height based on equipment type, location and vibration isolation condition:

Equipment Type	Floor Type	Vibration Isolation	Thickness of Housekeeping Pad mm (in)
Stationary, not motorized	All	All	100 (4)
Fans	All	Yes	150 (6)
Motorized, up to 7.5kW (10 HP)	All	Yes or No	150 (6)
Motorized, 11 to 19kW (15 to 25 HP)	Slab on Grade	No	250 (10)
	Slab on Grade	Yes	150 (6)
	Suspended Slab	Yes	150 (6)

Equipment Type	Floor Type	Vibration Isolation	Thickness of Housekeeping Pad mm (in)
Motorized, 22kW (30 HP) and over	Slab on Grade	No	300 (12)
	Slab on Grade	Yes	150 (6)
	Suspended Slab	Yes	150 (6)

- .9 For air handling equipment equipped with condensate drains, provide housekeeping pads with a minimum height of 150 mm (6 in.) unless higher dimensions are shown.

12.3 Concrete Housekeeping Curbs

- .1 Concrete housekeeping curbs constructed to the same requirements as for housekeeping pads except as follows.
- .2 Dimensions for containment curbs: 150 mm wide x 150 mm high (6 in. x 6 in.), unless otherwise shown.
- .3 Concrete curbs used in lieu of housekeeping pads when shown on drawings;
 - .1 curb height for AHUs: minimum 150 mm (6 in.) unless higher dimensions are shown.
 - .2 curb width for AHUs requiring seismic restraint:
 - (a) extending a minimum of 200 mm (8 in.) from the outside edge of the AHU base frame channel, and
 - (b) extending 100 mm (4 in.) from the inside face of the AHU base frame channel.
 - .3 curb width where no seismic restraint is required for AHUs:
 - (a) extending a minimum of 75 mm (3 in) greater than, and on each side of, the AHU base frame channel flange width.
- .4 Void space between underside of AHU and structural floor filled with 64 kg/m³ (4 lb/ft³) mineral-wool rigid board insulation.

END OF SECTION

MECHANICAL WORK IN HOSPITAL CONSTRUCTION 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 hospital. 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 Hospital's IPAC procedures.

1.2 Access Doors

- .1 Provide in contract, supply and installation of: 6 @ 24 x 24 keyed access doors and 4 @ 24 x 24 fire rated access doors. These spare access doors are for unexpected situations and in addition to access doors required in contract to provide access to installed devices in hard ceilings and shafts. Access doors may be provided at sizes equal to or smaller than those listed.

1.3 Chilled Water Connections

- .1 Provide connections to existing chilled water system by live tapping as the system is always active, or
- .2 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 in 1.8 below.

1.4 Medical Gas Connections

- .1 Make connections to the existing medical gas systems, on a gas by gas basis, within on night time shut-down. Provide additional valves where new connections are to be made to limit shutdown to one night.
- .2 Complete, inspect and certify the medical gas installation, by hospital's designated inspection agency prior to connection to the existing hospital.
- .3 Arrange for the inspection to the connections to the existing hospital to be made immediately at the completion of the work.

1.5 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

1.6 Spare Components

- .1 Provide the following components in addition to those required in contract. Components may be provided at sizes equal to or smaller than those listed.
- .2 Provide spare valves including installation on existing or new piping, modifications to insulation as required:
 - .1 Domestic Water service – 4 @ 3".
 - .1 Heating and Cooling service – 4 @ 1", 2 @3".
 - .2 Medical Gas service – 4 @ 1".
- .3 Provide 2 – 4" above grade floor drains complete with 30 feet of insulated 4" line and 30 feet of vent piping.
- .4 Provide the following spare fire dampers c/w duct access door and installation in new or existing ductwork
 - .1 2 @ 24" x 36"
- .5 Provide **20** type spare **A1** and **C1 diffusers and grilles** complete with installation, 30 feet of 12"x12" duct and insulation on supply duct.
- .6 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.
- .7 Provide 10 additional concealed pendant sprinkler heads complete with installation, 10 feet of 2" sprinkler piping, and all associated fittings.

1.7 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) three inch sprinkler lines
 - .2 Freezing of one (1) four inch sprinkler line
 - .3 Freezing of two (2) one inch water lines
 - .4 Freezing of four (4) four inch water lines
- .2 Freezing allowance may be used on pipe sizes equal to or smaller than those listed above.

1.8 Phasing

- .1 Carefully examine the phasing plan from the Architectural drawings and 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.
- .2 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.

- .3 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.
- .4 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.
- .5 Provide balance and reports at each phase of construction.

1.9 Air and Water Balancing

- .1 Air and water balancing is to be carried by the mechanical contractor (see spec section 20 08 05).
- .2 Provide air/water balancing at the end of **each** phase.

1.10 Work in Occupied Areas

- .1 Work in Owner occupied areas to be schedule with the Hospital.
- .2 Access to these areas will be at the discretion of the Hospital and strictly after hours unless otherwise noted on the drawings.

1.11 Phased Occupancy, Equipment Maintenance, Equipment Operation and Warrantee.

- .1 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.
- .2 The Mechanical Contractor to ensure all mechanical equipment is complete and functioning before testing and commissioning is done.
- .3 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 manufacturer 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 Hospital.
- .4 The mechanical contractor shall operate the systems to the Owners benefit to ensure that the occupied phases are fully serviced to the Owners schedule. 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 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 warrantees 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 warrantee to cover contract duration plus the standard warrantee period starting after substantial performance.

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 Common Hanger and Support Requirements for Piping
 - .2 20 05 49 Seismic Restraint for Mechanical Services
 - .3 25 55 13 Building Automation Smoke Damper Control Panels

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. 106 HRC – Miscellaneous Fuses
 - .6 CSA C22.2 No. 124 Mineral Insulated Cable
 - .7 CSA C22.2 No. 131 Type TECK 90 Cable
 - .8 CSA C22.2 No. 208 Fire Alarm and Signal Cable
 - .9 CSA C22.2 No. 230 Tray Cable
 - .10 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

- .1 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 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.

2.3 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.

2.4 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.

2.5 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.

2.6 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

2.7 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

2.8 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.

2.9 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 Installation of Power and Control Wiring – General Requirements

- .1 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.

3.5 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.

3.6 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.

3.7 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 controlling the equipment,

- .2 within 1 m (3 ft) of non-motorized equipment.
- .4 Disconnect switch types for motorized equipment:
 - .1 fused type for motor controllers,
 - .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 for non-motorized equipment:
 - .1 provide unfused disconnect switch for non-motorized mechanical equipment.
- .6 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.
- .7 Where fuse protection is specified, install fuses of the correct overcurrent rating as specified by the mechanical equipment installation instructions.
- .8 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.
- .9 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.

3.8 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.

3.9 Seismic Restraint

- .1 Provide seismic restraints for electrical conduit in accordance with specification section 20 05 49.

3.10 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.

3.11 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	●	
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: <ul style="list-style-type: none"> - 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: <ul style="list-style-type: none"> - 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: <ul style="list-style-type: none"> - 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: <ul style="list-style-type: none"> - 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.) 		●
	Power wiring from: <ul style="list-style-type: none"> - 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 in a junction box for each group of terminal boxes.		●
	Power wiring for controllers at 120 or 24 VAC, from junction box provided by Division 26 to each terminal unit controller.	●	

Schedule A – Coordination of Division 20 and 26 Scope of Work			
Reference	Work Element	Div. 20	Div. 26
	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.		●
	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	●	
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.	●	
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.	●	

Schedule A – Coordination of Division 20 and 26 Scope of Work			
Reference	Work Element	Div. 20	Div. 26
Life Safety Interface	Fire Alarm System (“FAS”) control and monitoring modules located at BAS control interface panel.		●
	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:

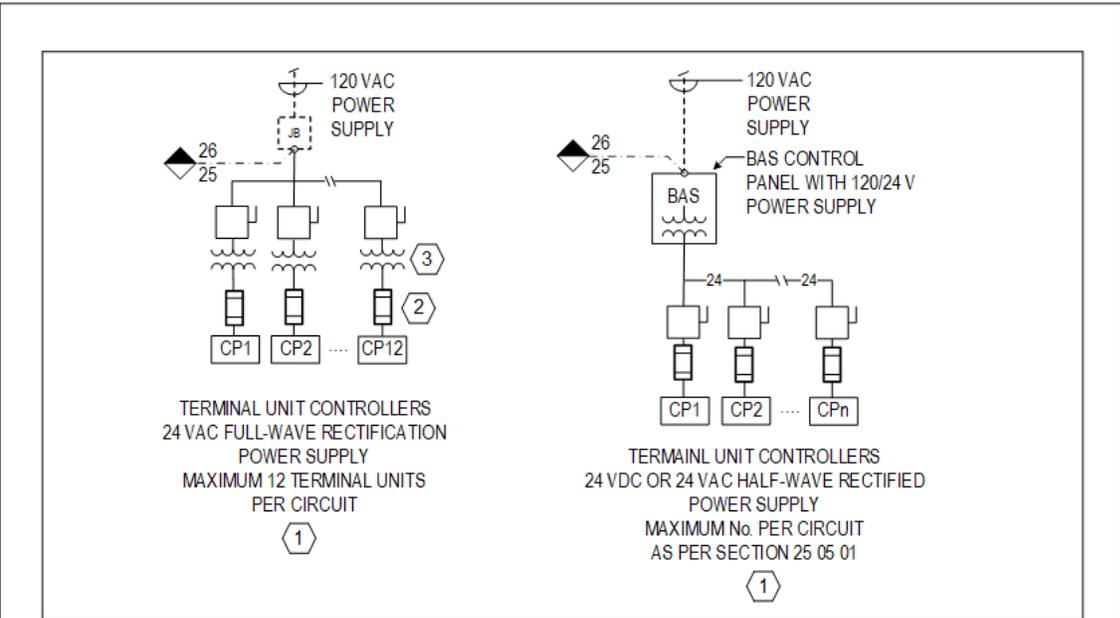
[1] MPP and MBP will be located in mechanical services rooms.

[2] PP and RP are not dedicated for mechanical equipment and may be located in any type of service room or space.

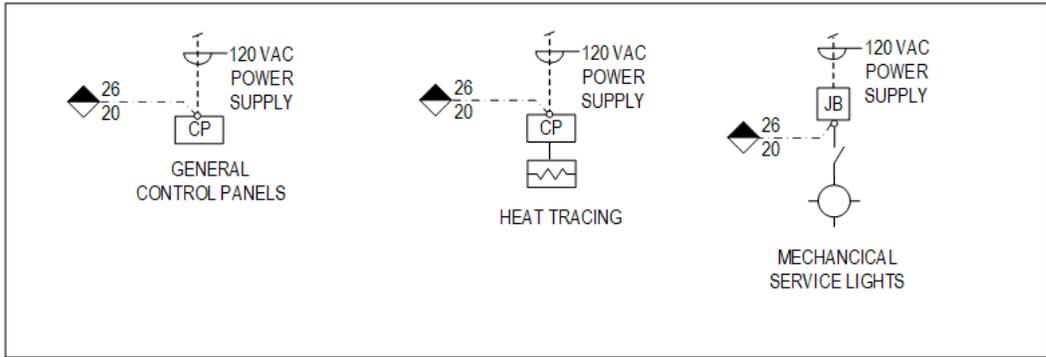
LEGEND

	CONSTANT SPEED MOTOR CONTROLLER		SCOPE OF WORK: DIVISION "A" / DIVISION "B" BOUNDARY
	VARIABLE FREQUENCY DRIVE		WIRING AND/OR EQUIPMENT BY DIVISIONS 20-25
	UNFUSED SERVICE DISCONNECT SWITCH		WIRING AND/OR EQUIPMENT BY DIVISION 26
	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		

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.



TERMINAL UNITS



MISCELLANEOUS EQUIPMENT

DRAWING NOTES
 (NOTES AND NUMBERING BELOW PERTAINS TO THIS DRAWING ONLY)

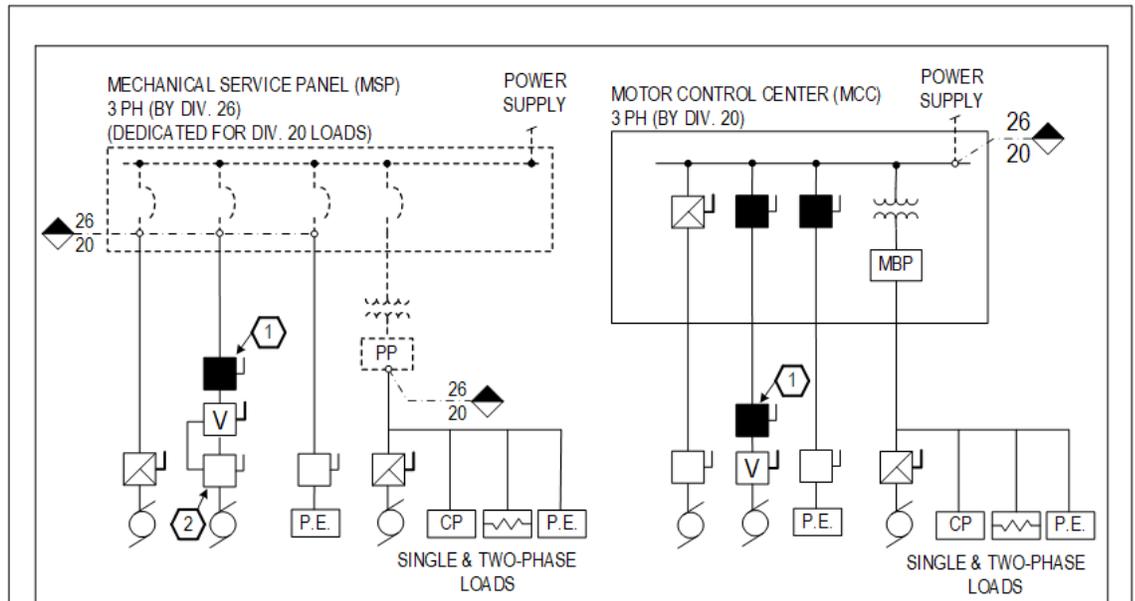
1. REFET TO SPECIFICATION SECTION 25 05 01 FOR APPLICABLE WIRING METHODS.
2. PROVIDE FUSE PROTECTION IF TRANSFORMER DOES NOT HAVE INTEGRAL CIRCUIT BREAKER.
3. PROVIDE DEDCIGATED TRANSFORMER FOR FULL-WAVE RECTIFIED 24 VAC CONTROL DEVICES.



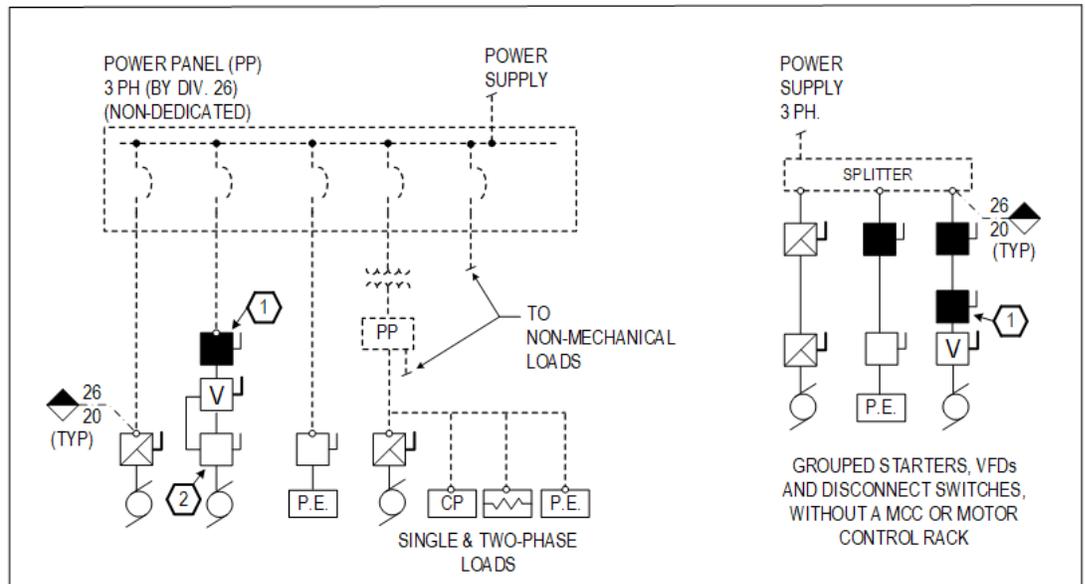
Sheet Title:
**MECHANICAL – ELECTRICAL
 COORDINATION BLOCK DIAGRAM
 (SHEET 2 OF 3)**

Date: 21 JUNE 2023	Rev. No.: 03	Checked: PS
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Standard Detail No.
20 05 12-002



DEDICATED POWER DISTRIBUTION EQUIPMENT



NON-DEDICATED POWER DISTRIBUTED EQUIPMENT

DRAWING NOTES
 (NOTES AND NUMBERING BELOW PERTAINS TO THIS DRAWING ONLY)

1. SEPARATE FUSED DISCONNECT WHEN REQUIRED TO MEET SPECIFIED SCCRV VALUES. (TYP).
2. SEPARATE UNFUSED DISCONNECT WHERE V.F.D. IS REMOTE FROM THE MOTOR. PROVIDE DISCONNECT SWITCH POSITION INDICATOR WITH INTERLOCK WIRING TO THE V.F.D. (TYP).

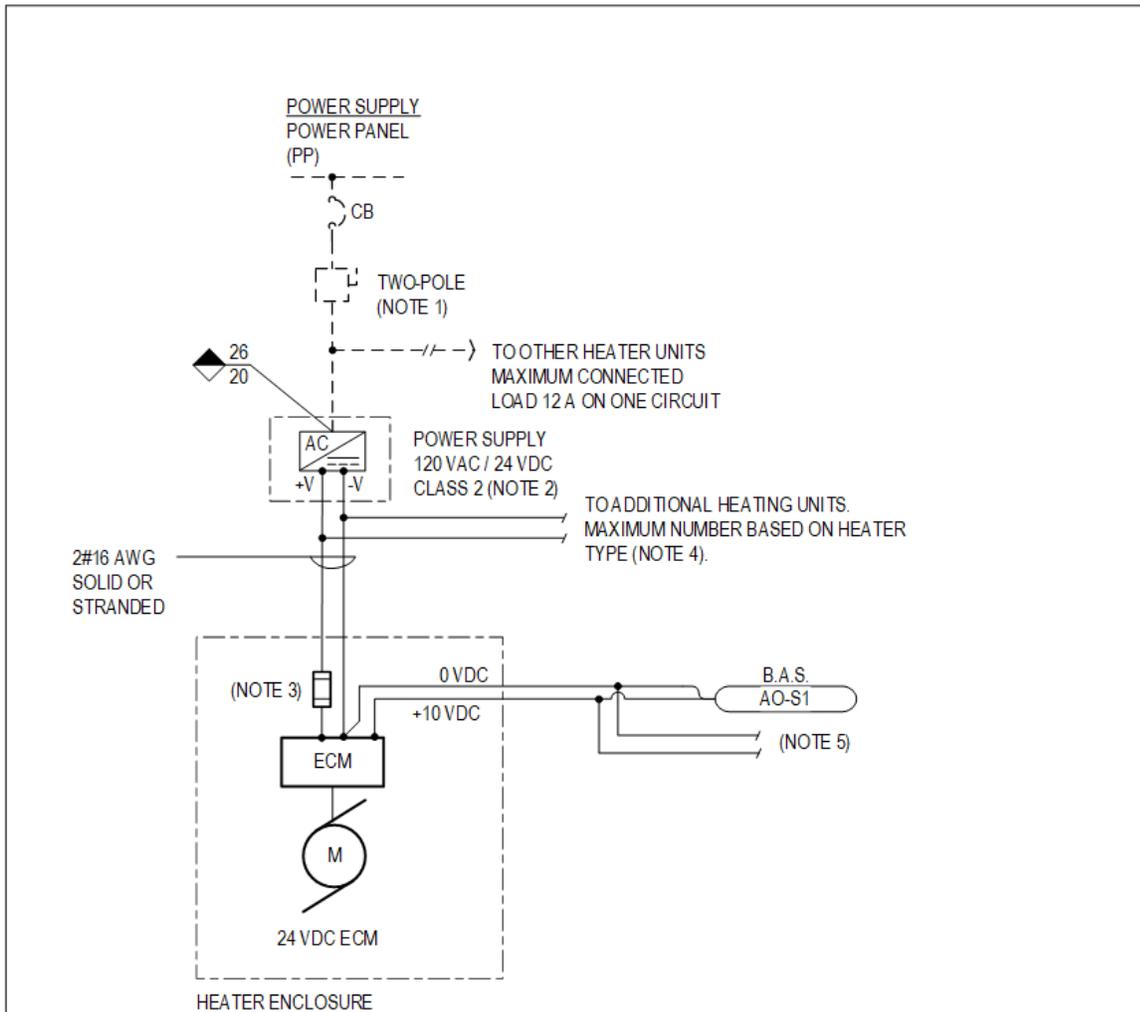
General Notes

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.
2. Dedicated power distribution equipment is only located in mechanical service rooms.



Sheet Title
**MECHANICAL – ELECTRICAL
 COORDINATION BLOCK DIAGRAM
 (SHEET 3 OF 3)**

Date 21 JUNE 2023	Rev. No. 04	Checked PS
Standard Detail No. 20 05 12 – 003		



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.

Issued For



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

INDICATING GAUGES 20 05 19

1 GENERAL

1.1 Scope

- .1 Provide temperature and pressure measuring devices and flow indicators as shown.

1.2 Submittals

- .1 Submit manufacturer's catalogue literature for;
 - .1 flow indicators,
 - .2 thermometers,
 - .3 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

2.2 Direct Reading Thermometers – Liquid and Gases

- .1 For liquid and compressed gas service only.
- .2 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

- .1 For measurement of pressure piping for liquid 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.

Standard of Acceptance

- Terice - 872

- .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.

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 heat exchangers,
 - .2 water heating and cooling coils,
 - .3 water boilers,
 - .4 chillers,
 - .5 open-circuit cooling towers and closed-circuit water coolers,
 - .6 domestic hot water tanks, and
 - .7 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 heat exchangers,
 - .2 water heating and cooling coils,
 - .3 steam piping to heating coils (inlet only),
 - .4 water boilers,
 - .5 chillers,
 - .6 closed-circuit water coolers,
 - .7 domestic hot water tanks,
 - .8 steam boilers,
 - .9 condensate receivers,
 - .10 deaerators,
 - .11 air-compressors (discharge only),
 - .12 compress-air dryers,

- .13 compressed-air receivers, and
- .14 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 Provide pressure snubbers on pressure gauges at the following locations:
 - .1 suction and discharge sides of positive-displacement pumps including oil pumps,
 - .2 air-compressor discharge, and inlet and discharge of compressed-air dryers, and at outlet of compressed-air receivers,
- .4 Install coil syphons on steam and condensate pressure gauges.

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

- .1 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
 - 23 05 23.13 General-Duty Valves for HVAC Water Piping
 - 23 05 23.19 Stainless Steel 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.

Function	Gate	Butterfly	Ball	Globe	Plug	DRV
Shut-Off	•	•	•		•	
Flow Balancing only (excluding pumps)				•		•
Pump Balancing		• [1] [3]		•		•

Notes:

[1] Gear operator with position limit memory stops.

[2] Not used.

[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 triple duty or throttling valves where shown in pump discharge piping with ten pipe diameters of straight pipe on the inlet side and two pipe diameters on outlet side.
- .4 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.

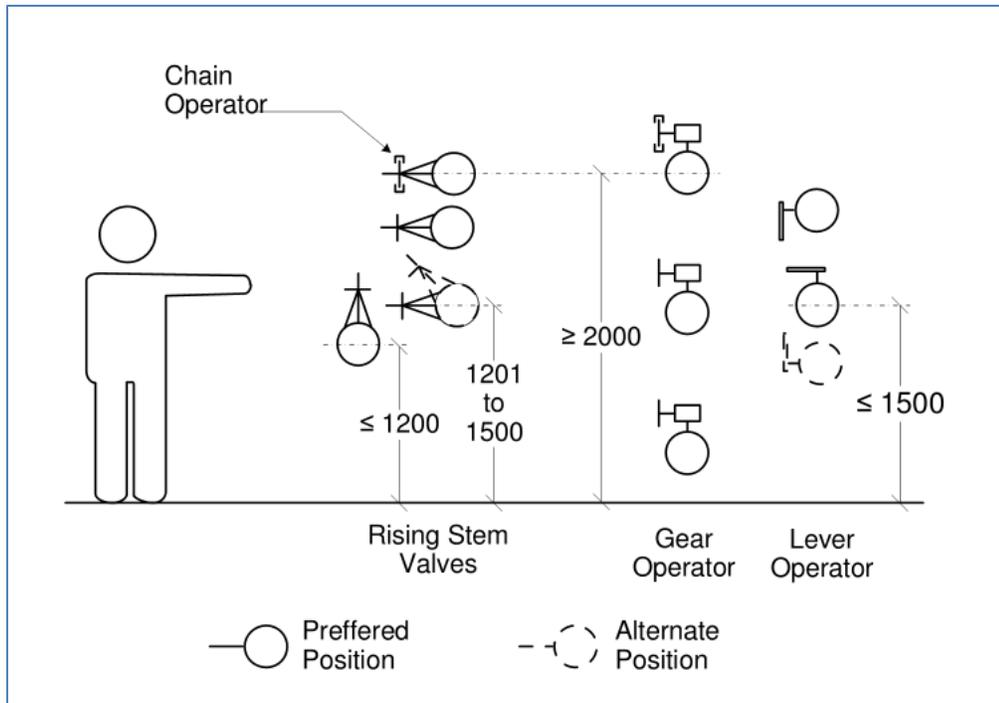


Figure 1: Valve Spindle Arrangement

- .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.

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 ≤ 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 LINE STOPPING

20 05 26

1 GENERAL.

1.1 Scope

- .1 Temporarily isolate portions of existing piping systems by means of pipe line-stopping.

1.2 Limitations on Use

- .1 Line-stopping is not to be used where isolation and/or draining of the pipeline is permitted by the Owner.
- .2 Line-stopping is 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
 - .2 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 22 11 16.16 Domestic Water Piping – Stainless Steel
 - .6 23 05 01 HVAC Piping Systems - General Requirements
 - .7 23 05 23.13 General-Duty Valves for HVAC Water Piping
 - .8 23 05 23.19 Stainless Steel Valves for HVAC Water Piping
 - .9 23 21 13.23 Hydronic Piping – Carbon Steel
 - .10 23 21 13.26 Hydronic Piping – Stainless Steel

1.4 Definitions and Abbreviations

- .1 The following definitions apply to this section.
 - .1 **Line-Stopping** – the method for temporarily blocking flow in an existing pipe by use of line-plugging or line-freezing.
 - .2 **Line-Freezing** – line-stopping by freezing the mains pipe fluid by application of cryogenic fluids to the exterior of the pipe.
 - .3 **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; not permissible in this project.

1.5 Applicable Codes and Standards

- .1 Legislation;
 - .1 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 Piping design and installation code:
 - .1 Refer to the applicable specification section for the piping system.
- .2 System design criteria.
 - .1 Refer to the applicable specification section for the piping system.

2 PRODUCTS

2.1 Valves

- .1 As specified in the applicable piping specification valve sections,
 - .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 line-stopping procedure(s). Exclude all personnel not necessary for the actual line-stopping operation from the work area.

3.2 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.

3.3 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.

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 21 05 01 Common Work Results for Fire Suppression
 - .2 22 60 13.70 Medical Gas Piping
 - .3 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 48 Vibration Isolation
 - .2 20 05 49 Seismic Restraints for Mechanical Services
 - .3 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 vertical piping located in vertical services spaces (shafts) where any of the following criteria apply;
 - (a) piping is NPS 8 and larger,
 - (b) the vertical pipe length exceeds 25 m (82 ft),
 - (c) pipe expansion joints are shown, or

- (d) vibration isolated supports, variable spring supports or constant load supports are shown.
- .2 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: hot-dipped galvanized,
 - .3 other indoor locations: plain finish, zinc plated, or painted finish.
 - (a) exception: do not use any zinc coated or electro-plated products in data center rooms.
- .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 – Inserts for New Concrete

- .1 General:
 - .1 upper hanger attachment for casting into new cast-in-place concrete decks, for piping or equipment supports,
 - .2 for attachment to formwork prior to concrete pour,
 - .3 designed to receive USS coarse thread hanger rods.
 - .4 in the following tables, pipe size limit is based on insulated pipe filled with water at the maximum allowable span in accordance with Schedules A1(a), A2(a), and A3 at the end of this section. Larger pipe sizes may apply where reduced spans are used in accordance with the alternate rod size and support span limits in accordance with Schedules A1(b) and A2(b) as the end of this section.
- .2 Fixed rod position:
 - .1 fixed position type,
 - .2 listed to CAN/UL 203 for fire protection piping, for pipe NPS ¾ through NPS 8,
 - .3 materials: malleable iron, or zinc-plated carbon-steel with plastic form, with nailing feature,
 - .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
Ø1/2	5.0 (1130)	3

Rod Nominal Size	Tension Load kN (lbf)	Single Pipe Size Limit NPS
Ø5/8	5.6 (1260)	4
Ø3/4	11.1 (2500)	8

Standard of Acceptance

- Anvil - fig. 152
- Hilti - fig. KCM

.3 Fixed rod position – high capacity:

- .1 fixed position type,
- .2 stainless steel insert body, with two (2) fibreglass and concrete barrier disc for attachment to concrete rebar,
- .3 minimum load rating in tension based on connected rod size:

Rod Nominal Size	Tension Load kN (lbf)	Single Pipe Size Limit NPS
Ø3/4	14.4 (2500)	8
Ø7/8	19.9 (4480)	12
Ø1	26.2 (5900)	18
Ø1-1/4	42.2 (9500)	20
Ø1-1/2	61.4 (13,800)	30

Standard of Acceptance

- Anvil - fig. 286

.4 Single-direction adjustable rod position:

- .1 listed to CAN/UL 203 for fire protection piping, for pipe NPS ¾ through NPS 8.
- .2 galvanized wedge inserts to MSS SP-58 type 18, with single-direction adjustment of rod position,
- .3 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
Ø1/2	5.0 (1130)	3
Ø5/8	5.6 (1200)	4
Ø3/4	11.1 (1200)	8

Standard of Acceptance

- Anvil - fig. 281
- Unistrut - fig. P-3245

- .5 Concrete inserts – channel type;
 - .1 single hanger or multiple hangers support,
 - .2 2.75 mm (12 Ga) thick channels, hot-dipped galvanized, with concrete embedment tabs, open bottom channel allowing multiple support points and lateral position adjustment,
 - .3 with back plates, end caps and closure strips to prevent concrete spillage into channel space,
 - .4 minimum point load spacing: 300 mm (12 in.)
 - .5 maximum tension load rating for single hanger support:

Channel Length mm (in.)	Tension Load kN (lbf)	Tension Load kN/m (lbf/ft)	Single Pipe Size Limit NPS
200 (8)	4.4 (1000)	---	6
300 (12)	6.6 (1500)	---	8
450 (18)	17.8 (4000)	23.8 (2000)	12

Standard of Acceptance

- Unistrut - fig. P-3249 to P-3270 series.

2.3 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

2.4 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
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

2.5 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

.3 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

.4 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

2.6 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

2.7 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

2.8 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

2.9 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

2.10 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

2.11 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

2.12 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

2.13 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)

2.14 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)

2.15 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.

2.16 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

2.17 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

2.18 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

2.19 Vibration Isolation Supports

- .1 Refer to specification section 20 05 48.

2.20 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

2.21 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.

2.22 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,
- .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 Support vertical cold piping and hot piping for riser heights that are greater than 25 m (82 ft) but do not exceed 50 m (165 ft) in height as follows:
 - .1 provide a custom engineered support system utilizing variable spring isolators,
 - .2 provide pipe anchors at the mid-point of the riser, and
 - .3 provide at least one spring support per riser section above and below the anchor point.

- .5 Support vertical cold piping and hot piping for riser heights greater than 50 m (165 ft) as follows:
 - .1 provide a custom engineered support system utilizing constant load supports for each pipe section located between expansion joints,
 - .2 variable spring supports may be used at intermediate locations between main constant load supports,
 - .3 provide pipe anchor supports at the base of the riser, and at intermediate locations along riser length at locations as shown,
 - .4 provide in-line expansion joints between each pair of pipe anchors on the same riser in accordance with Specification section 20 05 16,
 - .5 design pipe anchors to withstand pressure thrust created by the expansion joints, unless pressure-balanced expansion joints are used,
- .6 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.
- .7 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 attached 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 $\leq 100^{\circ}\text{C}$, 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 Pipe 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)
1/2	Ø 3/8	1.5 m (5 ft)
3/4 to 1 1/4	Ø 3/8	1.8 m (6 ft)
1 1/2	Ø 3/8	2.4 m (8 ft)
2	Ø 3/8	2.4 m (8 ft)
2 1/2	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 3/4	4.3 (14)
8	Ø 3/4	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		Application Legend	
CL	Clevis hanger	A	Acceptable
CL(EY)	Clevis hanger with extended yoke for installation under pipe insulation	---	Not permitted
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		

**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
1/2 - 3/4	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

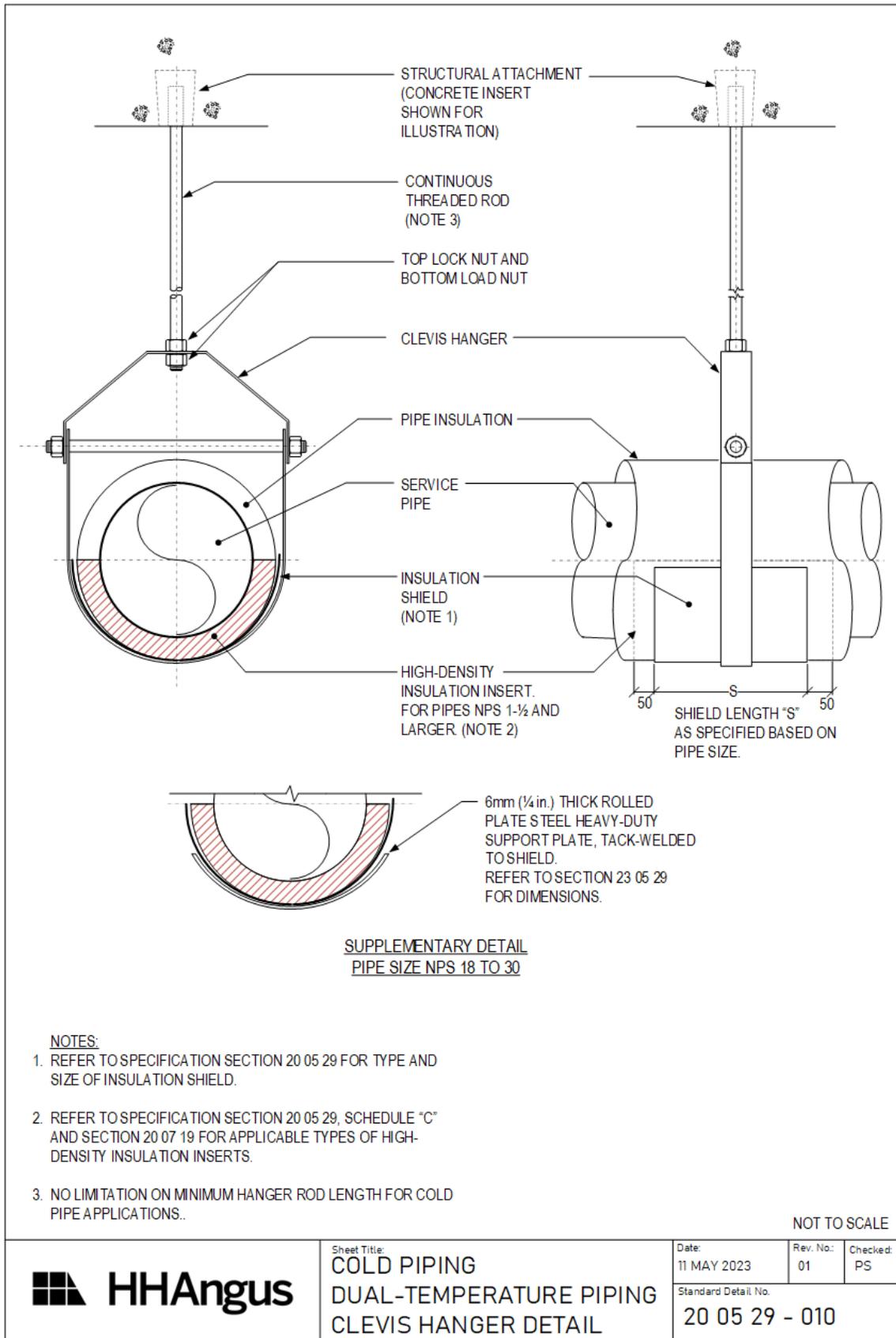
REQ	Required
ALT	Acceptable Alternate
	Not Applicable

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

Service Temperature °C (F)	Pipe Size NPS	Hanger/ Support Position [Note 1, 2]	Pipe Saddle	Insulation Shield	
				Shield	High-Density Insert Type [Note 5]
	≤ 1-1/4	Insulation		REQ	

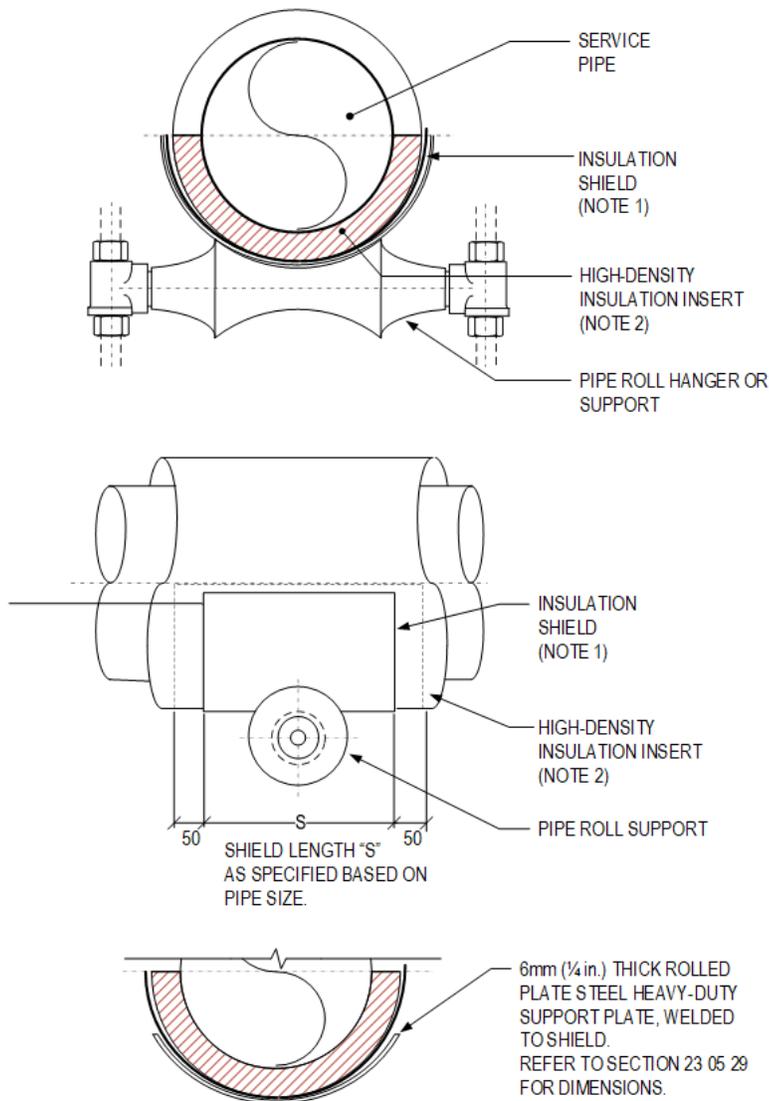
Schedule C (Con't)

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	



NOTES:

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 FOR COLD PIPE APPLICATIONS..



SUPPLEMENTARY DETAIL
PIPE SIZE NPS 18 TO 30

NOTES:

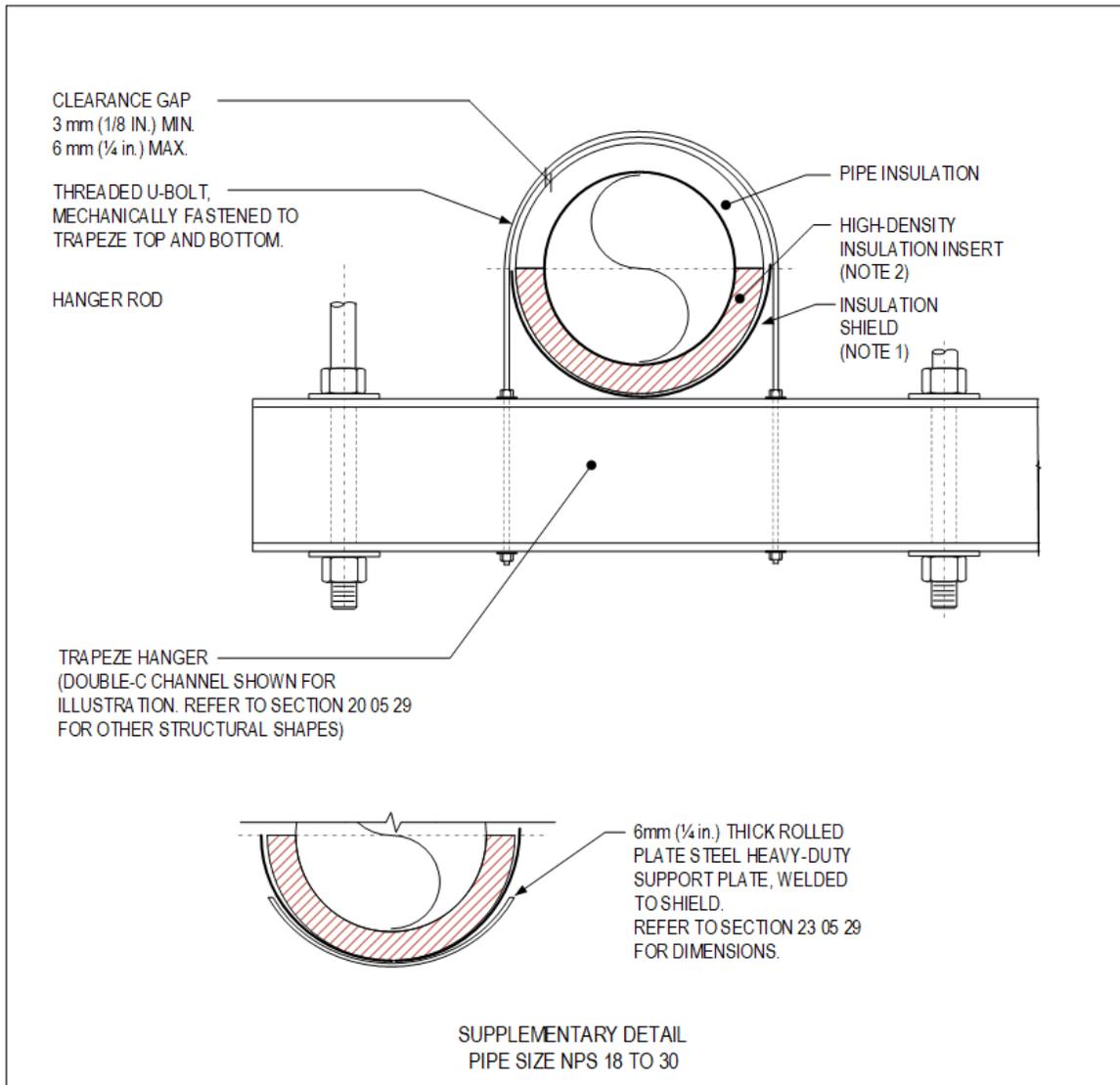
1. REFER TO SPECIFICATION SECTION 20 05 29 FOR TYPE AND SIZE OF INSULATION SHIELD.
2. REFER TO SPECIFICATION SECTION 20 05 29, SCHEDULE "C" AND SECTION 20 07 19 FOR APPLICABLE TYPES OF HIGH-DENSITY INSULATION INSERTS.
3. NO LIMITATION ON MINIMUM HANGER ROD LENGTH.

NOT TO SCALE



Sheet Title:
**COLD PIPING AND
 DUAL-TEMPERATURE PIPING
 ROLL HANGER DETAIL**

Date: 11 MAY 2023	Rev. No.: 02	Checked: PS
Standard Detail No. 20 05 29 - 011		



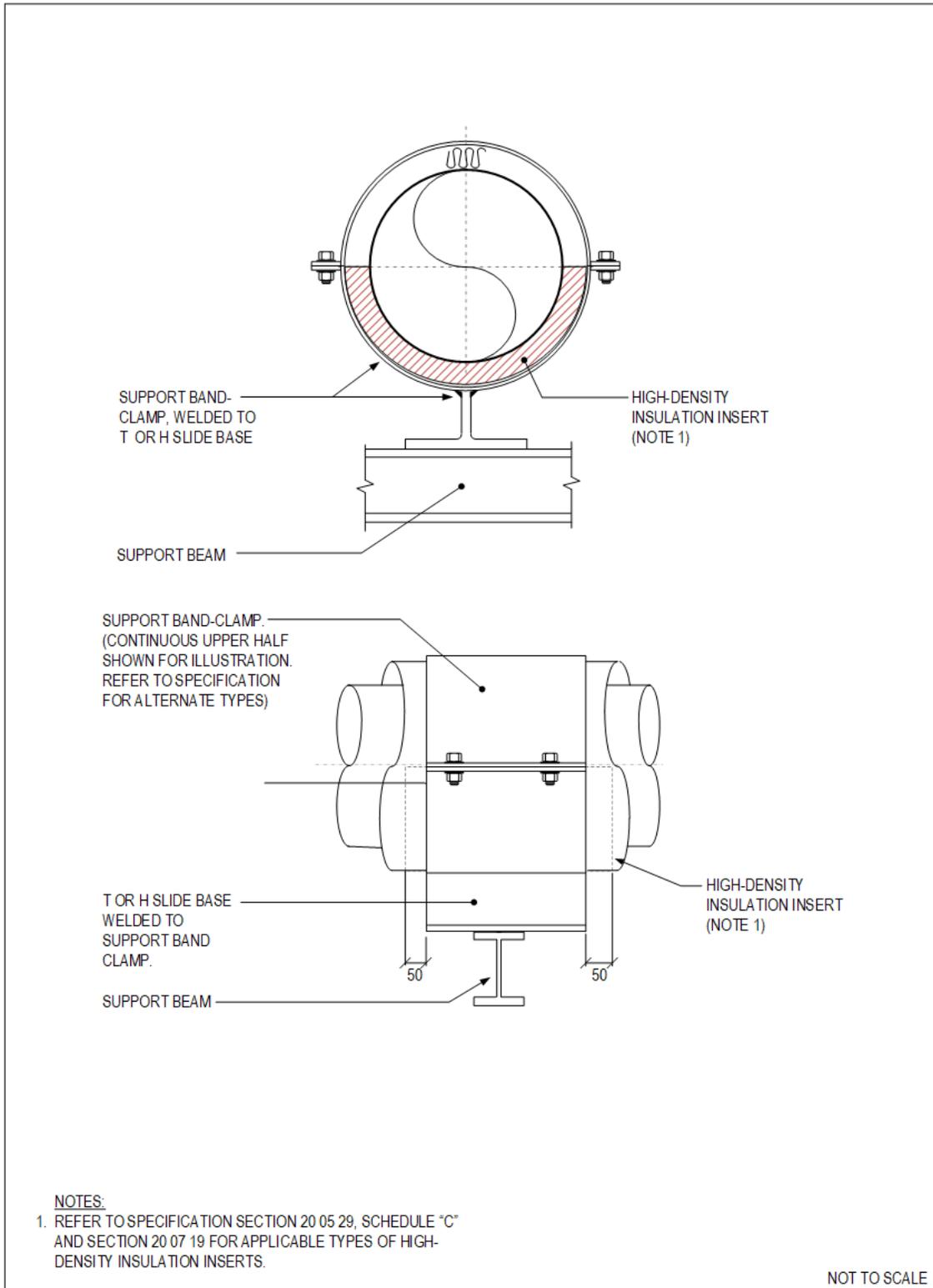
- NOTES:**
- REFER TO SPECIFICATION SECTION 20 05 29 FOR TYPE AND SIZE OF INSULATION SHIELD.
 - REFER TO SPECIFICATION SECTION 20 05 29, SCHEDULE "C" AND SECTION 20 07 19 FOR APPLICABLE TYPES OF HIGH-DENSITY INSULATION INSERTS.

NOT TO SCALE

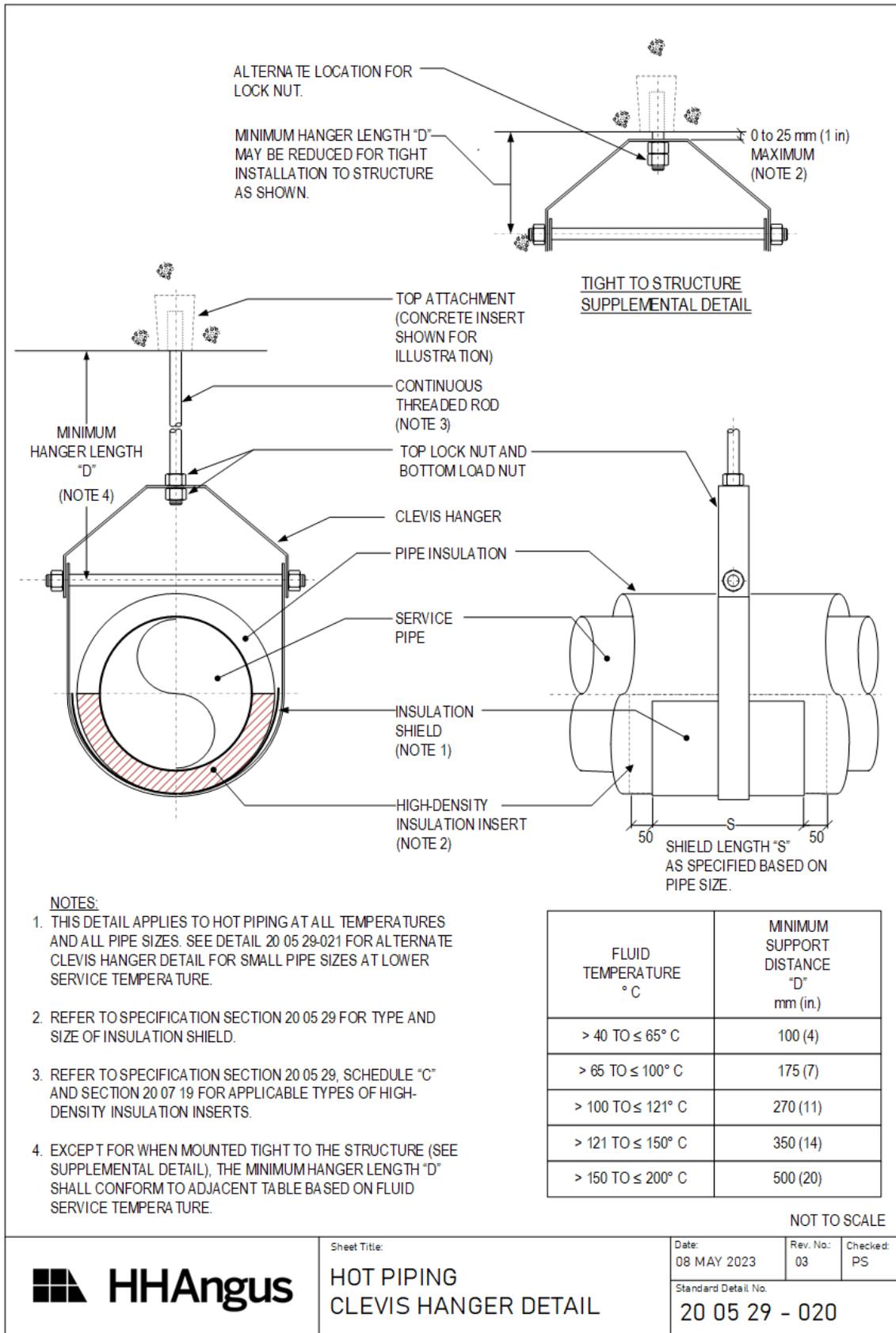


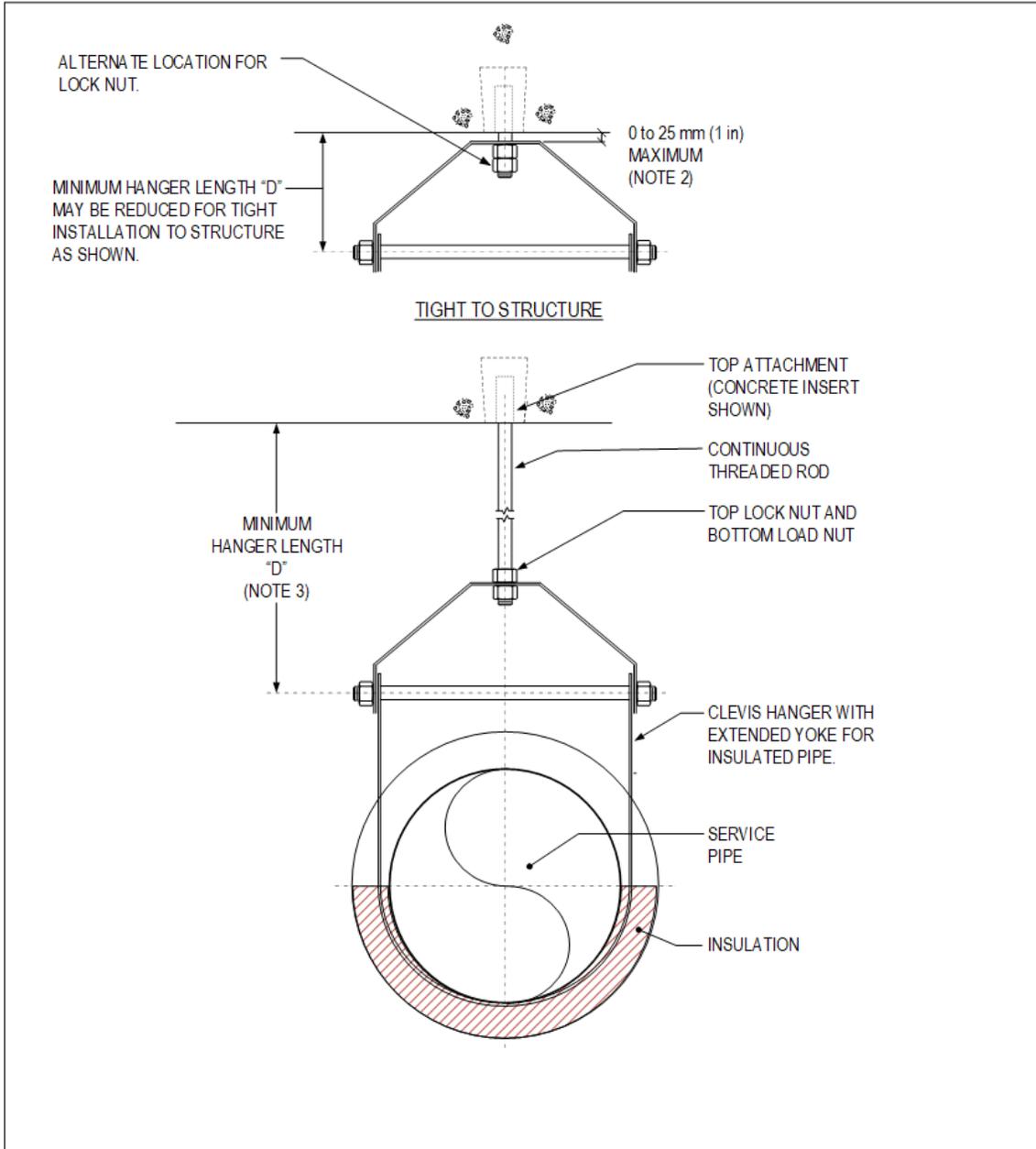
Sheet Title:
**COLD PIPING AND
 DUAL-TEMPERATURE PIPING
 TRAPEZE HANGER DETAIL**

Date: 11 MAY 2023	Rev. No.: 02	Checked: PS
Standard Detail No. 20 05 29 - 012		



	Sheet Title: COLD PIPING AND DUAL-TEMPERATURE PIPING SLIDE SUPPORT DETAIL	Date: 11 MAY 2023	Rev. No.: 01	Checked: PS
	Standard Detail No. 20 05 29-013			



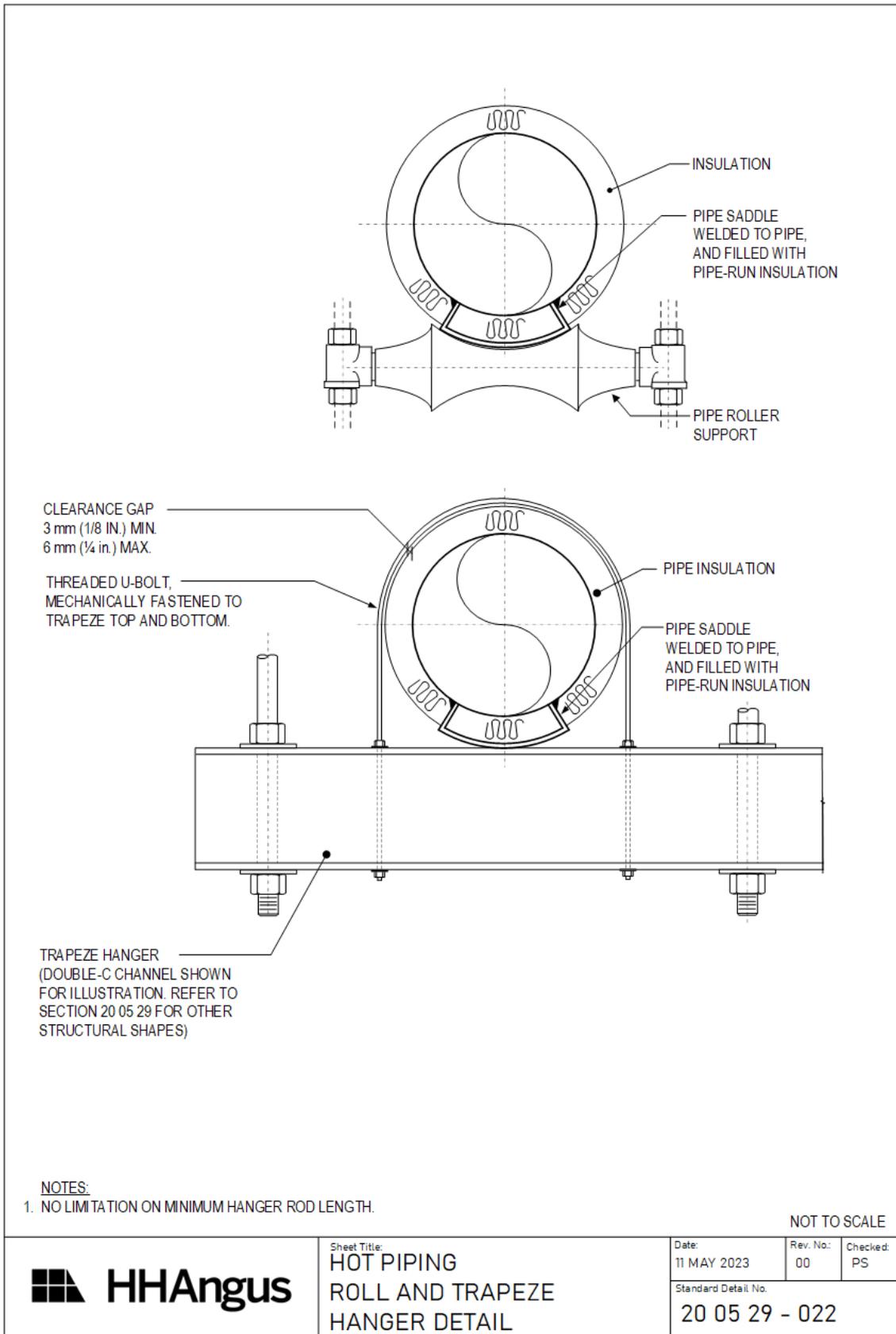


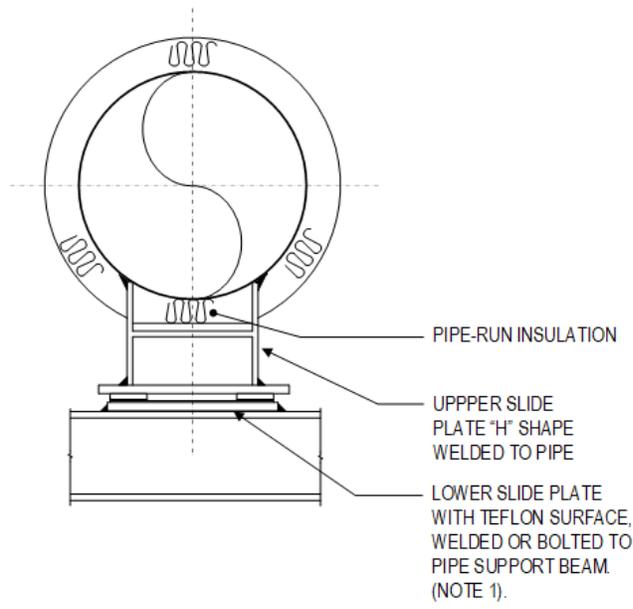
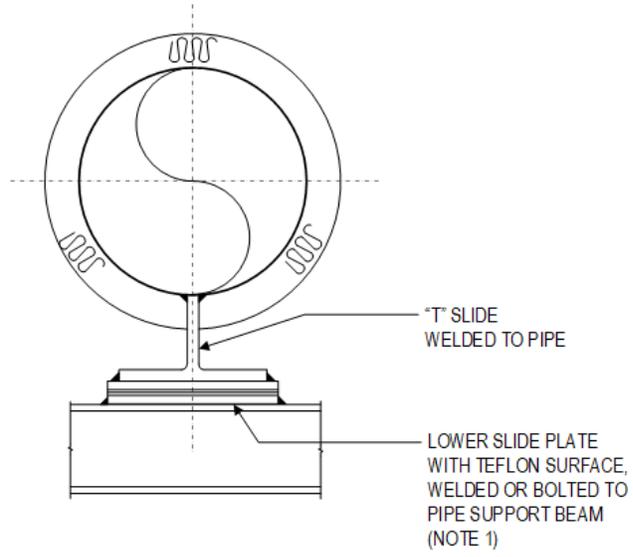
- NOTES:**
- THIS DETAIL APPLIES TO HOT PIPING \leq NPS 4 WITH FLUID TEMPERATURES \leq 100°C.
 - MAXIMUM LENGTH OF EXPOSED ROD WHEN HANGER IS INSTALLED TIGHT TO STRUCTURE.
 - WHERE DIMENSION "D" WILL BE LESS THAN AS SHOWN IN THIS TABLE, USE ROLLER, TRAPEZE, OR SLIDE SUPPORTS.

FLUID TEMPERATURE °C	MINIMUM SUPPORT DISTANCE "D" mm (in.)
> 40 TO \leq 65° C	100 (4)
> 65 TO \leq 100° C	175 (7)

NOT TO SCALE

	Sheet Title: HOT PIPING \leq 100° C SIZE \leq NPS 4 CLEVIS HANGER DETAIL	Date: 11 MAY 2023	Rev. No.: 00	Checked: PS
		Standard Detail No. 20 05 29 - 021		

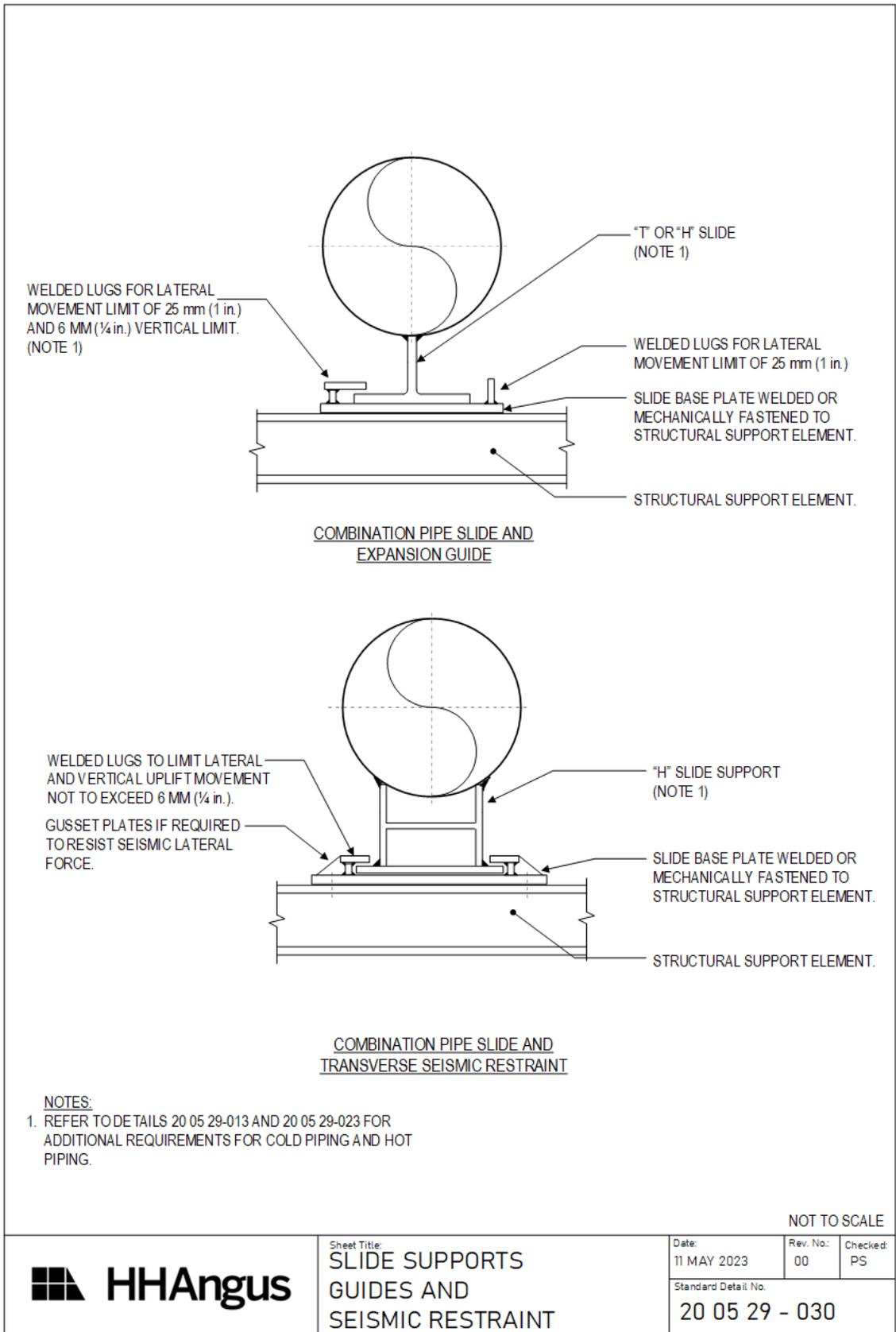




NOTES:
 1. TEFLON SLIDE PLATES ONLY REQUIRED FOR HOT PIPING WITH SERVICE TEMPERATURE > 121° C, INCLUDING STEAM AT PRESSURES > 103 kPa.

NOT TO SCALE

	Sheet Title:	Date:	Rev. No.:	Checked:
	HOT PIPING SLIDE SUPPORT DETAILS	11 MAY 2023	00	PS
		Standard Detail No. 20 05 29 - 023		



END OF SECTION

VIBRATION ISOLATION 20 05 48

1 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, Expansion Joints, Anchors & Guides
 - .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.
- .2 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 Resilient Isolator Pads – Type P1

- .1 Elastomer-in-shear pads:
 - .1 rubber waffle or ribbed pads:

- (a) 45 or 60 durometer neoprene depending on loading, minimum of 22 mm (7/8 in) thick,
- (b) load rating: up to 5 mm (0.19 in) static deflection and up to nominally 4400 kg (9700 lbs.) load,
- .2 rubber-steel-rubber pads:
 - (a) two layers of rubber waffle or ribbed pad, 13 mm (½ in) thick, as specified above,
 - (b) bonded to 6 mm (¼ in) steel plate, with holes sleeved and fitted with isolation washers.
- .3 Neoprene jacketed pre-compressed moulded fiberglass pads.

2.3 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,

2.4 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.

2.5 Isolator Springs – Type S2

- .1 Enclosed spring isolator:
 - .1 free-standing, enclosed (housed) spring isolator, selected for static deflections as shown,
 - .2 suitable for equipment subject to wind loads, large changes in mass due to change in water content, torque loads, and/or seismic loads,
 - .3 load rating: up to 100 mm (4 in) static deflection and up to nominally 8000 kg (17,600 lbs.) load,
 - .4 housing: fabricated and welded steel members, hot-dipped galvanized after fabrication, with;
 - (a) top load plate with adjusting and leveling bolts,
 - (b) vertical restraints with isolation washers,
 - (c) bottom plate with non-skid noise isolation pads and bolt holes for fastening to the floor,
 - .5 ratio of lateral spring stiffness to vertical spring stiffness:
 - (a) 1.2 or greater for equipment installed outdoors,
 - (b) 1.0 or greater for equipment installed indoors,
 - .6 overload capacity: 50% minimum,
 - .7 springs coated in a colour-coded corrosion protection finish and tested with a 1000 hour salt spray rating to ASTM B117.

2.6 Isolation Springs - Type S3

- .1 Restrained open spring isolator:
 - .1 free-standing, open (un-enclosed) spring isolator, with vertical limit stops, selected for static deflections as shown,
 - .2 suitable for equipment subject to changes in mass due to change in water content,
 - .3 load rating: up to 50 mm (2 in) static deflection and nominally 1500 kg (3300 lbs.) load,
 - .4 spring assembly:
 - (a) top load plate with adjusting and leveling nut and bolt,
 - (b) integral vertical restraint limit with elastomeric washer,
 - (c) bottom fastening plate with noise isolation pad and mounting holes.
 - .5 ratio of lateral spring stiffness to vertical spring stiffness: 0.8 or greater.
 - .6 overload capacity: 50% minimum,
 - .7 springs coated in a colour-coded corrosion protection finish and tested with a 1000 hour salt spray rating to ASTM B117.

2.7 Isolator Springs – Type S4

- .1 Open spring thrust restraint isolators:
 - .1 horizontal arrangement, with equipment and structure mounting plates,
 - .2 open spring, with load plate and isolator bushing,
 - .3 static deflection to match equipment isolator.

2.8 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.,

2.9 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,

2.10 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.

2.11 Equipment Base – Type A

- .1 Vibration isolators attached directly to equipment,
- .2 No supplementary base required.

2.12 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)

2.13 Equipment Base – Type B-CT

- .1 Fabricated steel frame or rails – for cooling towers, evaporative fluid coolers, and evaporative condensers:
 - .1 prefabricated supplementary steel base for cooling towers, evaporative fluid coolers and evaporative condensers,
 - .2 fabricated from structural steel shapes, specifically designed for each equipment operating weight and support point locations,

- .3 maximum beam deflection: not greater than 1/360 of span and not to exceed 12.5 mm (1/2 in),
- .4 welded and/or bolted structural connections,
- .5 hot-dipped galvanized grade Z700 (G235) to ASTM A653 after fabrication,

2.14 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.
 - .3 spring mount units carried by height-saver gusseted brackets welded to frame and
 - .4 'T' shaped bases to support horizontal pump elbows.

2.15 Acoustic Barriers for Anchors and Guides

- .1 Manufactured from 25 mm (1 in) thick neoprene isolation with ductile reinforcing material.

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

- .1 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 25 mm (1 in) minimum for type C bases, and
 - .2 50 mm (2 in) minimum for type A and B bases.

3.3 Equipment Vibration Isolation

- .1 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 Type H3 isolators for suspended unit heaters.
- .4 Provide Type S4 horizontal thrust restraints for horizontal discharge fans developing over 1.5 kPa (6 in wg) total static pressure, arranged symmetrically on either side of unit and attached at the center-line of thrust.
- .5 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	Variable support hanger to section 20 05 29	Equal to the equipment isolator static deflection, but not less than 20 (0.75)
	< 10	S1 or H2 [Note 1]	
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)
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.
- .2 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

1 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 29 Common Hanger and Support Requirements
 - .2 20 05 48 Vibration Isolation
 - .3 26 05 49 Seismic Restraints for Electrical Services

1.3 Definitions

- .1 The following definitions apply for the purpose of this section.

Transverse restraint - restraint(s) applied to limit motion perpendicular to the centerline of the pipe, duct or conduit.

Longitudinal restraint - restraint(s) applied to limit motion parallel to the centerline of the pipe, duct or conduit.

Restraint: a device which limits movement of 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.

- .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 $0.3 F_a S_a(0.2) I_E S_p$, as defined in the National Building Code of Canada.

“ K_v ” vertical seismic force coefficient.

“ 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 “ $S_a(0.2)$ ” for the spectral response acceleration value at 0.2 seconds as defined in the National Building Code of Canada.

1.4 Applicable Codes and Standards

.1 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 |

.2 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 |

.3 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 restrains. Mark-ups of Consultant drawing or Contractor installation drawings may be used for this purpose.
- .3 Analysis of dead loads, static 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. All seismic restraint devices shall be designed 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, required calculations, and reports shall be sealed by the specialist seismic professional 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.
- .2 Seismic restraint products shall either be:
 - .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 restrain ratings.

1.7 Manufacturer 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.
- .2 Manufacturer of pipe riser supports are responsible for:
 - .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 as applicable for the place of the Work. Seismic calculation and restraint methods as described in ASHRAE D-90316, SMACNA seismic guideline and MSS SP-127 are acceptable as the baseline requirement.
- .2 Design of seismic restraints to be based 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 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:
$$F_v = 0.15 \times C_p \times W_p \times 1.15.$$
- .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.

$$K_{s,inserts} = K_s \times \frac{R_{p,applicable\ equipment}}{1.5}$$

1.9 Seismic Qualification of Equipment

- .1 Applies where other specifications of Division 20 to 25 require equipment to be seismically qualified.
- .2 Design unitary or package equipment to withstand the seismic force criteria as specified herein.
- .3 Design the equipment base frame to allow anchoring of the packaged equipment to the supporting structure by use of through-bolt anchors.
- .4 Seismically qualify and certify complete unitary or packaged equipment by the shaker table method in accordance with ICC ES-AC156 and ASCE 7 for validating continued operation after the test seismic movement.
- .5 For clarity, calculation of seismic forces for use with ASCE 7 are subject to the following for installations in Canada:
 - .1 calculate seismic forces in accordance with the building code at the place of the Work, or in its absence the National Building Code of Canada,
 - .2 under ASCE 7, the “S_{DS}” parameter is equivalent to NBCC value equal to “2/3 · F_a(0.2) · S_a(0.2)”
 - .3 under ASCE 7, the Component importance factor is to be read as the Building Importance Factor in accordance with the National Building Code of Canada,
 - .4 unless otherwise specified in the product technical Specification section, the building height factor under ASCE 7 of “z/h” is the same as NBCC “h_x/h_n” and is to have a value of 1.0.
 - .5 other factors in conformance with this Specification section.

1.10 Submittals

- .1 Submit shop drawings in accordance with Division 1 and as follows.
- .2 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 a calculation analysis summary (spreadsheet is acceptable) for each piece of equipment, including the following information:
 - (a) Equipment ID,
 - (b) Floor level,
 - (c) Horizontal seismic force factor,
 - (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 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.
 - .8 Calculations and designs shall be sealed by a Professional Engineer licensed in the province or territory of the location of the project.
- .3 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 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.
 - .4 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 Restraints 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 Fire protection automatic sprinkler systems and fire standpipe systems are to be braced 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 described in paragraph .2 below, the following ductwork is not required to have seismic restraints where all the following conditions are met;
 - .1 ducts and duct supports are constructed to SMACNA duct construction standards,
 - .2 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,
 - .3 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 are exempt,
 - .4 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 are exempt,
 - .5 for other ducts not described in items.3 or .4 above are exempt where:
 - (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, 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) 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 Ducts conveying toxic or flammable gases, chemical or biological exhaust, or ducts used for smoke control or smoke venting are to be seismically restrained – no exemptions apply.

3.4 Exemptions for Pipe Seismic Restraints

- .1 Except as described 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,
 - .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,
 - .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 Piping conveying fuel oil, natural gas, propane gas and liquid, medical gases and compressed gases are to be seismically restrained – no exemptions apply.

3.5 Building Structural Connections

- .1 Select building connection devices based on seismic loads for actual equipment purchased.
- .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 were 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.
- .1 The following table for equipment connectors takes precedence over the requirements of Specification section 20 05 16.

Equipment Type	Limits	Connector Type
Refrigeration Condensing Units and Condenser Units	All	Flexible Metal Hose
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
Duct mounted humidifiers	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

- .10 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 equality. Support the guide from the floor level.
 - .2 this requirement applies to piping that is otherwise exempt from seismic restraints.

3.8 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,

3.9 Conduit Restraints

- .1 Conduits for mechanical wiring are to be restrained in accordance with the requirements of section 26 05 49.

3.10 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.

3.11 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.

3.12 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.

3.13 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.

3.14 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

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 125 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

2.3 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)

- .2 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.
- .3 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 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.

2.6 Valve and Steam Trap 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.

2.7 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.

2.8 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.

2.9 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 - Except Non-Medical Gas Systems

- .1 Provide manufactured pipe markers of the following types based on area of the building:
- .1 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:
- .1 Use the existing piping marker colour coding system for building additions and alterations.

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.

3.4 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.

3.5 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.

3.6 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.

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

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 Isotope Drain, Isotope Vent, Decontamination Drain and Tank	Orange	Black	

END OF SECTION

COMMON REQUIREMENTS FOR MECHANICAL INSULATION 20 07 11

1 GENERAL

1.1 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
 - .5 20 05 29 Common Hanger and Support Requirements for Piping

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, equipment 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 Table 1 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.
- .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 C1126 (Gr.1) Standard Specification for Faced and Unfaced Rigid Cellular Phenolic Thermal Insulation

.19 ASTM C1290	Standard Specification for Flexible Fibrous Glass Blanket Insulation Used to Externally Insulate HVAC Ducts
.20 ASTM C1393	Standard Specification for Perpendicularly Oriented Mineral Fiber Roll and Sheet Thermal Insulation for Pipes and Tanks
.21 ASTM E84	Standard Test Method for Surface Burning Characteristics of Building Materials
.22 CGSB 51-GP-52MA	Vapour Barrier, Jacket and Facing Material for Pipe, Duct, and Equipment Thermal Insulation.
.23 CGSB 51.53-95	Poly(Vinyl Chloride) Jacket Sheeting, for Insulated Pipes Vessels and Round Ducts.

1.5 Qualified Tradespersons

- .1 Work to be performed by a recognized specialist firm with an established reputation in this field.

Standard of Acceptance

- 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 Issued For Tender

- .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,
- .3 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.
 - .5 make-up curved surfaces with custom made swaged ring or lobster back covers.

- .6 for indoor mechanical services;
 - (a) seal cover joints for cold and dual temperature services with clear or colour-matched calking.
- .7 on outdoor mechanical services;
 - (a) seal cover joints for cold and dual temperature services with clear or colour-matched calking to permit expansion of metal finish covers.

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

1.1 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

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
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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),
- .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

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 Table 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 louvres.
- .4 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 indoor ducts,
 - .2 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.

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,
 - .2 apply [vapour barrier tape][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 tape] [vapour barrier coating 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 Table 2 at the end of this specification section and installed in accordance with specification section 20 07 11 and/except as specified herein.
- .2 Not applicable.

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 Table 1 - Ductwork, Insulation Type and Thickness
 - .2 Table 3 - Ductwork Insulation Protective Finishes.

**Table 1:
 Ductwork Insulation Type and Thickness**

Duct Nominal Air 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)

.... continued on next page

**Table 1: (continued)
Ductwork Insulation Type and Thickness**

Duct Nominal Air 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.

**Table 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

PIPING INSULATION 20 07 19

1 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

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-fibre):
 - .1 factory molded rigid glass-fibre 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 fibre 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-fibre 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 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 fibre 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 fibre):

- .1 factory molded mineral fibre 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 fibre 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 fibre, high temperature):

- .1 factory molded mineral fibre, 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/cu ft),
- .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

.7 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/cu ft),
- .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-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.

Standard of Acceptance

- Firwin Corporation
- Thermohelp Canada Inc.

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 centre 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.
 - .1 Table 1A for all piping except engine combustion gas exhaust piping,
 - .2 Table 1B for engine combustion gas exhaust piping.
- .2 Insulate condensate piping in accordance with the same criteria as its associated steam system.
- .3 Insulate 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:
 - (a) 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 Secure insulation for domestic hot water piping, domestic hot water recirculation piping, non-potable hot water piping and non-potable hot water recirculation piping in accordance with the requirements for insulating Cold and Dual Temperature piping.
- .3 Secure insulation with integral ASJ or FSK jackets by stapling the lap flap on 75 mm (3 in) centers or by use of self-sealing lap adhesive strip.
- .4 Secure insulation that does not have an integral ASJ or FSK jacket by use of stainless steel wire at not less than 300 mm (12 in) centers, or by a continuous wire helix on the same center spacing.
- .5 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 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 band straps on 300 mm (12 in) centers.
- .6 Secure butt joints with vapour barrier tape or insulation butt strips.
- .7 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 Secure insulation with integral ASJ and FSK jackets by;
 - .1 sealing all lap flaps and butt strips with vapour barrier adhesive, or
 - .2 securing insulation with staples on 75 mm (3 in) centers and covering longitudinal seams with vapour barrier tape, or
 - .3 use of integral self-sealing vapour barrier jacket with lap flaps and butt strips.
- .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 Secure type P-6 insulation with field-applied adhesive or self-adhesive longitudinal edge seams, and apply vapour barrier adhesive/sealant to butt joints.
- .6 Secure butt joints with vapour barrier tape, unless otherwise sealed using vapour barrier adhesives and coatings.
- .7 For straight pipe runs greater than 15 m (50 ft) and at every 15 m (50 ft) length thereafter, provide an insulation expansion joint consisting of 50 mm (2 in) wide flexible glass-fibre insulation for full depth of pipe insulation. Seal adjacent pipe insulation ends with vapour barrier coating.
- .8 Where pipe anchors are attached to chilled water 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,

3.6 Insulation of Fittings, Flanges, and Couplings – Hot, Cold and Dual Temperature Piping

- .1 Insulate fittings including elbows and tees, other than flanges and grooved-couplings:
 - .1 NPS 1½ and smaller:
 - (a) miter cut insulation to create tight fit,
 - (b) 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.
 - .2 NPS 2 and larger:
 - (a) use matching preformed insulation inserts, or fabricate tightly-fitting mitered insulation segments made from the same material as pipe insulation,
 - (b) number of mitered segments to be sufficient to maintain thickness of insulation around throat of elbow or tee,
- .2 Insulate flanges and grooved-joint couplings:
 - .1 insulate with preformed inserts or build-up insulation with same material as on adjacent pipe:
 - (a) butt pipe insulation to each side of flange or grooved-joint coupling,
 - (b) build up rigid insulation blocking on each side of flange or grooved-joint coupling, with a width dimension same as pipe insulation thickness,
 - (c) apply insulation layer over the top of the flange or coupling to a thickness equal to pipe insulation thickness.
- .3 Where type P-5 or P-7 insulation is used;
 - .1 insulate as described above except use factory made insulation inserts, or fabricate inserts to suit the pipe fitting, flange or coupling.
- .4 Where type P-6 insulation is used;
 - .1 insulation as described above except 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.
- .5 Secure insulation with stainless steel wire (Hot piping), or vapour barrier tape (all piping), prior to application of coatings and finishes.

3.7 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,
 - .6 steam separators.
- .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:
 - .1 detachable insulated box type with embossed aluminum or stainless steel jacket, with vapor barrier tape applied to seams when installed, and lined with one layer of 25 mm (1 in) P6 elastomeric blanket with no voids at corners or joints,
 - .2 alternatively, for accessories NPS 8 and larger, install one layer of 25 mm (1 in) type P-6 elastomeric blanket insulation adhered to pipeline accessories with 100% adhesive coverage, and all joints sealed with manufacturers sealant, including the joint between P-6 insulation and adjacent piping insulation,
 - (a) 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 alternatively, for accessories NPS 4 and smaller, 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 and Dual Temperature Piping systems as follows:
 - .1 insulate with flexible blanket insulation, fitted pipe insulation 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.

3.8 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:
 - .1 where the 1st insulation layer is ceramic fibre, 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 where the 2nd insulation layer is mineral wool, 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 where calcium silicate insulation is used, do not use adhesive to attach the insulation to the equipment,
- .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;
 - (a) provide an insulation expansion joint consisting of 50 mm (2 in) wide type P-10 insulation for full depth of both insulation layers,
 - (b) 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.

3.9 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 flexible blanket insulation of same type as pipe insulation, and seal all joints with two coats of vapour barrier coating complete with reinforcing membrane or vapour barrier tape.

3.10 Additional Requirements for Insulation of MRI Quench Vent Piping

- .1 In addition to the general requirements for Cold and Dual Temperature piping insulation specified herein, insulate MRI quench vent piping in accordance with the following supplemental requirements:
 - .1 insulate piping located inside the building,
 - .2 insulate piping located outdoors as follows:
 - (a) insulate vertical vent piping to a height of 2.8 m (8 ft) above the roof or ground level,
 - (b) horizontal vent piping and discharge are not required to be insulated.
 - .3 provide two layers of insulation of applicable thickness as specified in the article Schedules at the end of this Section,
 - .4 stagger insulation joints between the layers so that no joint in one layer aligns with a joint on the other layer,
 - .5 provide vapour barrier sealing on the first (inner) layer using reinforced vapour barrier coating,
 - .6 cover the second insulation layer with jacket material as specified in the article Schedules at the end of this section.
 - .7 install insulation over expansion joints to allow removal to permit inspection of the expansion joint,

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 lagging 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 a separate protective finishing jacket is used, 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 where a separate protective finishing jacket is provided, no additional sealing of the insulation is required.
- .3 Indoor installations – wet areas:

- .1 regardless of how insulation is secured, apply vapour barrier tape to:
 - (a) all longitudinal lap seams and butt edges,
 - (b) 100% coverage of insulation at pipe joints, fittings, couplings, etc.
- .4 Outdoor installation:
 - .1 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

- .1 Seal Cold and Dual Temperature piping insulation in accordance with Specification section 20 07 11 and/except as specified herein.
- .2 Indoor installation (except wet locations):
 - .1 except for chilled water and Dual Temperature piping, tightly seal insulation ASJ jacket longitudinal seams and butt joints;
 - (a) using factory or field fabricated lap seams and butt joint strips with adhesive, or
 - (b) by applying colour matched vapour barrier tape to all edges, overlapping joint by minimum 50 mm (2 in) each side,
 - (c) where factory lap seams are damaged, apply colour matched vapor barrier tape along the damaged edges,
 - .2 for chilled water and dual temperature piping insulation with ASJ jackets, tightly seal longitudinal seams and butt joints;
 - (a) with two coats of vapor barrier coating complete with reinforcing membrane,
 - (b) for pipe size NPS 6 and smaller, colour matched vapour barrier tape is permitted to be used depending on location of piping in accordance with the following table.

Insulation Joint Sealing – Pipes NPS 6 and Smaller		
Piping Location	Vapour Barrier Tape	Vapour Barrier Coating with Membrane
Mechanical Service Rooms	No	Required
Vertical Service Spaces (shafts)	No	Required
Tunnels and trenches	No	Required
Unconditioned spaces	No	Required
Conditioned Spaces	Permitted [Note 1]	Permitted
Ceiling spaces over Conditioned Spaces	Permitted [Note 1]	Permitted
IT rooms	No	Required

Notes:

[1] Pipe size NPS 6 and smaller only.

- (a) overlap insulation edges and butt joint by minimum 50 mm (2 in) each side,
- (b) 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.
- .3 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.
- .4 seal insulation on pipe elbows, tees, flanges, joints, couplings, and other fittings;

- (a) with two coats of vapor barrier coating complete with reinforcing membrane,
- (b) for pipe sizes NPS 6 and smaller, colour matched vapour barrier tape may be used in locations as described in the above table for piping.

.3 Indoor installations – wet areas:

- .1 in wet areas, tightly seal piping in accordance with the requirements for outdoor installation except use vapour barrier coatings.

.4 Outdoor installation:

- .1 tightly seal insulation with two coats of vapour barrier mastic complete with reinforcing membrane;
 - (a) at all lap edges and butt joints,
 - (b) 100% coverage of insulation of pipe elbows, tees, flanges, joints, couplings, and other fittings,
 - (c) to cover mechanical fastener penetrations including staples,
 - (d) in all cases overlapping the joint, fitting or fastener by a minimum 50 mm (2 in) each side.

.5 In all locations;

- .1 seal insulation that does not have a factory applied ASJ jacket with 100% coverage of two coats of vapor barrier coating/mastic complete with reinforcing membrane,
- .2 seal high-density inserts for pipe supports with two coats of vapour barrier coating/mastic complete with reinforcing membrane, overlapping adjacent insulation a minimum of 50 mm (2 in).

3.15 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).

3.16 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.
- .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.

3.17 Standard Details

- .1 Refer to Specification section 20 05 29 for illustration of coordination of insulation with pipe supports, unless otherwise shown on drawings.

3.18 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 A2 Hot Equipment Insulation Type, Thickness, and Coverings For Engine Combustion Gas Exhaust Piping
 - .3 Schedule B Cold and Dual Temperature Piping Systems, Insulation Type and Thickness
 - .4 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 > 860 kPa (125 psi)	177 to 315°C (351 to 600°F)	P-3	115 (4.5) [Note 3]	125 (5) [Note 3]	125 (5)	125 (5)	125 (5)
		P-4	---	---	---	---	125 (5) [Note 1, 2]
		P-7	200 (8) [Note 3]	200 (8) [Note 3]	200 (8)	175 (7)	175 (7)
Steam and Condensate > 100 kPa (15 psi) and ≤ 860 kPa (125 psi) Boiler Feed Water	122 to 176 (251 to 350)	P-1 P-3	80 (3) [Note 3]	100 (4) [Note 3]	115 (4.5)	115 (4.5)	115 (4.5)
		P-2 P-4	---	---	---	---	150 (6) [Note 1, 2]
		P-7	125 (5) [Note 3]	175 (7) [Note 3]	175 (7)	175 (7)	150 (6)
Safety Relief Piping	122 to 176 (251 to 350)	P-1 P-3	40 (1½)	40 (1½)	40 (1½)	40 (1½)	40 (1½)
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 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)				
Pure Water (with heat sanitization)	25 to 93 (77 to 200)	P-1 P-3	25 (1)	25 (1)	25 (1)	25 (1)	25 (1)
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)
Domestic Hot Water Domestic Hot Water Recirculation Not-Potable Hot Water Non-Portable Hot Water Recirculation	41 to 60 (105 to 140)	P-1 P-3	25 (1)	25 (1)	40 (1½)	40 (1½)	40 (1½)
Condenser Water (outdoors)	16.5 to 40 (61 to 104)	P-3 P-4 P-5	40 (1½)	40 (1½)	40 (1½)	40 (1½)	40 (1½)
Fire protection Sprinkler piping and valves, Fire protection Standpipe piping and valves [Note 4]	4 to 40 (50 to 104)	P-1 P-3	25 (1)	25 (1)	40 (1½)	40 (1½)	40 (1½)

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 A2
Hot Equipment Insulation Type, Thickness, and Coverings
For Engine Combustion Gas Exhaust Piping

Equipment Description	Exhaust Gas Service Temperature °C (°F)	1 st Layer Type x Thickness mm (in)	2 nd Layer Type x Thickness mm (in)	Protective Finishing Covering, Exposed Piping [Note 1]
Natural Gas Engine combustion gas exhaust piping	≤ 700 (≤ 1292)	P-10 50 (2)	P-3 90 (3.5)	Fabric
		P-10 50 (2)	P-3 150 (6) [Note 2]	Stainless Steel
Diesel Engine combustion gas exhaust piping	≤ 540 (≤ 1000)	P-10 25 (1)	P-3 50 (2)	Fabric
		P-10 50 (2)	P-3 90 (3.5)	Stainless Steel
		P-7 40 (1.5)	P-7 50 (2)	Fabric
		P-7 75 (3)	P-7 90 (3.5)	Stainless Steel

Notes:

[1] For exposed piping located indoors. See Schedule C for other locations.

[2] Made up of two equal thickness layers with a total thickness of the indicated value.

Schedule B
Cold and Dual Temperature Piping Insulation Type and Thickness

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)				
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, Glycol Heat Recovery	4 to 16 (39 to 61)	P-1 P-3 P-5	25 (1)	25 (1)	40 (1½)	40 (1½)	50 (2)
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]	---	---
MRI Quench Vent	-268 (-450)	P-3 (inner layer)	---	---	---	25 (1)	25 (1)
		P-6 (outer layer)	---	---	---	25 (1)	25 (1)

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	Fire Protection Piping	PVC (red in colour)
		All other piping	Metal

END OF SECTION

START-UP AND PERFORMANCE TESTING REPORTING

20 08 01

1 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 20 08 05 Testing, Adjusting and Balancing
 - .2 20 08 11 Testing of Integrated Mechanical Life Safety and Fire Protection Systems

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 forma.

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,
 - .5 Alternate Season test 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) chemical water treatment - pipe cleaning,
 - (b) chemical water treatment - passivating and inhibition,
 - (c) refrigeration equipment,
 - (d) packaged AC equipment,
 - (e) heating boilers,
 - (f) steam boilers,
 - (g) deaerators,
 - (h) packaged humidity steam generators,
 - (i) domestic hot water heaters,
 - (j) air compressors,
 - (k) cooling towers,
 - (l) adjustable frequency drives,
 - (m) 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.

4.5 Alternate Season Testing Report

- .1 Provide alternate season test report 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

TESTING OF INTEGRATED MECHANICAL FIRE PROTECTION AND LIFE SAFETY SYSTEMS 20 08 11

1 GENERAL

1.1 Scope

- .1 Provide testing of integrated fire protection and life safety systems and related equipment provided under Division 20 to 25 with those provided under other Divisions of the Work, in accordance with Division 01.
- .2 This specification is limited to testing of the interconnections between fire protection and/or life safety 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 Fire Protection and Life Safety Systems

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 Refer to section 01 75 11.

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 FPLS systems provided under Divisions 20 to 25 and those provided under other Divisions of the Work.
- .2 Include all labor and material as required to participate in and implement the integrated FPLS testing process for equipment and systems provided under Division 20 to 25.

3.2 Integrated Test Plan and Procedures - Development

- .1 Participate in the development of the integrated FPLS 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 FPLS test plan.

3.3 Integration Test Plan – Implementation

- .1 Complete related FPLS system testing in accordance with the applicable technical specification sections of Divisions 20 to 25, prior to implementation of integrated FPLS testing. Where testing of such systems inherently test the FPLS system interconnection(s), such testing is not required to be duplicated for the integrated FPLS testing provided the results of the integration test are recorded in accordance with the requirements of the integrated FPLS test plan.
- .2 Prior to implementing any integrated FPLS test,
 - .1 provide written confirmation from each trade contractor under Divisions 20 to 25 of the Work, that their respective FPLS related equipment or systems, or parts thereof, have been installed in accordance with the design and are ready for integrated FPLS testing,
 - .2 provide test verification reports from the organization that verified the installation of any FPLS system as required by referenced codes or standards, such as NFPA or ULC.
 - .3 provide a copy of inspection reports from an authority having jurisdiction governing a FPLS system.
- .3 Coordinate with the ITC and provide all necessary resources to implement the integrated FPLS test plan.

3.4 Final Test Results Report

- .1 The final test report will be prepared by the ITC.

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
 - .3 20 08 11 Testing of Integrated Mechanical Fire Protection and Life Safety Systems

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 1.2 Technical Requirements for the Commissioning Process for Existing HVAC&R Systems and Assemblies
 - .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 cooling generation systems,
 - .3 heating generation systems,
 - .4 hydronic distribution systems,
 - .5 air distribution and exhaust systems,
 - .6 domestic hot water systems,
 - .7 domestic cold water systems,
 - .8 fire protection systems / suppression systems,
 - .9 constant speed motor controllers and variable frequency drives,
 - .10 building automation systems,
 - .11 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 1.2 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 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) IAQ
 - (g) Energy efficiency
 - (h) System operation
 - (i) Automatic controls
 - (j) Service, maintenance, diagnostics and repairs
 - (k) Use of reports and logs
 - (l) 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, i.e. 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.
- .4 Training Manuals
- .1 Provide training material hand-outs for each session.
 - .2 Collect training material and bind into separate binders.

END OF SECTION

CLOSEOUT REQUIREMENTS FOR MECHANICAL WORK 20 77 19.20

1 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:	<input type="checkbox"/> Reviewed <input type="checkbox"/> 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:	<input type="checkbox"/> Reviewed <input type="checkbox"/> 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:	<input type="checkbox"/> Reviewed <input type="checkbox"/> 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:	<input type="checkbox"/> Reviewed <input type="checkbox"/> Incomplete or deficient - resubmit
Signed:	
Date:	

End of Section

COMMON WORK RESULTS FOR FIRE SUPPRESSION

21 05 01

1.1 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

- .1 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.

2.2 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.
- .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:

Standard of Acceptance

- Masters Pro-Dope
- Masters Orange or White Tape.

- (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.

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 di-electric 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 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.

3.4 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 20 08 11 Testing of Integrated Mechanical Life Safety and Fire Protection Systems
 - .2 21 05 01 Common Work Results for Fire Suppression

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
 - .3 UL 1478A Standard for Pressure Relief Valves for Sprinkler Systems
 - .4 UL 2443 Flexible Sprinkler Hose with Fittings for Fire Protection Service
 - .5 ULC/ORD-C312 Check Valves for Fire Protection Service

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: 2060 kPa (300 psi)
- .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.
- .5 Changes to pipe sizes, pipe layout and head layouts accompanied with modified hydraulic calculations and sealed by a professional engineer licensed in the jurisdiction of the Work may be submitted for approval at the time of shop drawing submission, but prior to installation, purchasing or fabrication of associated materials and equipment.

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.
- .3 Samples:
 - .1 Submit samples of;
 - (a) sprinkler heads,
 - (b) signs.

1.9 Maintenance Materials

- .1 Provide cabinet, containing special sprinkler wrench, and spare stock of sprinklers. Include at least one head of each type and temperature rating installed in system.

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	Joining Method	ASTM A53, ASTM A135	ASTM A795
≤ 2-1/2	Threaded, Cut Groove	Schedule 40	Standard Weight
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 40	Standard-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

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

2.4 Signage

.1 Construction:

.1 1.2 mm (18 ga.) thick aluminium, with Mylar protective facing, red enamel background, white letters, inscription in accordance with NFPA standards,

.2 Size:

.1 230 x 180 mm (9 x 7 in) for automatic control valves and alarm valves,

.2 50 x 150 mm (2 x 6 in) for other valves,

.3 130 x 180 mm (5 x 7 in) for hydraulic calculation signs,

2.5 Maintenance Materials

.1 Storage cabinet: steel cabinet with lockable doors, baked enamel red finish,

.2 Included maintenance materials:

.1 special sprinkler wrench,

.2 spare stock of sprinklers, with at least one head of each type and temperature rating installed in the system.

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 Extend piping from existing mains and branches and connect to sprinklers.

.3 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.
- .4 Provide NPS $\frac{3}{4}$ manual air vent valve with cap and chain at the top of each sprinkler riser and where shown;
 - .1 run NPS $\frac{3}{4}$ 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.
- .5 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 Pipe Joints (other than Mechanical Tees for Branch Piping)

- .1 Make pipe joints using jointing methods in accordance with Specification section 21 05 01.

3.3 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.

3.4 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 Identification and Signage

- .1 Provide signs at each valve, including control valves, shut-off valves, drain valves, vent valves and test valve, identifying portion of system controlled. Provide hydraulic design parameters nameplate on each alarm check valve.
- .2 Fasten signs to pipe in immediate vicinity of valve.
- .3 Coordinate with Electrical Division 26 to ensure consistency between fire alarm annunciation and associated tagging.

3.6 Maintenance Materials Cabinet

- .1 Coordinate with Owner as to their desired location for installation of the maintenance materials cabinet.
- .2 Provide signage on the front of the cabinet identifying its function.

3.7 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.

3.8 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.

3.9 Integrated Testing of Life Safety and Fire Protection Systems

- .1 Participate as required in the integrated system testing of the standpipe system in accordance with specification section 20 08 11.

3.10 Testing Reports and Certificates

- .1 Provide completed and signed Contractor's Material and Test Certificate for above ground 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 non-potable water piping systems,
 - .3 drainage system including:
 - (a) sanitary drainage and vent systems,
 - .4 other plumbing systems including:
 - (a) specific duty piping systems otherwise specified in Division 22.

1.2 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.
- .3 Product standards:
 - .1 CSA B272 Pre-Fabricated Self Sealing Roof Vent Flashings

1.3 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.

1.4 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)
 - .3 Non-potable water:
 - (a) Design pressure: 900 kPa (130 psig)
 - (b) Design temperature: 107°C (225°F)

2 PRODUCTS

2.1 Flashings

- .1 Through-roof penetration flashing, and other waterproofed areas:
 - .1 manufactured from composite material in accordance with CSA B272,
 - .2 minimum dimensions of 500 mm x 500 mm (20 in x 20 in),
 - .3 with sleeve extending at least 150 mm (6 in) above roof.

2.2 Dielectric Unions

- .1 Construction:
 - .1 Bronze or brass body with non-metallic fitting or coating the FNPT tailpiece.
 - .2 FNPT x Copper sweat connection.
 - .3 Pressure rating; ASME Class 3000 at 121°C (250°F)

Standard of Acceptance

- Hart Industrial Unions - fig. D-3136 or Polymer Composite Coating

2.3 Dielectric Flanges

- .1 Construction:
 - .1 ASME Class 150 or 300 carbon steel flange, Van-stone style with copper tube adapter tailpiece.
 - .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 (200 psi) at 121°C (250°F)
 - (b) Class 300: 2800 kPa (400 psi) at 121°C (250°F)

Standard of Acceptance

- CTS Flange Canada - fig. BF / WBG

3 INSTALLATION

3.1 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.

3.2 Domestic Cold Water System Distribution

- .1 Extend existing domestic cold water system with
 - .1 distribution pipe and fittings,

- .2 valves,
- .3 premises backflow isolation,
- .4 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.

3.3 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 cold water connections to hot water tank, with shut-off and expansion tank on supply and valved drain at bottom of tank.
- .3 Provide valved connections from hot water supply system to fixtures and other equipment requiring hot water.

3.4 Domestic Hot Water Recirculation System

- .1 Extend existing domestic hot water recirculation system with
 - .1 distribution pipe and fittings
 - .2 valves
 - .3 pumps
- .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.

3.5 Dissimilar Metals Galvanic Isolation

- .1 Provide dielectric unions or flanges to separate copper and copper alloy tube and fitting materials from contact with carbon (plain and galvanized) steel material.
 - .1 For clarity, dielectric unions or flanges are not required when connecting copper to T304 or T316 stainless steel pipe or tubing.
- .2 Refer to specification section 23 05 01 for exemptions when connecting domestic water copper piping or stainless steel piping to HVAC piping systems.

3.6 Drainage

- .1 Existing storm drainage piping system is to remain.
- .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.

3.7 Flashings

- .1 Provide flashing for piping penetrations through roofs and other waterproofed areas. Leave flashing ready for Roofing or Waterproofing Trades to make watertight connections.

3.8 Vent Termination (VTR)

- .1 Fit vents passing through roof with vent stack sleeve terminating not less than 150 mm (6 in) above roof, above flood level of roof, and 900 mm (3 ft) above or 3500 mm (11.5 ft) horizontally from any air intake, door, or operable window.

3.9 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.

3.10 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.

3.11 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.

3.12 Flushing and Disinfecting - Water Service Pipe

- .1 Complete piping pressure tests prior to flushing and disinfecting operations. Notify Consultant at least two days in advance of date when disinfecting operations are proposed, so that the Consultant may witness the tests.
- .2 Isolate the water service pipe inside the building at the point of entry, from the building water distribution system. Flush water service pipes for a minimum of 10 minutes to produce a water velocity of 1.5 m/s (5 fps) and discharge water to drain or other acceptable area.
 - .1 Minimum flushing flow rates:

Pipe size	Minimum Flow	
	L/s	USGPM
2	3.3	52
2 1/2	4.7	75
3	7.3	115

4	12.6	200
6	23.4	450
8	49	780
10	76	1200
12	110	1750

- .3 Disinfect water service pipes NPS 4 and larger:
- .1 Provide chemicals and equipment to clean, disinfect and flush domestic water service pipes in accordance with AWWA C651.
 - .2 Drain down system to remove flushing water.
 - .3 Isolate service water pipe from the building distribution system.
 - .4 Disinfect water supply pipe by introducing chlorine close to point of connection to the municipal water supply and evenly add to water as water service pipe is refilling, to provide an initial concentration of 50 mg/L.
 - .5 Close off drains and maintain chlorinated water in mains pipe for 24 hours.
 - .6 At the end of 24 hours, arrange and pay for laboratory testing of water samples taken from newly disinfected main. If the residual chlorine is < 25 mg/L, drain down water and repeat disinfection for an additional 24 hours and lab testing until a residual of minimum 25 mg/L is obtained.
 - .7 After the lab test indicates a residual of 25 mg/L, flush line to remove chlorine solution.

3.13 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.[]

- .6 When flushing has been completed to satisfaction of Consultant, introduce strong solution of chlorine into watermain and ensure that it is distributed throughout entire system:
 - .1 Drain down system to remove flushing water,
 - .2 Introduce Chlorine close to point of re-filling of system, and evenly add to water as system is refilling, to provide an initial concentration of 50 mg/L
 - .3 Operate valves, hydrants, and appurtenances while main contains chlorine solution.
 - .4 Flush line to remove chlorine solution after 24 hours contact time.
 - .5 Arrange and pay for laboratory testing of water samples taken from newly disinfected main.
 - .6 Where samples do not meet laboratory test standard for potable water, disinfection procedure and testing is to be repeated until satisfactory results are achieved.]

3.14 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.
 - .2 Non-potable water piping systems including:
 - (a) Process water systems

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 Gate Valves, Non-Potable Applications (type GTVNP)

- .1 For non-potable water systems only. Do not use on potable water systems.

- .2 NPS 2½ to NPS 12, cast iron:

- .1 To MSS SP-70, Class 125, cast iron body with flat faced flange, bronze or bronze faced solid wedge disc with bronze seat rings, OS & Y, bolted bonnet, flanged ends.

- (a) Required MCPR: 1200 kPa (174 psi) at 93°C (200°F).

Standard of Acceptance

- Kitz - fig. 72
- Crane - fig. 465 ½
- Jenkins - fig. 454J
- Nibco - fig. F-617-O

- .3 NPS 2½ to NPS 24, stainless steel:

- .1 To ASME B16.34, Class 150, ASTM A216 grade WCB cast steel body with raised faced flange, flexible Type 416 stainless steel disc and hard faced seat rings, rising stem, OS & Y, bolted bonnet, flanged ends.

- .2 ASME Class 150:

- (a) Required MCPR: 1700 kPa (246 psi) at 93°C (200°F).

Standard of Acceptance

- Kitz - fig. 150 SCLS
- Crane - fig. 47 XU-F
- Jenkins - fig. J1009B8F
- Powell - fig. 1503-FC8G

- .3 ASME Class 300:

- (a) Required MCPR: 4000 kPa (580 psi) at 93°C (200°F).

Standard of Acceptance

- Kitz - fig. 300 SCLS
- Crane - fig. 33 XU-F
- Powell - fig. 3003-FC8G

2.8 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

2.9 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

2.10 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

2.11 Swing Check Valves – Non-slam

.1 For building sump pumps service only.

.2 NPS 2 and larger, flanged:

- .1 To MSS SP-71, Class 125, swing check type with external lever weight and/or spring closure, cast iron body, renewable bronze seat rings, bronze faced iron or bronze disc, bolted cap, flanged ends.
- .2 Required MCPR: 1200 kPa (174 psi) at 93°C (200°F).

Standard of Acceptance

- Val-Matic - fig. 7800LW / 7800LS
- DeZurik - fig. APCP swing check

2.12 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

2.13 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

2.14 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

Table 1: Manual Valve Selection		
Piping System	Pipe and Tube Material	Manual Valve Type
	Galvanized Steel	BV-1, BV-2 GLV-1 GTV-1, GTV-2, GTVNP BFV-1, BFV-2, BFV-3, BFV-4

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

3.5 Double Regulating Valves Installation

- .1 Where double regulating valves are used, supply one flow meter for double regulating and triple duty valves and turn over to operating staff during operations and maintenance training. Obtain and provide a copy to the owner of a signed receipt showing time, date, and name of recipient.
- .2 Consult with double regulating valve manufacturer to ensure correct valve selection. Balancing valves to be sized according to design flow rate.
- .3 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

- .4 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.
- .5 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.
- .6 Double regulating valves shall not be used as isolation valves. Where double regulating valves are installed, provide isolation valve downstream.

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 cold water booster pumps,
 - .2 domestic hot water systems,
 - .3 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.

Standard of Acceptance(no alternatives)

- Air & Water and Precision Balancing – Matthew Crittenden matt@awpbgroup.com – 647-896-5353

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 ±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	± 0.2°C over 0 to +40°C
Temperature	Liquid	Digital Electronic Thermometer	± 0.4°C < 0°C and >+40°C
Pressure	Liquid, Gas, Steam	Bourbon type	± 1.0% of reading
RPM	Motor, fans	Chronometer tachometer	± 1.0% of reading
Voltage	All	Portable	± 2.5% of reading
Current	All	Portable clamp-on ammeter	± 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, or

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 - EQUIPMENT TESTING

4.1 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 Include nameplate data and as-tested results.

- .3 Hot water heaters:
 - .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 pressure rating (MAWP),
 - .8 pressure relief valve rating (pressure setpoint, heat rating, steam rating),
 - .9 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) calculated heat output rating at measured design water flow rate and measured temperatures.
- .4 Hot water heat exchangers:
 - .1 manufacturer and type,
 - .2 inlet and outlet temperatures,
 - .3 pressure drop,
 - .4 design pressure rating (MAWP),
 - .5 heat performance:
 - (a) entering and leaving water temperature,
 - (b) entering and leaving water pressure,
 - (c) liquid flow rate (minimum, maximum),
 - (d) input steam flow rate and pressure (where applicable),
 - (e) calculated heat output rating at measured design water flow rate and measured temperatures.
- .5 Pumps:
 - .1 manufacturer name,
 - .2 model or serial number,
 - .3 flow rate,
 - .4 developed pump head,
 - .5 RPM.

5 EXECUTION - MISCELLANEOUS

5.1 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.

6 EXECUTION - REPORT PRESENTATION AND VERIFICATION

6.1 Required Reports

- .1 Provide the following reports:
 - .1 Water balancing and equipment test report.

6.2 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.

6.3 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.

6.4 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 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

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 or 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

- .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 – STAINLESS-STEEL

22 11 16.16

1 GENERAL

1.1 Scope

- .1 Provide stainless-steel pipe and tube and fittings for potable domestic water piping systems for aboveground installations.
- .2 Use of stainless-steel pipe/tube is an alternative to copper tubing.
- .3 Size limits:
 - .1 Stainless-steel pipe: NPS 3/4 to NPS 12.
 - .2 Stainless-steel tube: OD ½ to OD 2.
- .4 Acid descaling and passivation of welded piping and tubing, depending on welding procedures used and quality of welding performed.

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.

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.
 - .2 **Plumbing fixtures:** has the meaning in the Ontario Building Code
- .2 In this specification section, reference to “piping” also means “tubing” unless the context indicates otherwise.

1.4 Applicable Codes and Standards

- .1 Installation codes and standards:
 - .1 ASME B31.9 Building Services Piping Code
 - .2 ASTM A380 Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems
 - .3 AWS D18.2 Guide to Weld Discoloration Levels on Inside of Austenitic Stainless Steel Tube
- .2 Product standards:
 - .1 ASME B1.20.1 Pipe Threads, General Purpose (inch)
 - .2 ASME B16.5 Pipe Flanges and Flanged Fittings
 - .3 ASME B16.9 Factory-Made Wrought Steel Buttwelding Fittings
 - .4 ASME B16.11 Forged Fittings, Socket Welding and Threaded

- .5 ASME B16.21 Nonmetallic Flat Gaskets for Pipe Flanges.
- .6 ASME B18.2.1 Square and Hex Bolts and Screws,
- .7 ASME B18.2.2 Square and Hex Nuts
- .8 ASTM A182 Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service
- .9 ASTM A312 Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes
- .10 ASTM A269 Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
- .11 ASTM A351 Standard Specification for Castings, Austenitic, for Pressure Containing Parts
- .12 ASTM A403 Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings
- .13 ASTM A182 Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High Temperature Service.
- .14 ASTM A193 Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High Temperature
- .15 ASTM A194 Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both
- .16 MSS SP-114 Corrosion Resistant Pipe Fittings Threaded and Socket Welding Class 150 and 1000

2 PRODUCTS

2.1 Stainless-steel Pipe, Fittings and Joints

.1 Pipe:

- .1 To ASTM A312 Type 304/304L or 316/316L, seamless or welded, and pipe schedule in accordance with the following table.

Table 1: Pipe Schedule Based on Jointing Method			
Joint Method	Pipe Size NPS	Maximum System Design Pressure	Schedule
Threaded	NPS ¾ to NPS 2	2750 kPa (400 psig)	40/40S
Welding (butt weld, socket weld)	NPS 2-1/2 to NPS 6	2750 kPa (400 psig)	10

Table 1: Pipe Schedule Based on Jointing Method			
Joint Method	Pipe Size NPS	Maximum System Design Pressure	Schedule
	NPS 8 to 12	1720 kPa (250 psig)	10
		2750 kPa (400 psig)	40/40S

.2 Threaded fittings:

- .1 End connections: NPT thread to ANSI B1.20.1.
- .2 Fittings: Class 150 and Class 1000 to MSS SP-114, and material to ASTM A351 Gr. CF8 or CF8M stainless-steel to match pipe grade.
- .3 Unions: Class 150 and Class 1000 to MSS SP-114, and material to ASTM A182 Gr. CF8 or CF8M stainless-steel to match pipe grade, with ground joint and face.
- .4 Threaded joint compound: Teflon pipe tape.

Standard of Acceptance

- Masters Orange or White Tape.

.3 Welding fittings:

- .1 Pipe fittings of same steel alloy and grade as connected pipe.
- .2 Butt-weld fittings:
 - (a) forged stainless-steel fitting to ASTM A403,
 - (b) wall thickness to match pipe,
 - (c) elbows to be long radius type.
- .3 Welding outlet fittings:
 - (a) forged stainless-steel to ASTM A182,
 - (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.
- .4 Socket welded fittings:
 - (a) forged stainless-steel to ASTM A182,
 - (b) dimensions and pressure ratings to ASME B16.11, Class 3000.
- .5 Half couplings:
 - (a) forged stainless-steel to ASTM A351,
 - (b) dimensions and pressure rating to ASME B16.11, Class 3000 socket weld or threaded ends,
 - (c) NPT ends to ASME B1.20.1.

.4 Flanges:

- .1 Raised face stainless-steel to ASTM A182, Class 150 and Class 300, weld neck with wall thickness to match pipe, or slip on type.
- .2 Studs and bolts: stainless-steel type 316, to ASTM A193.
- .3 Nuts: stainless-steel type 316, to ASTM A194.
- .5 Flange gaskets:
 - .1 For raised face and flat faced flanges to ANSI B16.21 or AWWA/ANSI C111.
 - .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

2.2 Stainless-steel Tube, Fittings and Joints

- .1 Tube:
 - .1 size: OD 1/4 to OD 2
 - .2 fully annealed Type 316/316L stainless-steel tubing: to ASTM A269.
 - .3 minimum design pressure: 2700 kPa (400 psi) at 85°C (185°F).
 - .4 tube wall thickness:

Table 2: Stainless Steel Tube Pipe Wall Thickness						
NPS	1/2	3/4	1	1-1/4	1-1/2	2
Tube OD, mm	Ø12	Ø20	Ø25	Ø32	Ø38	Ø50
Wall Thickness, mm	1.0	1.2	1.8	2.0	2.2	3.0

- .5 Tubes to be suitable for bending and flaring.
- .6 Tube OD tolerance to meet the requirements of the selected compression fitting manufacturer requirements.
- .2 Welded fittings:
 - .1 Specifically manufactured for stainless-steel tubing.
 - .2 Elbows, reducers and tees: wall thickness not less than that of pipe to which they are connected.
 - .3 Extended tube ends suitable for automatic orbital TIG welding.

3 EXECUTION

3.1 Installation of Piping and Tubing

- .1 Install piping and tubing in accordance with ASME B31.9 except/and as specified herein.
- .2 Refer to section 22 05 01 for piping design criteria and general requirements for piping installation.
- .3 Install piping close to building structure to minimize furring and conserve headroom. Group piping and run parallel to walls and ceilings.
- .4 Cut pipe/tube square, ream pipe/tube ends, and clean pipe/tube ends before joint assembly.
- .5 Before making welded joints, remove working parts of valves, clean inside of solder fittings and outside of mating pipe with emery paper and coat with flux.
- .6 Where welding is used, provide a removable 300 mm long spool section with flanged or grooved-end connections, which includes a butt-weld joint at its midpoint. Locate the spool piece in the largest pipe service that may be subjected to a post-weld pickling process.

3.2 Pipe Supports

- .1 Support piping and tubing in accordance with specification section 20 05 29 except as specified herein.
- .2 Support horizontal stainless steel pipe and tube in accordance with Table 3A and 3B:

Table 3A: Horizontal Pipe Support Spacing for Stainless Steel Pipe			
Pipe Size NPS	Pipe Schedule	Rod Diameter DN (inches)	Maximum Spacing m (ft)
1/2	40	M10 (3/8 in)	2.1 (6.7)
3/4	40	M10 (3/8 in)	2.4 (7.7)
1	40	M10 (3/8 in)	2.8 (9.0)
1-1/4	40	M10 (3/8 in)	3.0 (9.8)
1 1/2	40	M10 (3/8 in)	3.0 (9.8)
2	40	M10 (3/8 in)	3.0 (9.8)
2 1/2	10	M10 (3/8 in)	3.0 (9.8)
3	10	M12 (1/2 in)	3.0 (9.8)
4	10	M12 (1/2 in)	3.0 (9.8)
6	10	M12 (1/2 in)	3.0 (9.8)
8	10S or 40	M12 (1/2 in)	3.0 (9.8)
10	10S or 40	M16 (5/8 in)	3.0 (9.8)
12	10S or 40	M16 (5/8 in)	3.0 (9.8)

Table 1C: Horizontal Pipe Support Spacing for Stainless Steel 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	M10 (3/8 in)	3.0 m (10 ft)
3	M12 (1/2 in)	3.0 m (10 ft)
4	M12 (1/2 in)	3.0 m (10 ft)

- .3 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 and Flanges

- .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
150	1400 kPa (200 psi)	≤ 121°C (250°F)
300	3100 kPa (450 psi)	≤ 121°C (250°F)

3.4 Joints and Fittings

- .1 Use manufactured fittings except where otherwise permitted herein for branch connections.
- .2 Joints in tubing:
 - .1 NPS ½ to NPS 2:
 - (a) butt-welded
- .3 Joints in pipe:
 - .1 Pipe NPS ¾ to NPS 2:

- (a) NPT threaded joint to ANSI B1.20.1 and made with Teflon tape, or
- (b) socket welded.
- .2 Pipe NPS 2-1/2 and larger:
 - (a) flanged or butt- welded
- .4 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	Figure
95°C (203°F)	1720 kPa (250 psig)	EPDM	1.5 mm (1/6 in)	A-B AB-576
	2750 kPa (400 psig)	NBR	1.5 mm (1/6 in)	Durlon 7910

3.5 Limitations on Use of Threaded Joints

- .1 Use of threaded joints for NPS ¾ to NPS 2 pipe is limited to the following applications:
 - .1 for run-out branch connection to process equipment (not including plumbing fixtures),
 - .2 for run-out branch connection to hot water heaters with NPT connections,
 - .3 plumbing fixtures with water passages constructed of stainless-steel and which has NPT connections.
- .2 Where schedule 10 piping is used for branch connection to equipment, provide weld x NPT cast adaptor fittings. Do not thread schedule 10 pipe.

3.6 Branch Connections

- .1 Make branch connections to mains in accordance with the following table.
 - .1 For direct welding of pipe branch to main or use of half-couplings, this table is valid for design pressures up to 2070 kPa (300 psig) without adding reinforcement material. For welded branch connections at higher design pressures, only use butt-welded or integrally reinforced outlet fittings only.
 - .2 In this table, the following abbreviations apply, as applicable to pipe or tube.

Abbreviations – for pipe materials

- TH Threaded to MSS SP-114
- SW Socket weld fittings to ASTM A182 and ASME B16.11
- HC Half coupling to ASTM A351 and ASME B16.11
- BW Buttweld fitting to ASTM A403
- OF Reinforced Outlet Fittings to ASTM A182 and MSS SP-97
- DP Direct welding of Branch Pipe to Main without added reinforcement

Abbreviations – for tube material

- BWT Buttweld fitting for tubes

Allowable Branch to Main Connections Maximum 2070 kPa (300 psig) Design Pressure											
Branch NPS	Mains Pipe, NPS										
	1	1-1/4	1-1/2	2	2-1/2	3	4	6	8	10	12
3/4	TH SW BWT	TH SW BWT	TH SW BWT	TH SW BWT	BW SW	BW OF SW HC DP	BW OF SW HC DP	BW OF HC DP	BW OF HC DP	BW OF HC DP	BW OF HC DP
1	TH SW BWT	TH SW BWT	TH SW BWT	TH SW BWT	BW SW	BW OF SW DP	BW OF SW HC DP	BW OF HC DP	BW OF HC DP	BW OF HC DP	BW OF HC DP
1-1/4	---	TH SW BWT	TH SW BWT	TH SW BWT	BW SW	BW OF SW DP	BW OF SW DP	BW OF HC DP	BW OF HC DP	BW OF HC DP	BW OF HC DP
1-1/2	---	---	TH SW BWT	TH SW BWT	BW SW	BW OF SW DP	BW OF SW DP	BW OF HC DP	BW OF HC DP	BW OF HC DP	BW OF HC DP
2	---	---	---	TH SW BWT	BW SW	BW, OF SW	BW OF SW DP	BW OF DP	BW OF HC 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	BW OF DP
3	---	---	---	---	---	BW	BW OF SW	BW OF DP	BW OF DP	BW OF DP	BW OF DP
4	---	---	---	---	---	---	BW	BW OF	BW OF DP	BW OF DP	BW OF DP
6	---	---	---	---	---	---	---	BW	BW OF	BW OF DP	BW OF DP
8	---	---	---	---	---	---	---	---	BW	BW OF	BW OF DP
10	---	---	---	---	---	---	---	---	---	BW	BW
12	---	---	---	---	---	---	---	---	---	---	BW

.2 Use of Class 3000 half-couplings as a branch connector (HC), and direct welding of branch pipe to the main pipe (DP), is permitted in accordance with the following requirements:

- .1 half-coupling or branch pipe to sit-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 full-penetration groove weld,
 - .4 the half-coupling or direct branch pipe is attached with a groove weld and covered with a smooth finishing fillet cover weld, and
 - .5 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, flame-cut or drill and ream the main pipe to closely follow the dimensions of the saddle fitting.

3.7 Welding

- .1 Comply with section 20 05 24 and as specified herein.
- .2 Use welding procedures which reduce the formation of chromium carbide in the heat affected zone. Acceptance criteria is to achieve a No. 4 colour value in accordance with AWS D18.2, equivalent to 100 ppm oxygen content in the internal purge gas/air mix during welding.
- .3 Do not use carbon steel wire brushes for cleaning pipe or tube ends. Do not use stainless-steel wire brushes that have been previously used on carbon steel.
- .4 Weld pipe using automatic orbital tungsten inert gas (“TIG”) welding.
 - .1 Exception: use hand TIG weld for socket welds, branch connections other than butt-weld fittings, and slip-on flanges.
 - .2 Hand TIG tack welding for alignment of stainless-steel pipe is permitted, prior to automatic welding.
- .5 Use removable/inflatable gas dams to continuously purge the inside of pipes/tubes with 100% argon backing gas during welding. Use of argon mixed with carbon dioxide or other gasses is not permitted.
 - .1 Provide a purge restrictor on pipe to maintain oxygen levels in the gas exiting the weld gap from inside the pipe below a nominal 100 ppm; actual oxygen concentration is as required to obtain a heat affected zone (“HAZ”) colour as specified in accordance with AWS D18.2.
 - .2 Use portable oxygen analyzers reading ppm on pipe sizes NPS 2 ½ and larger, to check oxygen levels at purge outlet. Qualified time purging is acceptable on pipe sizes NPS 2 and smaller.
- .6 Use of backing gas is not required where the inside surface of the pipe is accessible for removal of the HAZ weld tint by grinding or manual application of pickling compound to remove the weld tint, while the weld is accessible before installation. This condition would apply to welding of flanges, or welding of branch connections using methods other than the use of butt-weld fittings.
 - .1 Use of a passivation-only solution is not acceptable for this purpose.
- .7 Use of welding methods other than TIG, or the use of TIG for the root pass and MIG for the second/cover pass, will be considered provided that the welding procedure can demonstrate the visual acceptance criteria specified herein.

3.8 Equipment Connections

- .1 Make pipe connections to equipment as follows.
 - .1 NPS 2 and smaller:
 - (a) threaded fittings
 - .2 NPS 2 ½ and larger:
 - (a) flanged connections
- .2 Where connection is made to equipment with a threaded fitting, provide a union between the isolation valve and the equipment connection.

3.9 Valves

- .1 Provide valves in accordance with specification section 22 05 23.13.
 - .1 Valve body material: copper alloy, ductile iron or stainless-steel
 - .2 Isolate equipment, fixtures and branches with gate, ball or butterfly valves.
 - .3 Use globe, DRVs, ball or butterfly valves for throttling service.

3.10 Pressure Testing, Flushing and Balancing

- .1 Pressure test, flush and balance water systems to specification section 22 05 01.

3.11 Post-Weld Pickling (descaling)

- .1 The following post-weld pickling (descaling) procedure may be omitted when approved by the Consultant where all of the following conditions are met:
 - .1 a written welding procedure and test plan is provided for review by the Consultant prior to any welding work, which demonstrates the control measures used to control the formation of chromium carbide scale in the heat affected zone of the interior surface of the pipe in accordance with the specified acceptance criteria,
 - .2 ensure proper use of backing (internal purging) gas and type of gas,
 - .3 orbital automatic TIG welding is used for butt-weld joints,
 - .4 three (3) welding samples of NPS 2 (tube), NPS 4 and NPS 6 are supplied to the Consultant prior to production welding as follows:
 - (a) a complete butt-weld using automatic orbital TIG welding, with each sample split lengthwise to expose the interior weld surface for examination,
 - (b) one (1) example for an integrally reinforced welding outlet fitting, using hand TIG welding, with interior surface exposed for examination, and
 - (c) the interior HAZ heat tint is not greater than the No. 4 sample colour in accordance with AWS D18.2,
 - .5 the Consultant may request up to three (3) production weld samples to be removed from the piping system, and the samples cut-open for visual examination,
 - .6 a completed and signed report is submitted for review by the Consultant at the completion of welding for each piping or tubing system, prior to flushing and cleaning of the piping/tubing. The report shall include compliance log of each weld to the weld specification including use of automatic welding and inert backing gas.
- .2 Pickling of piping systems only applies to welded piping or tubing systems.

- .3 After flushing and cleaning, provide the services of a specialist pipe cleaning company to chemically pickle the stainless-steel piping and tubing in accordance with ASTM A380, to remove weld heat tint (descaling) where welding of joints is used.
- .4 Provide test sample pipe welds of the type and size when requested by the specialist pipe cleaning company. The specialist company shall evaluate and determine the appropriate pickling method. The acceptance criteria is to achieve colour No. 4 in accordance with AWS D18.2.
- .5 Chemically pickle inside of piping and tubing to remove weld heat tint;
 - .1 perform pickling operations after pressure testing is completed, and before making connections to plumbing fixtures,
 - .2 provide temporary cross connections to bypass equipment,
 - .3 temporarily remove flexible connections at pumps and install stainless-steel spool pieces. Reinstall flexible connections after completion of pickling program,
 - .4 provide temporary recirculation piping as required,
 - .5 bypass piping material: stainless-steel 304, threaded, flanged, or welded. Hoses as recommended by the chemical cleaning company may be used,
 - .6 provide temporary circulating pumps and power supplies.
- .6 Cross-connecting domestic cold water, domestic hot water and domestic recirculating water piping/tubing systems to permit circulation of the pickling solution is permitted under the following conditions:
 - .1 temporarily remove any check valves in the distribution path,
 - .2 where a temporary branch connection is required, provide an isolation valve and arrange the branch/valve as a system drain,
 - .3 distribution piping may be sub-divided into sections and cleaned separately, provided the interconnection between sections is by means of flanges,
 - .4 where stainless-steel tubing is used to connect to plumbing fixtures, provide a temporary hose to cross-connect the hot and cold-water supplies,
 - .5 mark each temporary cross-connection with a high-visibility orange marker or tag,
 - .6 maintain a record log of all temporary cross-connections, indicating location of each connection, date of removal, and signed by the person checking their removal.
- .7 Continuously circulate pickling solution and periodically check concentration levels. Temporarily remove the spool test piece to permit visual inspection of the flange and butt welds. Continue to clean pipe until the acceptance criteria is achieved.
- .8 At completion of pickling, drain down and dispose of liquid solution as contaminated waste.
- .9 Prepare and submit a report from the specialist cleaning company at completion of pickling and passivation treatments, which details the results of the test. Include photographs of interior surface finishes at accessible butt-weld joints.

3.12 Passivation

- .1 After pickling of the piping or tubing system is completed (when required), passivate the inside of piping and tubing with nitric acid to ASTM A380.
 - .1 Passivation may form part of the pickling process, or may be post-pickling.
 - .2 For clarity, passivation is only required where circulation of a pickling solution is required.
- .2 At completion of passivation, drain down and dispose of passivation chemical as contaminated waste.

3.13 Final Flush

- .1 After pickling and passivation is completed (when required) and treatment solution has been drained, refill the system with municipal water and flush to drain until water pH level at 3% of randomly selected fixtures is within 0.5 pH of the incoming water supply value.
- .2 If the domestic water piping/tubing system will not be turned over to the owner within one month after final flush, drain down the piping or tubing system and leave it empty until just prior to handover to the owner, at which time refill the system. Alternatively, set-up and document a periodic flushing regime where each plumbing fixture is flushed for 30 seconds once a week.

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 61 Drinking Water System Components – Health Effects
 - .13 NSF/ANSI 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 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]

2.2 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.

2.3 Back-flow Preventers - Reduced Pressure Principle (“RP”)

- .1 Listed to CSA B.64.4.
- .2 Type: two independent check valves with intermediate relief valve and drain port,
- .3 NPS ½ to 2:
 - .1 quarter turn full port resilient seated ball valves on inlet and discharge connections,
 - .2 bronze inlet strainer,
 - .3 four (4) ball-valve test cocks,
 - .4 air gap drain,
 - .5 lead free and listed to NSF/ANSI 61/G or 372.
 - .6 required MCPR: 1200 kPa (175 psi) at 82°C (180°F).

Standard of Acceptance

- Watts - fig. LF909QT
- Apollo - fig. RPLF4A

- .4 NPS 2 to 10:
 - .1 butterfly or OS&Y resilient seated gate valves on inlet and discharge connections,
 - .2 four (4) ball-valve test cocks,
 - .3 air gap drain body,
 - .4 lead free and listed to NSF/ANSI 61/G or 372,

- .5 required MCPR: 1200 kPa (175 psi) at 60°C (140°F).

Standard of Acceptance

- Watts - fig. LF909-OSY
- Apollo - fig. RPDA40
- Cla-val Company - fig. RP-1EX

2.4 Back-flow Preventers – Double Check Valve Assemblies (“DCVA”)

- .1 Listed to CSA B64.5.
- .2 Type: double check valve backflow preventers, with two positive seating spring-loaded check valves.
- .3 NPS ½ to 2:
- .1 bronze body, replaceable seats and seat discs,
 - .2 quarter turn full port resilient seated ball valves on inlet and discharge connections,
 - .3 bronze inlet strainer,
 - .4 four (4) ball-valve test cocks,
 - .5 lead free and listed to NSF/ANSI 61/G or 372,
 - .6 required MCPR: 1200 kPa (175 psi) at 82°C (180°F).

Standard of Acceptance

- Watts - fig. LF007QT series
- Apollo - fig. DCLF4A series
-

- .4 NPS 2-1/2 to NPS 10:
- .1 T304 stainless steel body and stainless steel, bronze and EPDM trim,
 - .2 OS&Y resilient seated gate valves, or butterfly valves on inlet and discharge connections,
 - .3 four (4) ball-valve test cocks,
 - .4 lead free and listed to NSF/ANSI 61/G or 372,
 - .5 required MCPR: 1200 kPa (175 psi) at 60°C (140°F).

Standard of Acceptance

- Watts - fig. LF757, LF757N
- Apollo - fig. DCLF4A series (NPS 2-1/2 to 8 only).

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 Pressure Reducing Valves

- .1 Bronze body, self-contained type, single renewable nickel alloy seat and resilient disc.
- .2 Diaphragm suitable for 90°C (200°F) service.
- .3 Close coupled bronze strainer with stainless steel screen.
- .4 Required MCPR: 2060 kPa (300 psi) at 49°C (120°F).
- .5 Flow rates and pressure reduction: as shown on drawings.
- .6 Lead free and listed to NSF/ANSI 61/G or 372.

Standard of Acceptance

- Watts
- Cash Acme Valve
- Singer Valve
- Leslie
- Victaulic Bermad

2.7 Pressure Relief Valves

- .1 Brass body to ASME Section IV.
- .2 Preset pressure settings: 515, 700, 860 and 1030 kPa (75, 100, 125 and 150 psi).
- .3 Lead free and listed to NSF/ANSI 61/G or 372.

Standard of Acceptance

- Watts - fig. LF3L

2.8 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 lead free and listed to NSF/ANSI 61/G or 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 (1/8 in) diameter perforations,
- .3 required MCPR: 1370 kPa (200 psi) at 66°C (150°F),
- .4 lead free and listed to NSF/ANSI 61/G or 372.

Standard of Acceptance

- Watts - fig. LF98FB-CIB

2.9 Expansion Tanks

.1 Diaphragm style:

- .1 carbon steel body, butyl diaphragm, airside factory pre-charged to 80 kPa (12 psi), and stainless steel NPT pipe connections,
- .2 required MCPR: 1000 kPa (150 psig) at 93°C (200°F)
- .3 tank volume: 8, 17, 32 and 53 litres, as shown.
- .4 lead free and listed to NSF/ANSI 61/G or 372.

Standard of Acceptance

- Watts - fig. PLT series

3 EXECUTION

3.1 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.

3.2 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.

3.3 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.

3.4 Additional Requirements for Reduced Pressure Backflow Preventers

- .1 For reduced pressure type (RP) backflow preventers, install an inline spring-loaded disc or ball type check valve with threaded ends, within 300 mm (12 in.) of the inlet connection to the RP backflow preventer. Provide a pipe union on the upstream side of this check valve.

3.5 Pressure-Reducing Valves

- .1 Install pressure-reducing valves ("PRV") with upstream and downstream shut-off valve and unions, and provide a 115 mm (4½ in) pressure gauge immediately downstream of the PRV.
- .2 For high-flow/low-flow parallel PRV arrangements, install the high-flow valve in the pipe main run and the low-flow valve in the offset run. Set the low-flow PRV setpoint to be 35 to 70 kPa (5 to 10 psi) greater than the high-flow PRV setpoint.

3.6 Pressure Relief Valves

- .1 Provide pressure relief valves as follows:
 - .1 after each pressure reducing valve,

- .2 after each backflow preventer, and
 - .3 where shown on drawings.
- .2 Select relief valve setpoint to be not more than the design pressure of the piping system.

3.7 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.

3.8 Expansion Tank

- .1 Provide expansion tanks as follows:
 - .1 at each set of domestic hot water tanks or heaters,
 - .2 where shown on drawings.
- .2 Select tank volume size in accordance with Schedule A at the end of this section.
- .3 Install tank on cold water line immediately before the connection to the domestic hot water tank or heater.
- .4 Provide lockshield shut-off valve and pressure gauge on water line to expansion tank. Place a nylon tie-wrap through the lockshield to secure the valve in the open position.
- .5 Check and adjust pressure charge in accordance with manufacturer's instructions.
 - .1 Set minimum pressure on tank before domestic hot water piping is warmed up.
 - .2 Where the expansion tank is located other than the top of the building, increase the factory pre-set pressure charge by 10 kPa per 1 meter (1.3 psi per 3 feet) of riser height above the tank, before filling the water piping system with water.

3.9 Equipment Schedules

- .1 The following appended equipment schedules form part of this specification section.
 - .1 Schedule A Expansion Tanks

Schedule A – Expansion Tanks			
Equipment Tag	Location Reference	Expansion Tank Volume Litres	No of Individual Tanks Required
T-			
T-			

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 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.

2.3 PVC DWV Pipe and Fittings

.1 Application:

.1 Restricted to fixture drain piping and partial vent pipe for urinals.

.2 Pipe and fittings:

.1 PVC pipe and fittings 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 -"System XFR 15-50"

.3 Joint cement:

.1 one-step CSA listed cement for pipe sizes NPS 1½ to NPS 6.

.2 IPS primer Type P-70 and Heavy Bodied IPS Cement Type 711 for pipe sizes larger than NPS 6.

.3 Volatile Organic Content: maximum 510 g/L.

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

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 anti-aerosolizing outlets (laminar flow) that do not retain air.
- .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 Hand Hygiene Sink "HHS-1" (foot pedal)

- .1 Basin: White solid surface hand hygiene sink with removable shroud. 1 1/2" (DN 40) grid waste, left rear location, faucet anti-splash feature through middle of sink, bowl sloped towards drain. Overall (FB x LR x H) 16 15/16" [430mm] x 20 3/16" [512mm] x 21 1/4" [540mm]. Wall hung basin, no overflow, single hole, drilled for concealed arm carrier, fixture to include removable shroud.

Standard of Acceptance

- Franke Nightingale AHWSS1720W-OO
- .2 Faucet: Deck mounted faucet, gooseneck, 4.5" spout reach, rigid with swivel option selectable during installation, non-aerating, laminar flow outlet, vandal proof. Faucet c/w hot and cold water floor mounted pedal box with self close pedals, chrome plated finish

Standard of Acceptance

- Delta 54T5437A
- .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
- Franke IWC2203

2.3 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 on 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)

Fixture Type	Mounting Height Reference (above finished floor)	Mounting Height Mm (inch)	
		Barrier-Free	All Other
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]
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.

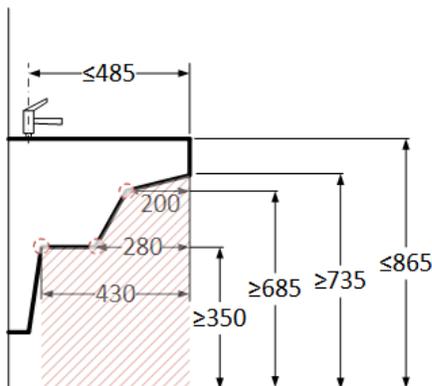


Figure 1: Barrier-Free Lavatory Clearances

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
Faucets	Healthcare, Long-Term Care, Retirement Homes	43°C (109°F)
	Other Occupancies	49°C (120°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.

END OF SECTION

MEDICAL GAS PIPING 22 60 13.70

1 GENERAL

1.1 Scope

- .1 Provide medical gas piping distribution systems including:
 - .1 piping, fittings, and valves,
 - .2 medical gas control panels,
 - .3 emergency oxygen inlet stations,
 - .4 line pressure regulators and safety valves,
 - .5 terminal units, including terminal units to be installed in Medical Supply Units, headwall units and ceiling mounted service columns.
 - .6 pipe hangers and accessories,
- .2 Applicable systems:
 - .1 Medical pressure gases intended for patient care:
 - (a) oxygen USP,
 - .2 Medical vacuum.
- .3 Refer to specification section 22 63 26.70 for zone valve stations and combination zone valve/zone alarm panels.

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 02 Qualifications and Authorities
 - .2 20 05 24 Welding and Brazing
 - .3 20 05 25 Excavation and Backfilling
 - .4 20 05 29 Common Hanger and Support Requirements for Piping
 - .5 22 63 26.70 Medical Gas Control Equipment

1.3 Definitions

- .1 The following definitions apply to this section and referenced 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 **Master alarm:** has the same meaning as “supply system alarm” in CSA Z7396.1.
 - .4 **Medical gas:** means all services within the scope of CAN/CSA-Z7396.1.
 - .5 **Medical pressure gas:** means only those medical gases which operated under positive pressure.
 - .6 **Medical supply units:** means those medical devices which supply medical gases within the scope of CSA Z305.8.

- .7 **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.
- .8 **Qualified installer:** a competent person or company responsible for the installation of medical gas pipeline systems or components within a medical gas system.
- .9 **Service units:** includes headwall units, ceiling-mounted service columns, ceiling-mounted articulating arms, patient service strips and medical supply units.
- .10 **Terminal unit:** an outlet assembly for medical gases in a medical gas pipeline system at which the operator makes connections and disconnections.
- .11 **USP:** United States Pharmacopeia.
- .12 **USP-NF:** USP National Formulary
- .13 **Zone, zone alarm, and zone valve:** have the same meaning as defined in 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 Z7396.1-17 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 to be performed by qualified, licensed and recognized firm with an established reputation in this field, using tradespersons holding applicable certificates of competency for pressure piping and brazing work.
- .2 In addition, medical gas systems shall be installed by a specialist firm that: has experienced in this type of work; is knowledgeable of the applicable regulations, installation codes and standards; has registered procedures for silver brazing; and regularly employs tradespersons qualified in pressure piping installation. Before commencing work on site, supply copies of tradespersons certificates of competency for brazing to the Owner for their records.
- .3 In addition, tradespersons performing work on medical gas systems shall be certified in accordance with *CSA Medical Gas Piping & Systems Installation Personnel Certification Program*. Prior to commencing work on site, supply copies of certification record to the Owner for each qualified tradesperson working performing work on the medical gas system.

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.

1.7 Design Criteria – Medical Gas and Vacuum Piping

- .1 Piping design and installation code:
 - .1 to ASME B31.3.
- .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)
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 tubing,

- .2 valves,
- .3 terminal units,
- .4 line pressure regulators, safety valves and assemblies,
- .5 emergency gas inlet connections.

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 shall be responsible to commission 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 Where specified as to be cleaned for oxygen service, material shall be cleaned in accordance with CGA G-4.1 or CAN/CSA Z15001, sealed in a plastic bag, labelled to state that the product has been so cleaned, 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 ASEM 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 the medical gasses.
 - .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 for medical gases, medical vacuum and AGSS.
 - .2 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.
 - .3 required MCPR: 4100 kPa (600 psig) at 38°C (100°F).
 - .4 lever handle with locking device.
 - .5 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.
 - .6 cleaned for oxygen service and with tube ends capped.

Standard of Acceptance

- Amico - fig. VV-ISO-G2L series
- Class I - fig. 7300 series
- BeaconMadaes - 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 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 Line Pressure Gauges

- .1 For source and distribution piping, not including zone valves.
- .2 To ASME B40.100 Grade 2A, direct pressure measurement, Ø115 mm (4½ in) dial type, silicone-free dampening, bronze tube, black solid front case, blow-out back, 0.5% full scale accuracy, adjustable pointer.
- .3 Measurement units and ranges:
 - .1 Gases: dual units kPa/psi;
 - (a) 0 to 700 kPa / 0 to 100 psig for all gases except Nitrogen, and Instrument Air,
 - (b) 0 to 2000 kPa / 0 to 300 psi for Nitrogen and Instrument Air,
 - .2 Vacuum: dual units kPa/in.Hg;
 - (a) -100 to 0 kPa / 30 in.Hg. to 0 for Medical Vacuum and AGSS.
- .4 Cleaned for oxygen service.

Standard of Acceptance

- Trerice - 450B

.5 Accessories:

- .1 pressure snubbers:
 - (a) brass construction, NPT threaded ends.
 - (b) cleaned for oxygen service.

Standard of Acceptance

- Terice – 872-1

- .2 needle valves:
 - (a) rising stem, brass or T316 stainless steel construction, NPT threaded ends.
 - (b) cleaned for oxygen service.

Standard of Acceptance

- Terice - 735 / 740

2.10 Medical Gas Control Panels

- .1 Recessed, wall mounted in 1.3 mm (18 ga) painted steel back box with supports to secure unit within wall or partition and anodized aluminum fascia,
- .2 Anodized aluminum front cover, with panel covered gas pressure regulation controls:
 - .1 inlet pressure gauge: 0-2000 kPa (0-300 psig) mounted ahead of shut-off valve,
 - .2 shut-off valve: integral 2000 kPa (300 psi) quarter-turn valve valve,
 - .3 pressure regulator: self-actuated, adjustable from 0 to 1700 kPa (0 to 250 psi)
 - .4 outlet pressure gauge: 0-2000 kPa (0-300 psig) mounted ahead of shut-off valve,
 - .5 DISS check body, of type to suit medical gas service.
- .3 Internal tubing: NPS 3/8 type K copper to ASTM B819, with inlet and outlet extension risers.
- .4 Maximum pressure rating: 1700 kPa (250 psi).
- .5 Cleaned for oxygen service and with tube ends capped.

Standard of Acceptance

- Amico - fig. Alert-1 Gas Control Panel
- Class 1 - fig. NCP/IP/CCP

2.11 Line Pressure Regulator Valves

- .1 Forged brass body and housing cap, large diaphragm for high flow applications, and adjustable loading handle.
- .2 Internal materials suitable for each applicable medical gas and conforming to CAN/CSA Z10524-2.
- .3 Pressure ratings:
 - .1 valve maximum inlet gas pressure rating: 2400 kPa (250 psi).
 - .2 operating nominal inlet (intermediate) pressures:
 - (a) Oxygen, Medical Air, and Nitrous Oxide: 700 kPa (100 psi)
 - (b) Nitrogen and Instrument Air: 2000 kPa (300 psi)
 - (c) Carbon Dioxide: 850 kPa (120 psi)
- .4 Cleaned for oxygen service.
- .5 Accessories:
 - .1 Ø65 mm (2-1/2 in.dia.) pressure gauge measuring outlet pressure.

Standard of Acceptance

- Amico
- Class 1
- BeaconMadaes

2.12 Pressure Safety Valves

- .1 Bronze body, re-seatable, spring loaded type, with brass or bronze trim, with NPT connections.
- .2 Relief flow rating: full flow of all connected upstream sources.
- .3 Relieving setpoint:
 - (a) Oxygen, Medical Air, and Nitrous Oxide: 514 kPa (75 psi)
 - (b) Nitrogen and Instrument Air: 1380 kPa (200 psi)
 - (c) Carbon Dioxide: 720 kPa (105 psi)
- .4 ASME Section VIII, UV code stamped.
- .5 Cleaned for oxygen service.

Standard of Acceptance

- Amico
- Class 1
- BeaconMadaes

2.13 Dual Line Pressure Regulator Station

- .1 Factory assembled line pressure regulation station with dual line pressure regulators, dual pressure relief valves, one (1) inlet pressure gauge and two (2) outlet pressure gauges, downstream test ports, and ball valves to isolate each regulator/relief valve assembly.
- .2 Silver brazed joints except at equipment connections.
- .3 Line pressure regulator valves:
 - .1 construction: as specified herein,
 - .2 number of valves: two, and each sized for full design flow.
 - .3 outlet pressure at a flow rate of 57 SCMH (2000 SCFH):
 - (a) in accordance with CSA Z7396.1.
 - (b) with pressure variation less than 15 kPa (2 psi) from full flow at required outlet pressure.
- .4 Safety valves:
 - .1 construction: as specified herein,
 - .2 number of valves: two, and each sized for full design flow.
 - .3 each safety valve installed to protect its associated line pressure regulating valve and with no intervening valve between them.
- .5 Isolation valves: two piece union-style bronze body, quarter turn, NPT threaded ends.
- .6 CRN to CSA B51 as an assembly or as individual components.
- .7 Cleaned for oxygen service.

Standard of Acceptance

- Amico - fig. M-DLRS-CSA-05 / -05HP
- Class 1 - fig. DSA-500 series

- BeaconMadaes - fig. DLRA500, with second relief valve.

2.14 Emergency Oxygen Inlet Station

- .1 Cabinet:
 - .1 stainless steel enclosure, weatherproof design conforming to NEMA 4, with hinged lockable front panel door, for recessed mounting.
 - .2 door exterior label: **"EMERGENCY LOW PRESSURE GASEOUS OXYGEN INLET"**
 - .3 operating instruction label posted on inside face of door.
- .2 Factory piping and components:
 - .1 pipe/tube size: NPS 1 unless otherwise shown on drawings.
 - .2 type K piping as specified herein with brazed joints.
 - .3 inlet connection, with NPT ends and plug.
 - .4 ball valve as specified herein with 1/8" FNPT port downstream of piping.
 - .5 Ø65mm (2-1/2 in. dia.) brass body pressure gauge, 0 to 700 kPa / 0-100 psi dual scale reading, labelled and colour coded for Oxygen. Pressure gauge located downstream of the ball valve.
- .3 Field installed accessories:
 - .1 line sized check valve of type as specified herein.
 - .2 ASME code rated pressure relief valve, with setpoint of 515 kPa (75 psi).
- .4 CRN to CSA B51 as an assembly or as individual components.
- .5 Cleaned for oxygen service.

Standard of Acceptance

- Amico - fig. M-FILL-OXY-LP
- Class 1 - fig. XM series
- BeaconMadaes - fig. EOSC

2.15 Medical Gas 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 type with serviceable primary check valve.

- .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 medical gas 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 consoles,
 - (d) recess mount for ceilings,
 - (e) recess mount for suspended service columns,
 - (f) recess mount for installation in medical supply units,
 - (g) non-ferrous material compatible for installation in MRI 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

2.16 Medical Gas 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, 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 Where fittings other than valves, pressure regulators, safety valves or terminal units are not supplied to site as "cleaned for oxygen service", they shall be cleaned on site in accordance with CGA G-4.1 as follows:
 - .1 Prepare a written site cleaning report, which describes:
 - (a) the cleaning method,
 - (b) the fittings and equipment which are subject to the field cleaning,
 - (c) the name and signature of the person supervising the field cleaning.
 - .2 Wash the part before installation with hot solution of trisodium phosphate in water 500 g in 12.5 litres (1 lb in 2.5 gal),
 - .3 Scrub inside of parts, and fittings with cleaning solution and agitate parts and fittings in bath of cleaning solution.
 - .4 Thoroughly rinse in fresh clean water and blow dry with nitrogen.
 - .5 Inspection: use the white light and UV light test method described in CGA-4.1 on a 5% random sampling basis where the number of fittings of one type exceeds 20 units, and inspect all units of a fitting type which numbers less than 20.
- .3 Keep cutting and reaming tools scrupulously clean and free from oil or grease.
- .4 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 service valves other than those located in zone valve boxes, provide common-keyed padlocks on each service valve, not including zone valves. 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 Line Pressure Regulator Stations

- .1 Provide line pressure regulator stations where not otherwise provided as part of packaged source equipment or manifold control stations.
- .2 Install line pressure regulator stations at a nominal height of 1500 mm (5 ft) above the floor, arranged so that the pressure gauges and regulator adjustment handles are readily visible and accessible.
- .3 Set the line pressure regulator setpoints as follows:

Regulator	Line Pressure Regulator Setpoints
	kPa (psi) gauge
	Oxygen
Primary regulator	360 (52)
Secondary regulator	260 (38)

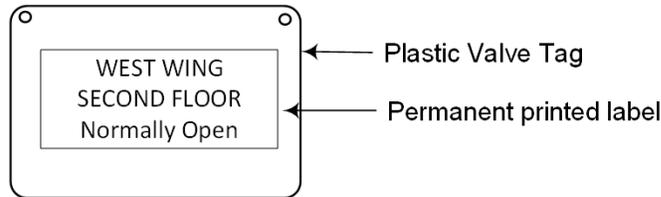
3.7 Safety Valves

- .1 Install safety valve vent piping in copper tube with brazed joints.
- .2 Pipe safety valves discharge piping for all medical pressure 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

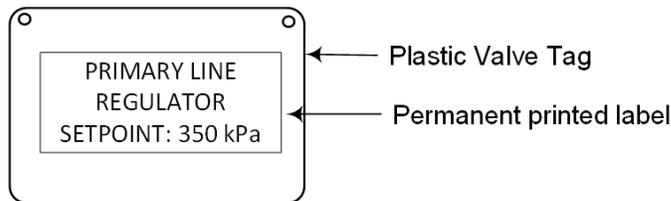
3.8 Identification

- .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.



3.9 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.

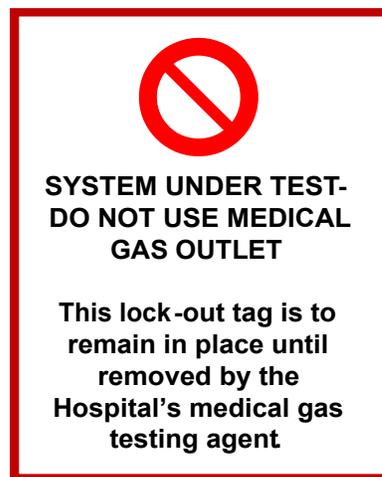
3.10 Terminal Units for Installation in Service Units

- .1 Service units are provided under Division 11 and/or Division 26 and include:
 - .1 internal medical gas piping using copper tubing or flexible hose as applicable to the equipment,
 - .2 installation of terminal units.
- .2 Supply medical gas terminal units to the vendor supplying the service units for factory installation in the service units.
- .3 Coordinate with the Division providing the service units including:
 - .1 scheduling delivery of medical gas terminal units to the service units vendor(s) manufacturing facility.
- .4 Make connections of medical gas piping to headwall units and / or patient service strips to the capped tube connections provided with the Service Units.
- .5 Make connections of medical gas piping to ceiling service columns, ceiling articulating arms and / or medical supply units as follows:
 - .1 provide a service ball valve in the ceiling immediately adjacent to the Service Unit for each medical gas,
 - .2 provide a DISS body without check valve and mount it on the Service Unit mounting plate unless it has been confirmed by the Contractor that the DISS body without check valve has been provided as part of the supply unit.

- .6 Witness the final testing of the installed service units and assist the certification agency as necessary. The responsibility for medical gas piping inside the service unit including pressure testing remains with the service unit vendor.
- .7 Refer to architectural and/or electrical design documents for locations of service units and quantity of terminal units required.

3.11 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 hospital's 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 medical gas 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 Service Units (as applicable) and install test caps on medical vacuum and AGSS DISS outlets,
 - (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 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 Service Units (as applicable) and install test caps on medical vacuum and AGSS DISS outlets,
 - (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 pressure 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 Service Units (as applicable) disconnected and keep test caps on medical vacuum and AGSS DISS outlets,
 - (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 pressure 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 hoses inside of Supply Units (if applicable) and purge the medical gas piping systems. 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 pressure 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 herein 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 Service Units (as applicable) and install test caps on medical vacuum and AGSS DISS outlets.
- .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 medical gas.
 - (a) Label each gauge with the applicable medical gas 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 medical gas 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 Supply Units:
- .1 After completion and acceptance of the main cross-contamination test (including correction of any cross-connection defects), reconnect the internal hoses in the Supply Units (as applicable) and perform a final pressure test and cross-contamination test of the 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 Service 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 Supply Unit.
 - .3 After completion of the Supply Unit pressure test, individually test each medical gas service to the Service Units, with only the one medical gas pipeline 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.

3.12 Contractor Responsibilities During Certification Testing

- .1 Medical gas 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 Master alarm system 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 Medical gas installation contractor shall provide qualified representative who are knowledgeable in medical gas 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 medical gas system 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 medical gas 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 distribution piping with applicable medical gases sufficiently to remove the test gases. Purge airflow through each terminal unit.
- .6 Assist the inspection body in any subsequent retesting.

3.13 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.

3.14 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.

3.15 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 copies of each brazer's certificate of competency (license) who performed all or part of the work,
 - .4 copies of each tradesperson's certificate issued under the *CSA Medical Gas Piping & Systems Installation Personnel Certification Program*,
 - .5 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),
 - .6 in-process examination records of brazed joints,
 - .7 pressure test reports,
 - .8 particulate matter test report,
 - .9 cross-contamination test records,
 - .10 operating and maintenance manuals which
 - .11 filled out, signed and dated commissioning test plant reports,
 - .12 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)

*Medical gas pipeline systems — Part 1: Pipelines for medical gases,
 medical vacuum, medical support gases, and anaesthetic gas
 scavenging systems*

Z7396.1-17

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 Clause 11.4.1.4.)

SAMPLE

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.

Issued For Tender

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

MEDICAL GAS CONTROL EQUIPMENT 22 63 26.70

1 GENERAL

1.1 Scope

- .1 Provide medical gas system controls including:
 - .1 supply system alarm panels,
 - .2 zone alarm panels,
 - .3 zone valve stations,
 - .4 instrumentation and accessories.
- .2 Applicable systems: refer to specification section 23 63 13.70
- .3 Comply with the requirements of Part 1-General of specification section 22 60 13.70 except/and as required herein.

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 Seismic Restraint
 - .3 22 60 13.70 Medical Gas Piping

1.3 Applicable Codes and Standards

- .1 Product standards:
 - .1 CSA C22.2 No. 92.1 Enclosures for Electrical Equipment, Non-Environmental Considerations
 - .2 CSA C22.2 No. 205 Signaling Equipment
 - .3 CAN/CSA C22.2 No. 60601.1 Medical Electrical Equipment – Part 1: General Requirements for Basic Safety and Essential Performance

1.4 Seismic Qualification

- .1 Seismically qualify (certify) control panels for medical gas systems to remain operational after being subjected to the design seismic forces assuming a building height factor (NBCC) $A_x = 3.0$ with equipment rigidly mounted, by the shaker table method in accordance with Specification section 20 05 49.

1.5 Submittals

- .1 Submit manufacturer catalogue cut-sheets for the materials specified herein.
- .2 Submit shop drawings for;
 - .1 alarm wiring which are project specific.

2 PRODUCTS

2.1 General Requirements for Medical Gas Alarm Panels

- .1 General:

- .1 Common requirements for supply system alarm panels and zone alarm panels.
- .2 Listed to CSA C22.2 No. 205.
- .3 Conforms to CSA Z7396.1
- .2 Cabinet:
 - .1 Tamper-proof, painted, steel back box, for [recessed][surface] mounting with a maximum wall cavity depth of 105 mm (4 in.) from wall finish surface, and removable openings for gas piping and electrical connection.
 - .2 Tamper-proof, painted, hinged front panel, with front mounted display of gas information.
 - .3 Internal power transformers with overcurrent protection.
 - .4 Power supply: 120 VAC, 60 Hz.
- .3 Alarm display unit:
 - .1 Microprocessor based controller:
 - (a) Either:
 - i) one (1) 250 mm (10 in.) colour TFT LCD display for graphical and text display for all gases/vacuum, or
 - ii) multiple TFT colour LCD touchscreen displays for individual gases;
 - (b) virtual graphical display indicating gas pressure status, with continuous green-normal and continuous red-alarm display,
 - (c) LED indicators and controls for alarm silence,
 - (d) built-in web server for remote access to view alarm web page and data,
 - (e) web-page configurable to allow linking to other zone alarm web pages,
 - (f) alarm notification via email or text message through any SMTP gateway,
 - (g) graphical display of alarm panel to mobile devices via WIFI or cellular network.
 - (h) gas specific colour identification in accordance with CSA Z7396.1
 - .2 Programmable and operating functions:
 - (a) high and low gas pressure alarms for medical gases,
 - (b) low pressure alarm for medical vacuum and AGSS,
 - (c) configurable repeat alarm horn time delay,
 - (d) alarm history recall,
 - (e) transient signal detection and display,
 - (f) alarm history recall,
 - (g) self-test diagnostic function to test status indicators and alarm horn,
 - .3 System initiates an alarm if there is an open or shorted sensor circuit, or a sensor input is not connected.
 - .4 Alarm horn sound level: 70 dBA at 2 m (6.5 ft.).

2.2 Local Zone Alarm Panels

- .1 General:
 - .1 Complies with the general requirements for alarm panels specified above.
 - .2 Local alarm panels to monitor zone pipeline pressures for applicable medical gases.

- .3 Graphic interface to display zone or room identification, and which cannot be altered except by authorized personnel. Alternatively, cabinet door to be provided with a permanent, mechanically printed label which defines the zone being monitored/controlled, and which cannot be removed or altered from outside of the cabinet.
- .4 Display measured gas pressure/vacuum values, with selectable pressure units – kPa, psi, or in.Hg.
- .5 Custom alarm response instructions for each gas.
- .6 Capable of monitoring a minimum of eight (8) of the following gases or vacuum. Actual number and type of monitored gases or vacuum as shown on drawings:
 - (a) Oxygen,
 - (b) Nitrous Oxide,
 - (c) Nitrogen
 - (d) Instrument air
 - (e) Medical air
 - (f) Medical vacuum,
 - (g) Carbon dioxide, and
 - (h) Helium
 - (i) Anaesthetic Gas Scavenging System (AGSS)

Standard of Acceptance

- Amico - Alert-4 series
- BeaconMedaes - TotalAlert Infinity
- Tri-Tech - Med Touch Area Alarm Panel

- .2 Pressure transducers:
 - .1 Pressure transducers as specified below.
 - .2 Panel mounted with gas specific pressure transducer with DISS nut and nipple, or provided with zone valve stations.
 - .3 Minimum NPS 3/8 type K copper tube riser for each gas transducer, with matching gas specific DISS check body,
 - .4 Cleaned for oxygen service.

2.3 Zone Valves

- .1 Cabinet:
 - .1 Conform to CSA Z7396.1.
 - .2 Tamper-proof, painted steel back box, for recessed mounting with a maximum wall cavity depth measured from the finished wall opening surface of:
 - (a) 105 mm (4 in.) for valves NPS 2 and smaller,
 - (b) 170 mm (6.75 in.) for valves NPS 2-1/2 to NPS 3.
 - .3 Sliding, opaque door with pull-ring, and clear gauge window. Door designed so that in an emergency the door is pulled outwards and free of the cabinet to access the valves.
 - .4 Gas/vacuum services capacity: up to 7 separate gas valves.
 - .5 Pressure indicating gauge:
 - (a) dial indicating gauge, reading kPa and psi units, with normal operating pressure in the middle third of the gauge scale,

(b) mounted on the downstream side of zone valve.

.6 Labeling:

(a) gas/vacuum flow direction marked on piping inside of cabinet,

(b) provide labelling on panel cover in accordance with CSA Z7396.1 in both English and French.

.2 Valves:

.1 To specification section 22 60 13.70.

.2 Arranged to prevent closing of the valve box cover/door when the valve is in the closed position.

.3 Pressure transducers:

.1 Pressure transducers as specified herein.

.2 Factory installed, and located on downstream side of zone valve.

.3 Pre-wired to terminal strip(s) where field wiring to a remote zone alarm panel is required.

Standard of Acceptance

- Amico
- Class 1
- BeaconMedaes

2.4 Combination Zone Valves with Zone Alarm Panel

.1 Combination zone valves and alarm panels may be used where they comply with the following:

.1 Conforms to CSA Z7396.1.

.2 Zone valve box as specified herein, including both pressure gauge and digital zone alarm pressure display unit.

.3 Zone alarm functions as specified above except use microprocessor based, modular LED numeric pressure display with LED indicator lights for pressure normal and alarm status.

.4 Gas/vacuum services capacity: up to 7 separate gas valves.

.5 Internally mounted pressure transducer with DISS nut and nipple connection downstream of each zone valve.

Standard of Acceptance

- Amico - Combo Unit series
- Class 1 - CZVA series

2.5 Gas Pressure and Vacuum Transducers

.1 Construction:

.1 stainless steel wetted parts and pressure housing,

.2 automatic gas-specific detection feature,

.3 4-20 mA, 2 wire loop powered,

.4 gas/vacuum specific pressure sensors with DISS nut and nipple,

.5 integral interference barrier for increased RFI/EMI protection,

.6 CRN to CSA B51.

.7 CSA listed and suitable for remote installation or installation inside of alarm panels.

- .8 cleaned for oxygen service,
- .9 operating pressure range:
 - (a) Low pressure: 0 to 680 kPa (0-100 psig) for oxygen, medical air, nitrous oxide, carbon dioxide.
 - (b) Medium pressure: 0 to 1700 kPa (0-250 psi) for instrument air and nitrogen.
 - (c) Vacuum: 0 to 98 kPa (0-29 in.Hg) for medical vacuum and AGSS.

2.6 Gas Pressure and Vacuum Switches

- .1 Functions:
 - .1 Dual setting High and Low pressure switches with pressure gauge, for low pressure service for oxygen, medical air and nitrous oxide only.
 - .2 Single setting High or Low pressure switch without gauge, for medium pressure service for any medical gas.
 - .3 Single setting Low pressure switch without gauge, for high pressure manifold for “reserve in use” alarm.
 - .4 Single setting Low vacuum switch with vacuum gauge, for medical vacuum and AGSS.
- .2 Construction:
 - .1 switch type: SPDT (Form C) dry contact, 5 A at 120 VAC.
 - .2 listed to CSA C22.2 No. 14 for non-hazardous environments.
 - .3 CRN to CSA B51.
 - .4 enclosure: CSA C22.2 No. 92.1, Type 4.
 - (a) enclosure provides wiring termination access, or unit is provided with 20 mm (3/4 in.) NPT conduit connection for mounting on standard electrical junction box.
 - .5 switch suitable for remote installation or installation inside of alarm panels.
 - .6 Low Pressure gases:
 - (a) pressure rating: 860 kPa (120 psi),
 - (b) adjustment range: 3.5 to 550 kPa (0.5 to 80 psig)
 - (c) low alarm setpoint: 275 kPa (40 psig) factory set
 - (d) high alarm setpoint: 410 kPa (60 psig) factory set
 - .7 Medium Pressure gases:
 - (a) pressure rating: 1720 kPa (250 psi),
 - (b) adjustment range: 70 to 1720 kPa (10 to 250 psig)
 - (c) low alarm setpoint: field adjusted to suit specific medical gas
 - (d) high alarm setpoint: field adjusted to suit specific medical gas
 - .8 High Pressure gas manifold:
 - (a) pressure rating: 22 MPa (3200 psi)
 - (b) adjustment range: 1.1 to 22 MPa (160 to 3200 psig)
 - (c) low pressure setpoint: field adjusted to suit medical gas
 - .9 Vacuum:
 - (a) vacuum rating: 101 kPa (30 in.Hg.),
 - (b) adjustment range: -2.7 to -98 kPa (0.8 to 29 in.Hg.)

(c) low alarm setpoint: -50 kPa (-15 in.Hg. psig), factory set for medical vacuum

(d) low alarm setpoint: -34 kPa (-10 in.Hg. psig), factory set for AGSS

.10 cleaned for oxygen service.

.3 Accessories:

.1 Ø50 mm (2 in. dia.) dial pressure gauge for Low Pressure gas and vacuum switches.

.2 gas specific DISS nut and nipple.

2.7 Instrument and Control Wiring

.1 Instrumentation and control wiring in accordance with Specification section 20 05 12.

3 EXECUTION

3.1 Alarm Panels Installation

.1 Provide supply system alarm panels, zone alarm panels and combination zone/valve alarm panels configured to suit the applicable medical gas and vacuum services as shown on drawings.

.2 Install alarm panels in accordance with manufacturer instructions.

.3 Set alarm panels with top of panel at a height of 1500 mm (5 ft.) above finished floor, unless otherwise shown on drawings.

3.2 Pressure Transducers and Sensing Tubing Installation

.1 Connect pressure transducers to gas pipeline system only after the gas piping has been pressure tested.

.2 Pressure transducers for zone alarm panels shall only be installed in either the zone alarm panel, or in a zone valve box.

.3 Where pressure transducers are installed in the zone alarm panel;

.1 make tubing connections to gas main immediately downstream of zone control valve and before any connections to a terminal outlet.

.2 run NPS 3/8 type K copper medical gas tubing from the pipe main and connect to the copper sensing lines provided on the alarm panel.

.4 Manual valves shall not be installed between the gas main and the pressure transducer.

.5 Run control wiring in conduit from the transducer to the alarm panel in accordance with specification section 20 05 12.

3.3 Pressure and Vacuum Switches

.1 Install pressure and vacuum switches on source equipment and mains piping as shown, unless such instrumentation is already factory installed on packaged source equipment.

.2 Adjust and set high and low pressure and low vacuum setpoints in accordance with manufacturer instructions.

3.4 Pressure Switch Setpoints for Zone Alarm Panels

.1 Adjust and set pressure/vacuum switches for zone alarm panels in accordance with the following table 2:

Alarm	Table 2: Zone Alarm Panel Pressure Setpoints	
	kPa (psi) gauge	kPa (in.Hg.)
	Oxygen	Medical Vacuum
Low gas pressure Alarm setpoint	276 (40)	-40 (-12)
Nominal gas pressure	345 (50)	-68 (-20)
High gas pressure Alarm setpoint	413 (60)	N/A

3.5 Electrical supply and wiring

- .1 Dedicated emergency power circuits for alarm panels will be provided under Electrical Division 26 at 120 volt 60 Hz single phase and will terminate at the device power terminal strip in each alarm panel.
- .2 Provide wiring and conduit from these junction boxes to connect control devices being electrically powered in accordance with specification section 20 05 12.
- .3 Wiring between control and alarm panels and between panels and remote sensors to be provided in accordance with specification section 20 05 12.
- .4 Provide terminal junction boxes wherever signal and control wiring interfaces with alarm wiring.
- .5 Alarm wiring from main panel to terminal junction boxes to be Belden multi-pair colour coded 18 gauge wire with chrome PVC jacket run in EMT conduit.
- .6 Alarms to be wired to same terminal number in each terminal junction box and alarm panel.
- .7 Provide legend showing terminal number, colour code of wire and identifying common wire used for each alarm and each spare circuit.
- .8 25% of wire pairs and terminals to be provided as spare circuits in cable and spare terminals in terminal junction boxes and alarm panels.
- .9 Wire alarm panels in accordance with manufacturers wiring diagrams.

3.6 As-built Information

- .1 For remote mounted pressure transducers, mark-up the as-built drawings with dimensioned location of the pressure transducer.
- .2 In addition, for zone alarm panels, provide a diagram indicating the location of remotely mounted pressure transducers and place it inside the zone alarm panel.

3.7 Medical Gas System Commissioning and Certification

- .1 Refer to specification section 22 60 13.70.

3.8 Training and instruction

- .1 Arrange for manufacturers' representatives to provide instructions of Owners staff in use and maintenance of equipment associated with medical gas systems.

END OF SECTION

HVAC PIPING SYSTEMS GENERAL REQUIREMENTS 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.
- .2 This specification applies to;
 - .1 water based piping systems for building hydronic heating and cooling systems, and
 - .2 non-potable water systems for HVAC services.

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

- .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 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

- .1 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.
- .2 System includes but is not limited to;
 - .1 Boilers,
 - .2 Heat exchangers,
 - .3 Pumps,
 - .4 Expansion tanks,
 - .5 Convector,
 - .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	93 (200)	77 (170)	96 (205)	900 (125)	1030 (150)
Finned Radiation with enclosure	93 (200)	77 (170)	96 (205)	900 (125)	1030 (150)
Flat plate and cast iron radiators	60 (140)	50 (120)	93 (200)	900 (125)	1030 (150)
Terminal Reheat System	60 (140)	50 (120)	93 (200)	900 (125)	1030 (150)

1.7 Design Criteria - Cooling Water Systems

- .1 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.
- .2 System includes but is not limited to;
 - .1 Refrigeration machines,
 - .2 Heat exchangers,
 - .3 Thermal storage tanks,
 - .4 Ice builders,

- .5 Pumps,
- .6 Expansion tank,
- .7 Coolers,
- .8 Cooling towers,
- .9 Indoor condenser water basin,
- .10 Condenser water filters,
- .11 Cooling coils,
- .12 Fan coil units,
- .13 Server room cooling units,
- .14 Controls,
- .15 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)
Chilled water	5.5 (42)	14.5 (58)	38 (100)	900 (125)	1030 (150)

2 PRODUCTS

2.1 Dielectric Unions

- .1 Construction:
 - .1 Bronze or brass body with non-metallic fitting or coating the FNPT tailpiece.
 - .2 FNPT x Copper sweat connection.
 - .3 Pressure rating; ASME Class 3000 at 121°C (250°F)

Standard of Acceptance

- Hart Industrial Unions - fig. D-3136 or Polymer Composite Coating

2.2 Dielectric Flanges

- .1 Construction:
 - .1 ASME Class 150 or 300 carbon steel flange, Van-stone style with copper tube adapter tailpiece.
 - .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 (200 psi) at 121°C (250°F)
 - (b) Class 300: 2800 kPa (400 psi) at 121°C (250°F)

Standard of Acceptance

- CTS Flange Canada - fig. BF / WBG

2.3 Cam and Groove Fittings

- .1 NPS 2 size:
 - .1 Brass body cam and groove fittings, male groove end x female NPT end, with camlock female dust cap.

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 Do not use galvanized materials in contact with glycols.
- .11 All HVAC equipment, valves, expansion joints, 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.
- .12 Refer to piping system specifications for additional requirements.

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.
- .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 Dissimilar Metals Galvanic Isolation

- .1 Provide dielectric unions or flanges to separate copper and copper alloy tube and fitting materials from contact with carbon steel material. This includes equipment such as coils with copper header connections.
- .2 Dielectric unions or flanges are not required when all of the following conditions are met:
 - .1 the hydronic water treatment program (existing or new) includes a cathodic and/or anodic filming chemistry for mixed metals,
 - .2 copper tubing is not used in the piping system, except for the final 1 m (40 in) length connection to terminal equipment and in which the tubing is isolated from the carbon steel piping by a bronze body or carbon steel body valve (no brass) , and
 - .3 terminal equipment which contains copper or copper alloy tubing is connected to carbon steel piping with a flexible connector having an internal non-metallic hose.

- .3 For clarity, where copper tubing is installed in a part of a carbon steel piping system, dielectric unions or flanges are required.

3.4 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.

3.5 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.

3.6 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	HTS/R HS/R CHS/R	Carbon Steel	23 21 13.23	23 05 23.13
		Copper or Stainless Steel	23 21 13.33	23 05 23.13
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

1.1 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

.3 NPS 14 to NPS 24, for grooved end pipe:

- .1 To CSA B242, ductile iron body with corrosion inhibitor finish, with grooved ends.
- .2 Stainless steel shaft, corrosion-inhibitor encapsulated ductile iron disc with offset design, and replaceable EPDM resilient seat for bi-directional flow and bubble tight shut-off under system pressure.
- .3 ISO mounting pad.

- .4 Gear operator.
- .5 Required MCPR: 2065 kPa (300 psig) at 107°C (225°F).

Standard of Acceptance

- Victaulic - fig. AGS Vic-300 W709

2.6 Butterfly Valve - High Pressure (type "HP")

- .1 NPS 2½ to NPS 36:
 - .1 To MSS SP-68, high pressure offset-disc type, carbon steel lug body with flange bolt holes drilled and tapped, suitable for single flange connection to ASME/ANSI B16.5 flanges (NPS 24 and under) and ASME/ANSI B16.47 Series A flanges (NPS 30 to NPS 48).
 - .2 316 or 17-4 stainless steel disc and shaft, PTFE seat, bi-directional bubble tight shut-off under system pressure for dead-end service with flange removed from one side.
 - .3 ISO 5211 mounting pad.
 - .4 Locking handles up to NPS 4, and gear operators for NPS 6 and over.
 - .5 Class 150 valve (NPS 2½ to 36):
 - (a) Required MCPR: 1600 kPa (230 psig) at 121°C (250°F).

Standard of Acceptance

- DeZurik - fig. BHP
- Crane - fig. Flowseal 3LA series
- Apollo - fig. 230L
- WKM - fig. DynaCentric
- Nibco - fig. LCS-6822
- Keystone - fig. K-Lok 36
- Nibco SureSeal - fig. G1L
- Bray - fig. McCannalok

- .6 Class 300 valve (NPS 2½ to NPS 24)
 - (a) Required MCPR: 3500 kPa (507 psig) at 121°C (250°F).

Standard of Acceptance

- DeZurik - fig. BHP
- Crane - fig. Flowseal 3LA series
- Apollo - fig. 230L
- WKM - fig. DynaCentric
- Nibco - fig. LCS-7822
- Keystone - fig. K-Lok 37
- Bray - fig. McCannalok

2.7 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

2.8 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

.4 NPS 2 to NPS 12, for grooved end pipe

- .1 Ductile iron body, ductile iron or bronze disc, nickel seat, EPDM liner, stainless steel spring, with grooved ends.
- .2 Required MCPR: 2000 kPa (290 psig) at 110°C (230°F)

Standard of Acceptance

- Victaulic - fig. 716H/716
- Gruvlok - fig. 7800

2.9 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. Armstong - 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 chartes 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.

2.10 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

2.11 Triple Duty Valves

.1 Combination discharge non-slam check valve, isolation valve and balancing valve (“triple-duty”).

.2 NPS 1-1/4 to NPS 2:

- .1 Ductile iron body, Class 125, non-slam bronze disc with stainless steel spring, EPDM seat ring, plug type stem, flow measurement ports, tamper-proof setting, with NPT threaded ends.
- .2 Required MCPR: 900 kPa (130 psig) at 110°C (230°F)

Standard of Acceptance

- S.A. Armstrong - fig. FLO-TREX FTV-T
- ITT Bell & Gossett

.3 NPS 2 to NPS 12:

- .1 Cast or ductile iron body, non-slam bronze disc with stainless steel spring, EPDM seat ring, plug type stem, flow measurement ports, tamper-proof setting, with flanged or groove pipe ends.
- .2 Class 125 required MCPR: 900 kPa (130 psig) at 110°C (230°F)
- .3 Class 250 required MCPR: 2070 kPa (300 psig) at 110°C (230°F)

Standard of Acceptance

- S.A. Armstrong - fig. FLO-TREX FTV series
- ITT Bell & Gossett

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 Butterfly valves

- .1 Where butterfly valves are used, provide high pressure HP type butterfly valves as follows:
 - .1 at hot water boiler inlet and outlet connections,
 - .2 at refrigeration equipment evaporator and condenser water inlet and outlet connections,
 - .3 where valves are installed in pipe risers in vertical service shafts,
 - .4 where valves are used to isolate piping service to a building,
 - .5 as required based on valve size and pressure ratings, or
 - .6 at other locations as shown on drawings.
- .2 For butterfly valves with automatic control actuators, select RS or HP type valves as required so that valve torque requirements do not exceed 75% of installed valve actuator torque rating.

3.4 Check Valves

- .1 Provide an inline silent check valve on the pump discharge under any of the following conditions:
 - .1 multi-parallel pump installation,
 - .2 where the pump discharge piping rises to more than 5 m (15 ft) above the pump discharge, and
 - .3 at other 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.

3.5 Double Regulating Valves Installation

- .1 Where double regulating valves are used, supply one flow meter for double regulating and triple duty valves and turn over to operating staff during operations and maintenance training. Obtain and provide a copy to the owner of a signed receipt showing time, date, and name of recipient.

- .2 Consult with double regulating valve manufacturer to ensure correct valve selection. Balancing valves to be sized according to design flow rate.
- .3 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
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

- .4 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.
- .5 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.
- .6 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

STAINLESS STEEL VALVES FOR HVAC WATER PIPING

23 05 23.19

1 GENERAL

1.1 Scope

- .1 Provide stainless steel valves for HVAC stainless steel 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 stainless steel as specified in section 23 05 01, except as otherwise required for specific duty valves in other specification sections.
- .3 Stainless steel may be used as an alternative to copper piping for heating and cooling water systems.

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 Refer to section 20 05 23.

1.4 Applicable Codes and Standards

- .1 Refer to section 20 05 23 except/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

- .1 NPS 2 and under:
 - .1 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.
 - .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 Socket weld ends.

Standard of Acceptance

- ° M.A.Stewart – fig. G3SW <<400 psig>>

- Kitz - fig. 329FS
- Apollo - fig. 86A-200

.6 NPT threaded ends.

Standard of Acceptance

- M.A.Stewart – fig. G3
- Kitz - fig. 327F
- Apollo - fig. 86A-100

2.2 Globe Valves

.1 NPS 2 and under:

.1 To ASME B16.34 and MSS SP-42, ASTM A351 CF8M stainless steel body, CF8M disc, bolted bonnet, lockshield handles where shown, threaded ends.

.2 Class 150:

(a) required MCPR: 1600 kPa (230 psig) at 121°C (250°F).

Standard of Acceptance

- Kitz - fig. AK150UPM
- Crane/Aloyco - fig. 310

.3 Class 300:

(a) required MCPR: 3500 kPa (507 psig) at 121°C (250°F).

Standard of Acceptance

- Kitz - fig. AK300UPM
- Crane/Aloyco - fig. 2310

.2 NPS 2½ and over, flanged:

.1 To ASME B16.34 and MSS SP-42, Class 150, ASTM A351 CF8M stainless steel body, CF8M disc OS & Y, bolted bonnet, and raised face flanges.

.2 Class 150:

(a) Required MCPR: 1600 kPa (230 psig) at 121°C (250°F).

Standard of Acceptance

- Kitz - fig. 150UPAM
- Crane/Aloyco - fig. 317

.3 Class 300:

(a) Required MCPR: 3500 kPa (507 psig) at 121°C (250°F).

Standard of Acceptance

- Kitz - fig. 300UPAM
- Crane/Aloyco - fig. 2317

2.3 Butterfly Valve

.1 NPS 2½ to NPS 36:

- .1 To MSS SP-68, high pressure offset-disc type, T316 stainless steel lug body with flange bolt holes drilled and tapped, suitable for single flange connection to ASME/ANSI B16.5 flanges (NPS 24 and under) and ASME/ANSI B16.47 Series A flanges (NPS 30 to NPS 48).
- .2 316 or 17-4 stainless steel disc and shaft, PTFE seat complete with titanium or 316 stainless steel spiral wound back-up ring, bi-directional bubble tight shut-off under system pressure for dead-end service with flange removed from one side.
- .3 ISO 5211 mounting pad.
- .4 Locking handles up to NPS 4, and gear operators for NPS 6 and over.
- .5 Class 150 valve (NPS 2½ to 36):
 - (a) required MCPR: 1600 kPa (230 psig) at 121°C (250°F).

Standard of Acceptance

- DeZurik - fig. BHP
- Crane - fig. Flowseal 3LA series
- Apollo - fig. 230L
- WKM - fig. DynaCentric
- Keystone - fig. K-Lok 36
- Bray - fig. McCannalok

- .6 Class 300 valve (NPS 2½ to NPS 24)
 - (a) required MCPR: 4000 kPa (580 psig) at 121°C (250°F).

Standard of Acceptance

- DeZurik - fig. BHP
- Crane - fig. Flowseal 3LA series
- Apollo - fig. 230L
- WKM - fig. DynaCentric
- Keystone - fig. K-Lok 37
- Bray - fig. McCannalok

2.4 Inline Silent Check Valves

- .1 NPS 2 and under, threaded:
 - .1 To MSS SP-80, Class 125, ASTM A351 CF8M stainless steel body, spring-controlled inline style (non-flapper), body guided disc, resilient EPDM or PTFE seat or disc; stainless steel spring; with NPT threaded ends.
 - .2 Required MCPR: 1170 kPa (170 psig) at 121°C (250°F).

Standard of Acceptance

- Apollo - fig. 62-500

- .2 NPS 2½ to NPS 24, flanged:
 - .1 To MSS SP-126, Class 150 and 300, ASTM A351 CF8M stainless 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

3 EXECUTION

3.1 General

- .1 Refer to section 20 05 23 and as specified 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 ASME Class to match any Class rating shown on the drawings.

3.3 Butterfly valves

- .1 For butterfly valves with automatic control actuators, select butterfly valves so that valve torque requirements do not exceed 75% of installed valve actuator torque rating.

3.4 Check Valves

- .1 Provide an inline silent check valve on pump discharge and as otherwise shown.

End of Section

TESTING ADJUSTING AND BALANCING FOR HVAC

23 05 93.13

1 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) boiler feedwater pumps and central condensate receiver transfer pumps,
 - (c) process equipment and 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.
- .4 Rechecking of TAB during alternate heating/cooling season.

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 22 05 93 Testing Adjusting and Balancing for Plumbing
 - .2 23 05 93.23 Testing, Adjusting and Balancing Supplement for Healthcare
 - .3 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 (no alternatives)

- 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 ±5% of design value.
- .2 Measurement device accuracy:

Measurement	Application	Device	Accuracy
Air Flow	Plenums	Revolving Vane Anemometer, direct reading digital type	± 5.0% of reading over 1 m/s
Air Flow	Ducts	Pitot-tube duct traverse with electronic gauge	± 10.0% of reading over 5 m/s
Air Flow	Grilles and Diffusers	Revolving Vane Anemometer, direct reading digital type	± 5.0% of reading
Air Flow	Room air currents, Hoods (0.05 to 3.0 m/s)	Thermal Anemometer	± 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	± 0.2°C over 0 to +40°C
Temperature	Air, Liquid	Digital Electronic Thermometer	± 0.4°C < 0°C and >+40°C
Relative Humidity	Air	Digital Electronic Humidity Sensor	± 1.5%RH over 0 to 90%RH range
Pressure	Air	Magnahelic	± 2.0% of reading
Pressure	Liquid, Gas, Steam	Bourbon type	± 1.0% of reading
RPM	Motor, fans	Chronometer tachometer	± 1.0% of reading
Voltage	All	Portable	± 2.5% of reading
Current	All	Portable clamp-on ammeter	± 2.5% of reading

1.8 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][10][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 sample, 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)

Parameter	Unit	Abbreviation
	kilopascal	kPa (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 damper 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

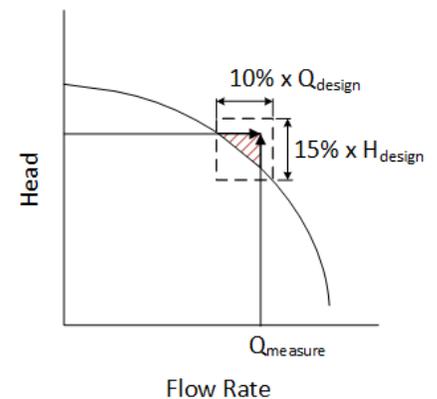
- .1 Where terminal units are equipped with integral air flow stations, do not use these air velocity stations as a proxy for manual duct traverse measurements of the zone airflow.

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.

3.8 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.

3.9 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.

3.10 Induction Unit Primary Air Supply System Balancing Procedure

- .1 Set system to operate with 100% return or supply air and measure plenum pressure at each induction unit on floor most remote from unit.
- .2 Adjust fan static pressure controller to provide design static pressure at most remote unit.
- .3 Check and adjust individual induction unit dampers to obtain design static pressure at each air plenum of each induction unit supplied by fan on test.
- .4 If nozzle plenum static pressure at an intermediate flow is less than that for design air quantity, reset fan static pressure controller to achieve required induction unit static pressure value and re-balance more remote units.

3.11 Outdoor Air Adjustment Procedure

- .1 After balancing of supply fan, return fan, and related exhaust fans systems, adjust the outdoor air dampers position to obtain minimum design fresh air quantity.
- .2 Measure outdoor air values by duct traverse reading across outdoor air intake, recirculation duct, and exhaust air duct.
 - .1 Where there is insufficient duct length to provide reliable traverse readings, determination of outdoor air flow rate may be estimated based on a mixed airflow coil or filter bank traverse and measurement of outdoor air, return air, and mixed air temperature, provided the temperature differential between outdoor and return air is at least 11°C (20°F).
 - .2 Where neither of the above methods can be used, a temporary outdoor air minimum damper position may be set by measuring the pressure drop across the outdoor air damper and estimating the airflow rate based on damper manufacturer pressure drop data. Once outdoor conditions are available, remeasure and reset the outdoor air damper minimum position based on mixed air temperature conditions.
 - .3 Where temperature is used to estimate the balanced minimum outdoor air flow rate, include calculations of same in the balancing report.
- .3 After the minimum outdoor air flow rate and damper position have been adjusted, operate the air handling system at 100% outdoor air. Check that supply fan and return fan are operating within 5% of their airflow rate at minimum outdoor air condition.
 - .1 If the supply or return air flow rates at 100% outdoor air exceed their respective airflow rates at minimum outdoor air condition by more than 5%, adjust the maximum outdoor and exhaust air dampers to reduce their percent opening until the airflow variance is less than 5%.
 - .2 If the supply or return airflow rates at 100% outdoor air is less than their respective airflow rates at minimum outdoor air condition by more than 5%;

- (a) reduce the minimum outdoor damper open position and return damper open position, and increase fan static pressure controller setpoint to re-establish minimum outdoor air flow rate,
- (b) recheck the supply or return fan airflow rates at 100% outdoor air damper position.
- (c) repeat above adjustment procedure until supply or return air fan airflow rates at 100% outdoor air is within 5% of their respective airflow rates at the minimum outdoor air damper position.

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

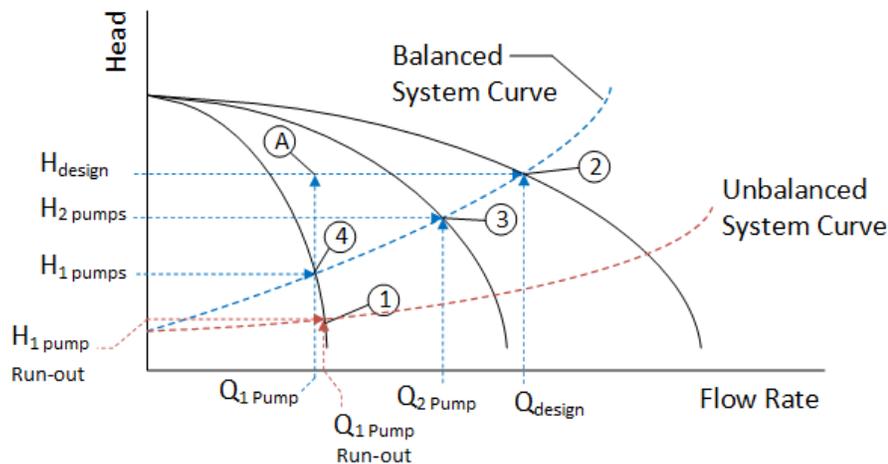
- .1 Obtain from Consultant the expected diversity value, or determine the percent diversity by dividing the pump design flow rate by the sum of all connected loads.
- .2 Where available pump capacity is less than total flow requirements of individual system parts, full flow in any part may be simulated 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.

4.5 Multiple Pump Systems Balancing Procedure

- .1 Balance multiple pump systems, which have two (2) or more pumps operating in parallel (not including stand-by pumps), in accordance with the following procedure. In the figure below, the state points are:
 - “A”: individual pump design data.
 - “1”: single pump operation at maximum run-out capacity without motor overload
 - “2”: multi-pump operation, balanced system,
 - “3”: N-1 pumps operating at balanced system demand point,
 - “4”: single pump operating at balanced system demand point.



- .2 Step 1 – establish single pump maximum run-out condition (unbalanced system):
 - .1 set all load equipment automatic control valves to 100% open,
 - .2 start one pump separately and open flow through associated source equipment (chiller, boiler, cooling tower, etc.) and run pump to full speed and open discharge valve to maximum open position without causing pump motor to exceed its power rating. This is point 1 on the figure above.

Record pump flow rate, head, and motor current. Mark this data on a multi-pump curve as maximum run-out condition.

- .3 Step 2 - balance pump discharge for all pump simultaneous operation:
 - .1 open all load valves 100% open,
 - .2 start-up all pumps which are required for maximum system design capacity along with associated chillers, cooling towers and boilers,
 - .3 concurrently throttle discharge valve at each pump to obtain total system design flow rate (point 3 in the above figure). Record this value as Maximum Rated Capacity ("MRC"),
 - (a) for pumps with VFD controllers, before throttling the pump discharge valve, reduce pump speeds until MRC is reached (point 2). If the resulting pump speed is more than 15% below pump maximum speed (50 Hz on a 60 Hz motor), increase pump speed to 50 Hz and then use pump discharge throttling valve to obtain MRC at point 2.
- .4 Step 3 – check operating points at reduced number of pumps:
 - .1 shut-down one pump and check operating point of remaining pumps on their pump curves. Check that the operating point does not cause any remaining pump from operating in a motor overload condition,
 - .2 repeat by shutting down additional pumps in sequence until one pump remains operating, and record all test values (flow, pressure, RPM and motor kW). Plot operating point on a multi-pump curve.

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 - ALTERNATE SEASON TESTING

- .1 Based on the scope of the Work, it is expected that complete or final testing of some of the HVAC equipment and systems will need to be deferred to an alternate season period after Substantial Performance / date or Ready-for-Takeover of the Work, but before expiry of the warranty period.
- .2 Alternate season testing is required for heating or cooling equipment which cannot be tested at full load conditions due to ambient outdoor conditions at time of TAB work prior to achieving Substantial Performance / Ready-for-Takeover of the Work.
- .3 As the Work nears Substantial Performance, review with Consultant to determine which equipment and systems will require final TAB work to be deferred to the alternate season. For equipment and systems whose TAB work is to be deferred, provide initial balancing of the systems to a sufficient extent to allow general functional testing of associated services including building control systems.
- .4 Requirements for alternate season TAB work:
 - .1 Plan and allow for costs for alternate season TAB work to be performed at night and on weekends.
 - .2 Perform final balancing of deferred equipment and systems. Arrange with Owner's operations staff to operate equipment normally scheduled off during TAB work times.
 - .3 Where the balancing of deferred equipment and systems interfaces or interacts with previously balanced equipment or systems, check operating performance characters of previously balanced and adjusted equipment or systems to verify continued as-balanced condition.
 - .4 Include the measurement and recording of temperatures and pressures at all gauges, as well as outdoor and indoor conditions.
 - .5 Measure and record the motor amperages and drive RPM of all fans and pumps during re-checking.

- .5 Report
 - .1 Provide an addendum report to the original balancing report for all alternate season balancing results.

7 EXECUTION – MISCELLANEOUS

7.1 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.

8 EXECUTION - REPORT PRESENTATION AND VERIFICATION

8.1 Required Reports

- .1 Provide the following reports:
 - .1 Air and water balancing report,
 - .2 Alternate season test report.

8.2 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.

8.3 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.

8.4 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

1 GENERAL

1.1 Scope

- .1 Test, adjust, and balance ("TAB") airflows for rooms and spaces in healthcare facilities.
- .2 This section is supplementary to Specification section 23 05 93.13 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:
 - .1 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

- .1 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

- .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

- .1 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 10% of Specialty Rooms as selected by the Owner or Consultant.
- .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	Treatment rooms, Operative birthing rooms, Operating rooms, Sterile storage and core spaces, Medical device reprocessing, Invasive imaging rooms,	2.5 Pa (0.01 in.w.c.)	Positive
	Biomedical waste treatment, Autopsy	2.5 Pa (0.01 in.w.c.)	Negative
	Protective Environment Rooms (PER)	7.5 Pa (0.03 in.w.c.)	Positive to corridor
	Airborne Isolation Rooms (AIR)	7.5 Pa (0.03 in.w.c.)	Negative to corridor
			Negative to adjacent (non-communicating) spaces
	AIR anteroom	2.5 Pa (0.01 in.w.c.)	Negative to corridor
			Positive to AIR room
	Combination PER/AIR Room	7.5 Pa (0.03 in.w.c.)	Positive to corridor (PER mode)
			Negative to Corridor (AIR mode)
	Combination PER/AIR Room Anteroom	2.5 Pa (0.01 in.w.c.)	Negative to corridor
Negative to PER/AIR room			
Airborne Isolation Process Rooms	7.5 Pa (0.03 in.w.c.)	Negative to corridor	

Occupancy	Room Type	Measurement Parameter (minimum)	Positive or Negative [Note 2]
	Combination Airborne Isolation/Protective Isolation Process Room Anteroom	2.5 Pa (0.01 in.w.c.)	Negative to corridor
			Negative to process room
Laboratories	Rooms with chemical fume hoods	2.5 Pa (0.01 in.w.c.)	Negative
	Rooms with biological hoods	5.0 Pa (0.02 in.w.c.)	Negative
Pharmacies	Hazardous compounding	2.5 Pa (0.01 in.w.c.)	Negative
	Hazardous compounding anteroom	5.0 Pa (0.02 in.w.c.)	Positive to corridor
		2.5 Pa (0.01 in.w.c.)	Positive to compounding room
	Clean compounding	12.5 Pa (0.05 in.w.c.)	Positive
	Clean compounding anteroom	7.5 Pa (0.03 in.w.c.)	Positive to corridor
		5.0 Pa (0.02 in.w.c.)	Negative to compounding room

End of Section

HYDRONIC PIPING – CARBON STEEL

23 21 13.23

1 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 2750 kPa (400 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.
- .19 CSA B242 Groove and Shoulder Type Mechanical Pipe Couplings

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 Select pipe material and wall thickness/schedule (as defined in ASME B36.10), based on pipe size, design temperature and jointing method in accordance with the following table:
 - .1 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.

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
	>105°C (220°F)	Threaded or cut grooved	A106	Schedule 80
		Welded, flanged, roll grooved	A106, A53	Schedule 40
3 to 10	≤ 121°C	All	A53	Schedule 40
12 to 18	≤ 121°C	All	A53	Standard – 9.5 mm (0.375 in.)
20 to 24	≤ 121°C	All	A53	Schedule 30

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 buttwelding 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)
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
- .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 Buttweld 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 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.

END OF SECTION

HYDRONIC PIPING – STAINLESS STEEL

23 21 13.26

1 GENERAL

1.1 Scope

- .1 Provide stainless 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 2750 kPa (400 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 ASME B1.20.1 Pipe Threads, General Purpose (inch)
 - .2 ASME B16.5 Pipe Flanges and Flanged Fittings
 - .3 ASME B16.9 Factory-Made Wrought Steel Buttwelding Fittings
 - .4 ASME B16.11 Forged Fittings, Socket Welding and Threaded
 - .5 ASME B16.20 Metallic Gaskets for Pipe Flanges; Ring-Joint, Spiral-Wound, and Jacketed
 - .6 ASME B16.21 Nonmetallic Flat Gaskets for Pipe Flanges.
 - .7 ASTM A182 Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service
 - .8 ASTM A312 Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes
 - .9 ASTM A269 Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
 - .10 ASTM A351 Standard Specification for Castings, Austenitic, for Pressure Containing Parts
 - .11 ASTM A403 Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings

- .12 ASTM A182 Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High Temperature Service.
- .13 ASTM A193 Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High Temperature
- .14 ASTM A194 Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both
- .15 AWS D18.2 Guide to Weld Discoloration Levels on Inside of Austenitic Stainless Steel Tube
- .16 MSS SP-114 Corrosion Resistant Pipe Fittings Threaded and Socket Welding Class 150 and 1000

2 PRODUCTS

2.1 Pipe

.1 Stainless steel pipe:

.1 All sizes

(a) ASTM A312 Type 304/304L and 316/316L, seamless or welded, and pipe schedule in accordance with the following table.

Joint Method	Pipe Size NPS	Maximum System Design Pressure	Schedule
Welding (butt weld, socket weld)	NPS ½ to NPS 6	2750 kPa (400 psig)	10
	NPS 8 to 18	1720 kPa (250 psig)	10
		2750 kPa (400 psig)	40/40S
	NPS 20 to 24	1030 kPa (150 psig)	10
		1720 kPa (250 psig)	40/40S
		2750 kPa (400 psig)	40
Threaded	NPS ½ to NPS 2	2750 kPa (400 psig)	40/40S

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 1000 to MSS SP-114, and material to ASTM A351 Gr. CF8 or CF8M stainless steel to match pipe grade.

.3 Unions: Class 150 and Class 1000 to MSS SP-114, and material to ASTM A182 Gr. CF8 or CF8M stainless steel to match pipe grade, with ground joint and face.

- .4 Threaded joint compound: Teflon pipe tape sealant.

Standard of Acceptance

- Masters Orange or White Tape.

- .2 Welding fittings:

- .1 Pipe fittings of same steel alloy and grade as connected pipe.

- .2 Butt-weld fittings:

- (a) forged stainless steel fitting to ASTM A403,
- (b) wall thickness to match pipe,
- (c) elbows to be long radius type.

- .3 Welding outlet fittings:

- (a) forged stainless steel to ASTM A182,
- (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.

- .4 Socket welded fittings:

- (a) forged stainless steel to ASTM A182,
- (b) dimensions and pressure ratings to ASME B16.11, Class 3000.

- .5 Half couplings:

- (a) forged stainless steel to ASTM A351,
- (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 Raised face forged stainless steel to ASTM A182, Class 150 and Class 300, weld neck with wall thickness to match pipe, or slip on type.
- .2 Studs and bolts: to ASTM A193, Grade B8M Class 2,
- .3 Nuts: to ASTM A194 Grade B8M Class 2,
- .4 Gaskets for flanges to ANSI B16.21, ANSI B16.20 or ANSI A21.11.

Standard of Acceptance

- Chesterton - fig. 100, 195 and 450
- Beldam
- Ameraflex Sealing Products Co.

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 Stainless Steel Grade Selection

- .1 Provide the grade of stainless steel piping in accordance with the following table.

Piping System	Grade
All systems	304/304L

3.3 Class Rated Fittings and Flanges

- .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
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 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
 - (b) socket welded.
 - .2 Piping NPS 2-1/2 and larger:
 - (a) flanged or welded.
- .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

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

3.5 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
- .2 Where connection is made to equipment with a threaded fitting, provide a union between the isolation valve and the equipment connection.

3.6 Welding

- .1 Comply with section 20 05 24 and as specified herein.
- .2 Weld pipe using automatic orbital tungsten inert gas (“TIG”) welding.
 - .1 Exception: use hand TIG weld for socket welds, at integrally reinforced branch outlet fittings, and slip-on flanges.
 - .2 Hand TIG tack welding for alignment of stainless steel pipe is permitted, prior to automatic welding.
- .3 Continuously purge inside of pipes with argon backing gas during welding;
 - .1 Provide a purge restrictor on pipe to maintain oxygen levels below a nominal 50 ppm inside of pipe; actual oxygen concentration is as required to obtain a heat affected zone (“HAZ”) colour of No. 3 in accordance with AWS D18.2.
 - .2 Inject argon within 150 mm of weld - use extension tubes as necessary.
 - .3 Use portable oxygen analyzers reading ppm on pipe sizes NPS 2 ½ and larger, to check oxygen levels at purge outlet.
 - .4 Time purging is acceptable on pipe sizes NPS 2 and smaller.
- .4 Use of backing gas is not required where the inside surface of the weld is accessible for removal of the HAZ weld tint by grinding or manual application of pickling compound to remove the weld tint.

3.7 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 buttweld 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

Table 2a – Allowable Branch to Main Connections (NPS 1 to NPS 10)										
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 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.

3.8 Pressure Testing

- .1 Conduct pressure and leak tests in accordance with section 23 05 01.

3.9 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.

3.10 Post-weld Pickling

- .1 The following post-weld pickling procedure may be omitted when approved by the Consultant where all of the following conditions are met:
 - .1 A written welding procedure and test plan is provided for review by the Consultant prior to any welding work, which demonstrates the control measures used to ensure proper use of backing (internal purging) gas to control formation of HAZ weld tint on the inside of the pipe.
 - .2 Orbital automatic TIG welding is used for butt-weld joints.
 - .3 Three welding samples of NPS 2, NPS 4 and NPS 6 is supplied to the Consultant prior to production welding as follows:
 - (a) a complete butt-weld using automatic orbital TIG welding, with each sample split lengthwise to expose the interior weld surface for examination;

- (b) one (1) example for an integrally reinforced welding outlet fitting, using hand TIG welding, with interior surface exposed for examination;
 - (c) the interior HAZ heat tint is not greater than the No. 4 sample colour in accordance with AWS D18.2.
- .4 A completed and signed report is submitted for review by the Consultant at the completion of welding associated to each piping system, prior to flushing and cleaning of the piping.
- .2 After flushing and cleaning, provide the services of a specialist pipe cleaning company to chemically pickle the stainless steel piping and tubing, to remove weld heat tint where welded pipe joints or fittings are used.
 - .1 At completion of tests, drain down and dispose of cleaning chemicals as contaminated acid waste.

Standard of Acceptance

- CEDA - Reactor Ltd.
- .3 Select or provide a spool section with flanged ends at both ends and a butt-weld, to be used for final demonstration of pickling effectiveness. A weld-neck flange is suitable for this purpose.
 - .4 Provide test sample pipe welds of the type and size when requested by the specialist pipe cleaning company. The specialist company shall evaluate and determine the appropriate pickling method. The acceptance criteria is to achieve colour No. 4 in accordance with AWS D18.2.
 - .5 Chemically pickle inside of piping to remove weld heat tint.
 - .1 provide temporary cross connections to bypass equipment;
 - .2 temporarily remove flexible connections at pumps and install stainless steel spool pieces. Reinstall flexible connections after completion of pickling program;
 - .3 bypass piping material: stainless steel 304, threaded, flanged, or welded. Hoses as recommended by the chemical cleaning company may be used;
 - .4 provide temporary circulating pumps and power supplies.
 - .6 Continuously circulate pickling solution and periodically check concentration levels. Temporarily remove the spool test piece to permit visual inspection of the flange and butt welds. Continue to clean pipe until the acceptance criteria is achieved.
 - .7 At completion of pickling, drain down and dispose of liquid solution as contaminated waste.
 - .8 Mechanically grind or hand-pickle to remove HAZ weld tint on the outside pipe surface where the pipe is located outdoors, or where it is uninsulated indoors.
 - .9 Prepare and submit a report from the specialist cleaning company at completion of pickling and passivation treatments, which details the results of the test. Include photographs of interior surface finishes at accessible butt-weld joints.

3.11 Passivation

- .1 Passivate inside of piping with nitric acid to ASTM A380 standard.
 - .1 Passivation may form part of the pickling process, or may be post-pickling.
- .2 Provide temporary bypass piping around water storage tank.

- .3 At completion of passivation, drain down and dispose of passivation chemical as contaminated waste. Refill the system with clean municipal water for a final rinse and then completely drain the system. Do not allow municipal water to remain in the piping system.

3.12 Final Fill

- .1 Fill the piping system with reverse osmosis or deionized treated water that is pretreated to remove chlorine. The required water quality is to achieve a water resistivity of at least 60,000 $\Omega \cdot \text{cm}$. The use of other water sources including softened water, dealkalized water or municipal water is not permitted.
- .2 Circulate water for four hours. Take a water sample and have it analyzed at a accredited testing laboratory and submit the report to the Owner for acceptance.

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:
 - .1 (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 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 (c 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 ½ 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 20 05 49 Seismic Restraint
 - .3 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 [Seismic Qualification

- .1 Seismically qualify (certify) piping to remain operational after being subjected to the design seismic forces assuming a building height factor (NBCC) $A_x = 3.0$ with equipment rigidly mounted, by the shaker table method in accordance with Specification section 20 05 49.

1.5 Submittals

- .1 Submit manufacturer catalogue cut-sheets for products specified herein.
- .2 Include confirmation of CRN.

1.6 Quality Control

- .1 All products are to have Canadian Registration Numbers in accordance with CSA B51.

2 PRODUCTS

2.1 Diaphragm Expansion Tanks

- .1 Construction:
 - .1 ASME code stamped to ASME BPVC Section VIII,
 - .2 Canadian Registration Number to CSA B51,
 - .3 tank: carbon-steel shell, vertical cylindrical shape pressure vessel with dished ends,
 - .4 diaphragm: BUNA-N or EPDM elastomer, non-replaceable,
 - .5 tank capacity and acceptance volume as shown,

- .6 minimum component pressure rating: 700 kPa (100 psi) at 115°C (240°F),
- .7 finish: prime and finish coat on outside of tank,
- .8 annular base mounting ring for vertical installation,
- .9 seismic restraint design:
 - (a) tanks designed to withstand water movement in the tank due to imposed seismic forces and movement,
 - (b) vertical tanks: support legs and hold-down bolt-holes designed for a horizontal seismic cyclic load equal to 50% of tank and contents weight in shear, and each leg designed for 100% of the resulting bending moment, and
 - (c) safety factor of 4:1.
- .10 factory air-charged to 84 kPa (12 psi) (initial fill pressure of system).
- .2 Nozzles and couplings:
 - .1 NPS 1 expansion line fitting at bottom of tank,
 - .2 Schraeder tank valve fitting for compressed air located near top of tank.

Standard of Acceptance

- Amtrol - fig. Extrol SX series
- Taco - fig. CBX series
- Bell & Gossett - fig. D series
- Armstrong - fig. AX series

2.2 Bladder Type Expansion Tanks

- .1 Construction:
 - .1 ASME code stamped to ASME BPVC Section VIII,
 - .2 Canadian Registration Number to CSA B51,
 - .3 tank: carbon-steel shell, vertical cylindrical shape pressure vessel with dished ends,
 - .4 bladder: BUNA-N or EPDM elastomer, replaceable and fastened to underside of man-way flange,
 - .5 tank capacity and acceptance volume as shown,
 - .6 full-acceptance design,
 - .7 suitable for glycol-water solutions up to 50% concentration,
 - .8 minimum component pressure rating: [1000 kPa (150 psi)][2000 kPa (300 psi)] at 115°C (240°F),
 - .9 finish: primed on outside,
 - .10 annular base mount for vertical installation,
 - .11 top-mounted bolted access flange for replacement of the bladder,
 - .12 seismic restraint design:
 - (a) tanks designed to withstand water movement in the tank due to imposed seismic forces and movement,
 - (b) vertical tanks: support legs and hold-down bolt-holes designed for a horizontal seismic cyclic load equal to 50% of tank and contents weight in shear, and each leg designed for 100% of the resulting bending moment, and

- (c) safety factor of 4:1.
- .13 factory air-charged to 84 kPa (12 psi) (initial fill pressure of system).
- .2 Nozzles and couplings:
 - .1 NPS 1 expansion line fitting in the top flange to the bladder,
 - .2 Schraeder tank valve for compressed air located on top flange or at top of tank shell.

Standard of Acceptance

- Amtrol - fig. Extrol L series
- Taco - fig. CA series
- Bell & Gossett - fig. B series
- Armstrong - fig. L series

2.3 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.

2.4 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

2.5 Radiator Air Vents

- .1 Float operated with brass body;
 - .1 automatic type for remote installation for terminal heating units located at top of risers,
 - .2 screw-driver operated for locations inside of terminal heating unit enclosures other than when located at top of pipe risers,
 - .3 minimum component pressure rating: [700 kPa (100 psi)][1000 kPa (150 psi)][2000 kPa (300 psi)].

Standard of Acceptance

- Braukman - fig. EA122A
- Maid-O-Mist - fig. 37
- Spirax Sarco - fig. AE30
- Taco - fig. 417

2.6 Air Separator; Expansion Tank

- .1 Dip tube type air separator for installation at expansion tank,
 - .1 ASME code stamped to ASME BPVC Section VIII,
 - .2 Canadian Registration Number to CSA B51,
 - .3 cast iron body, with copper dip tubes, and stainless steel ball check,
 - .4 minimum component pressure rating: 1030 kPa (150 psi) at 121°C (250°F).

Standard of Acceptance

- Bell & Gossett - fig. Airtrol Tank Fitting
- Armstrong

2.7 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

2.8 Pressure Reducing Valves

- .1 Pressure reducing valve with integral inlet soft-seated check-valve and stainless steel mesh strainer;
 - .1 self-contained, single-seated, type,
 - .2 brass or cast iron body, EPT diaphragm, with fast-fill/purge release handle,
 - .3 pipe ends: NPT threaded,
 - .4 minimum component pressure rating: 860 kPa (125 psi) at 100°C (212°C),
 - .5 pressure regulator setting range:
 - (a) low range: 70 to 170 kPa (10 to 25 psi),
 - (b) high range: 170 to 410 kPa (25 to 60 psi).

Standard of Acceptance

- Bell & Gossett - fig. A430H
- Taco
- Watts

2.9 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

2.10 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

2.11 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

2.12 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 ½ 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.

2.13 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
- .2 12" high minimum or as required to fully enclose all components

Standard of Acceptance

- Acudor
- Cendrex
- Karp Inc

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 Expansion Tank Installation

- .1 Provide expansion tanks as shown.
- .2 Install equalizer line from [[air separator in] piping system to bottom of tank. Where multiple tanks are required for one system, provide a full size equalizing header pipe connection to each tank.
- .3 Provide domestic cold water line with ball valve, strainer, and line size backflow preventer with isolating valves connected to the equalizer line.
- .4 Provide a main system pressure relief valve on the equalizing line, with outlet piped down to within 150 mm (6 in.) of the floor adjacent to floor drain;
 - .1 select the pressure relief valve based on the total equivalent heat value of the associated heat source (heating or cooling), but not less than NPS ¾ in size,
- .5 Provide a domestic water make-up assembly consisting of:
 - .1 a reduced-pressure principle backflow preventer with inlet and outlet valves and strainer,
 - .2 a pressure reducing valve located downstream of the backflow preventer,
 - .3 a pressure gauge installed on the tank water space or on the equalizing line within 600 mm (24 in.) of the tank connection,
 - .4 drainage piping for the relief connection on backflow preventer and the make-up water assembly run to the nearest open drain,
 - .5 where shown, a compressed air line piped to each expansion tank or group of tanks with globe valve and check valve, terminating 1200 mm (4 ft) above finished floor near tanks with 6 m (20 ft) length of hose and hose end fitting compatible with Schraeder connection on the expansion tank.
- .6 Provide a lock-shield isolation valve on the expansion tank system pipe connection, and provide a key padlock on each tank isolation valve. Turn over the keys to Owner at time of hand-over of the Work.

- .7 Set-up the expansion tank(s) in accordance with the manufacturer instructions. Pre-charge the air pressure in the tank to the pressure as shown, prior to placing the system into operation. After the system is operating at the normal operating temperatures, adjust the air pressure in the tanks as follows:
 - .1 increase or decrease tank air pressure to achieve the final operating pressure as shown in equipment tank schedules,
 - .2 record the final operating tank pressure in an installation report.

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 Radiator Air Vent Installation

- .1 Provide automatic radiator air vents on Ø20 mm (¾ in. dia.) by 50 mm (2 in) long air chambers on return side of hot water convector-radiators and wall fin heaters connected to the top of flow risers. Pipe vent outlets to drain in visible locations.
- .2 Fit other hot water convector-radiators with Ø20 mm (¾ in.dia.) by 150 mm (6 in) air chamber with manual screwdriver-operated air vent piped through front or side of cabinet. Fit similar air chamber and screwdriver operated air vent, through front or side of cabinet, on high points of other wall-fin heating elements except that air chamber to be as long as is possible to install within wall-fin enclosure height.
- .3 Install air vent assemblies clear of dampers within heating units.

3.6 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.

3.7 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.

3.8 Pressure Reducing Valves Installation

- .1 Install pressure reducing valves with shut-off valve on either side of assembly and Ø115 mm (4½ in. dia.) pressure gauges on upstream and downstream sides of the pressure reducing valve.

3.9 Strainers Installation

- .1 Provide pipeline-size strainers in each of following locations
 - .1 on the inlet side of water meters,
 - .2 on the inlet side of automatic control valves (except at reheat coils with piping connections NPS ¾ or less, radiation, or radiant panels),
 - .3 on the inlet side of pressure reducing valves (except where pressure reducing valve is equipped with an integral strainer),
 - .4 on suction side of water pumps (except where a pump suction guide with integral strainer is used),
 - .5 on inlets to heat exchangers (except where heat exchanger is equipped with integral strainers, or where a dedicated pump with strainer is directly supplying the heat exchanger).
- .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 2½ 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.

3.10 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.

3.11 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

1.1 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.

1.2 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 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. Remove the control valve and provide a spool piece, or where flexible connectors are used at terminal units, cross connect the supply and return piping with these flexible connectors, bypassing the control valve and the terminal unit.
- .2 At major equipment such as boilers and chillers, provide temporary strainer cones installed in a pipe flange ahead of the equipment. Remove strainer after completion of system cleaning.

3.3 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

1 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 A90 Standard Test Method for Weight (Mass) of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings
 - .2 ASTM A653 Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot Dip Process
 - .3 ASTM A924 Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process

- | | | |
|-----|----------------|--|
| .4 | 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 |
| .5 | ASTM A283 | Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates |
| .6 | ASTM A36 | Standard Specification for Carbon Structural Steel |
| .7 | ASTM A480 | Specification for General requirements for Flat Rolled Plate, Sheet, and Strip |
| .8 | ASTM A463 | Standard Specification for Steel Sheet, Aluminum-Coated, by the Hot-Dip Process |
| .9 | ASTM B209 | Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate |
| .10 | 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

- .1 Outdoor ductwork, rooftop duct support frames, and weather shields are to be designed to meet the local wind loading in accordance with the building code requirements at the location of the Work.
- .2 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 integral drain pans and external drain pans including drain pipe connection,
 - .2 water-resistant ductwork,
 - .3 casings and plenums.

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, Type 304L,

- .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 in new concrete: manufactured concrete inserts.

Standard of Acceptance

- Myatt Fig. 485

- .2 for steel joist: galvanized joist clamps or steel plate washer.

Standard of Acceptance

- Anvil Fig. 61 or 86
- Anvil Fig. 60 for plate washer

- .3 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, 500 Pa (2 in wg) pressure class and higher:
 - .1 spiral flat type longitudinal seam, button punched.

3.2 External Drain Pans

- .1 Provide external drain pans where shown.
- .2 Materials: T304 stainless steel.
- .3 Fabricate drain pan with 50 mm (2 in.) high side walls.
- .4 Break the bottom panel in two-directions to allow water to drain to a low-point drain outlet,
- .5 Provide welded-on hanger attachments to allow support by hanger rod or support the underside of the drain pan.
- .6 Provide continuous welded joints along bottom of plenum, and extend welds up vertical joints. Mechanically grind or chemical pickle both the interior and exterior surfaces at the welds to remove the welding tint in the heat affected zone (HAZ).
- .7 Provide a NPS 3/4 x 75 mm (3 in.) long stainless steel drain tube connected to the duct drain pan at the low-point drain outlet.

3.3 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.

3.4 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 (1x1x1/8)	6 (1/4)
750 to 1050 (30 to 40)	40x40x3 (1 1/2x1 1/2x1/8)	6 (1/4)
1050 to 1500 (40 to 60)	40x40x3 (1 1/2x1 1/2x1/8)	10 (3/8)

Duct size mm (in)	Angle size mm (in)	Rod size mm (in)
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.

.4 For additional requirements for seismic restraints, refer to Section 20 05 49.

3.5 Pressure Classification and Seal Class

.1 Low pressure ductwork construction classification in accordance with Table 2.

Pressure class Pa (in wg)	Operating pressure Pa (in wg)	Velocity m/s (fpm)	Leakage Test Pressure Pa (in wg)
125 ($\frac{1}{2}$)	up to 125 ($\frac{1}{2}$)	10.0 (2000)	125 ($\frac{1}{2}$)
250 (1)	125 to 250 ($\frac{1}{2}$ 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 duct risers in vertical service space (duct shafts).	+1000 (4)	A	Transverse joints, longitudinal seams, ductwall penetrations, and other connections
3	Supply air ductwork from discharge side of fan to inlet of terminal units or reheat coil	+1000 (4)		
4	Return/exhaust air ductwork between a Heat Recovery Wheel and suction side of fan.	-1000 (4)		
5	Supply, return and exhaust ductwork located outdoors.	All classes as otherwise specified herein		
6	Autopsy exhaust ductwork.	-1000 (4)		
7	Process exhaust air ductwork between exhaust HEPA filters and suction side of fan.	-1000 (4)		
8	Process exhaust upstream of exhaust filters, or upstream of exhaust fan if there are no exhaust filters	-750 (3)		
9	Chemical fume hood exhaust ductwork on suction side of exhaust fan	-750 (3)		
10	Biohazard exhaust ductwork	-750 (3)		
11	Exhaust ductwork on discharge side of fans for: autopsy exhaust, process exhaust, chemical fume hood exhaust, biohazard exhaust	+500 (2)		
12	Perchloric Acid exhaust system on suction side of exhaust fan	-1500 (6)		
13	Perchloric Acid exhaust system on discharge side of exhaust fan	+500 (2)		
14	Return air and general exhaust risers in mechanical rooms and in vertical service spaces (duct shafts).	-750 (3)		

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 ductwork upstream of HEPA filters, including diffusers with integral HEPA filters. ⁽⁵⁾	+750 (3)		
16	Supply air ductwork downstream of terminal units or reheat coil with terminal HEPA filters	+500 (2)		
17	Return air and general exhaust air ductwork on suction side of fans <u>other than</u> in mechanical rooms and vertical service spaces.	-500 (2)	C	Transverse joints and other connections
18	Supply air ductwork downstream of terminal units or reheat coil.	-250 (1)	C	Transverse joints only
19	Relief air ductwork on discharge side of return fan; Fan coil units, suction and discharge.	+250 (1)	C	Transverse joints only

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-vented elbow	1.5	≤ 300 (12)	---	Default
			1.0	> 300 (12)	---	
2	CR3-3	Smooth radius Vented elbow	0.75	≤ 900 (36)	150 (6)	One full radius single thickness splitter vane

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
	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.
4	CR3-2	Radius Heel Sharp Throat	0.5	---	---	Double thickness turning vanes as per CR3-3, 4 or 5 depending on duct width

.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
		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.

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.

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

Table 6 : Round Duct, Elbows					
Ref. No.	Description	ASHRAE Fitting No.	Throat Radius Ratio R/W	Duct Width Limit mm (in)	Remarks
		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 Coors

- .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 at not more than 6 m (20 ft) intervals on supply air ductwork installed after HEPA filter,
 - .3 at base of each accessible duct riser,
 - .4 in front of and behind duct mounted coils,
 - .5 at activation side of fire, smoke, and combination fire/smoke dampers,
 - .6 and motorized dampers where damper actuator is located inside of duct or plenum.
- .2 Door size:
- .1 Select access door sizes based on smallest duct dimension in accordance with table 8.

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 1.33 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.

	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	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

Duct Type	Seal Class		
	C	B	A
Rectangular metal	24	12	6
Round Metal	12	6	3
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					
<p><u>Legend</u></p> <p>“Yes” means permitted material “---” means not permitted</p> <p>Where more than one material is indicate as permitted for a particular application or location, than any of those permitted materials may be used.</p>					
Application or Location	Galvanized Steel Z180 (G60)	Galvanized Steel Z275 (G90)	Stainless Steel	Aluminum	Notes
Outdoors	---	Yes	Yes	---	[1]
Intake air plenums	---	Yes	Yes	---	[1]
Exhaust air plenums	---	Yes	Yes	---	[1]
Parking garages	---	Yes	Yes	---	[1]
Indoor swimming pools and spas	---	---	Yes	Yes	[2]
Shower rooms	---	---	Yes	Yes	
Indoor painted ductwork	---	Yes	---	---	
Owner Process Equipment Exhaust	---	---	Yes	---	[2]
Duct-mounted humidifiers	---	---	Yes	---	
Shower exhaust ducts	---	---	Yes	Yes	
Buried ductwork	---	PVC Coated	Yes	---	
All other indoor locations	Yes	Yes	---	---	

Notes:

[1] For both insulated and uninsulated ductwork.

[2] No. 4 brushed finish for exposed ductwork and hoods, No. 2B mill finish for concealed ductwork.

Schedule B – Illustration of Referenced Fittings

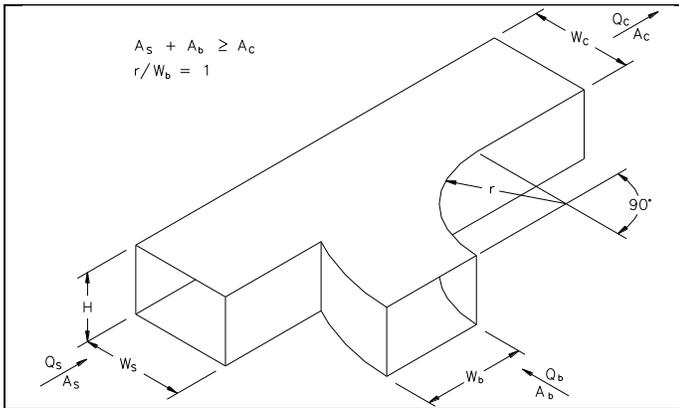
Rectangular Elbows (see Table 4 in Part 3.)

<p>$C_o = K C_p$</p> <p>where $K = \text{angle factor}$</p>	
<p>CR3-1</p>	<p>CR3-2</p>
<p>$C_o = K C_p$ $R_1 = R/CR$</p> <p>where $R = \text{throat radius}$ $R_1 = \text{splitter vane radius}$ $CR = \text{'CURVE RATIO'}$ $K = \text{angle factor}$</p>	<p>$C_o = K C_p$ $R_1 = R/CR$ $R_2 = R_1/CR = R/CR^2$</p> <p>where $R = \text{throat radius}$ $R_1 = \text{splitter vane \#1 radius}$ $R_2 = \text{splitter vane \#2 radius}$ $CR = \text{'CURVE RATIO'}$ $K = \text{angle factor}$</p>
<p>CR3-3</p>	<p>CR3-4</p>
<p>$C_o = K C_p$ $R_1 = R/CR$ $R_2 = R_1/CR = R/CR^2$ $R_3 = R_2/CR = R/CR^3$</p> <p>where $R = \text{throat radius}$ $R_1 = \text{splitter vane \#1 radius}$ $R_2 = \text{splitter vane \#2 radius}$ $R_3 = \text{splitter vane \#3 radius}$ $CR = \text{'CURVE RATIO'}$ $K = \text{angle factor}$</p>	<p>$r = 2.0 (50), s = 2.125 (60) \text{ in. (mm)}$</p>
<p>CR3-5</p>	<p>CR3-15</p>

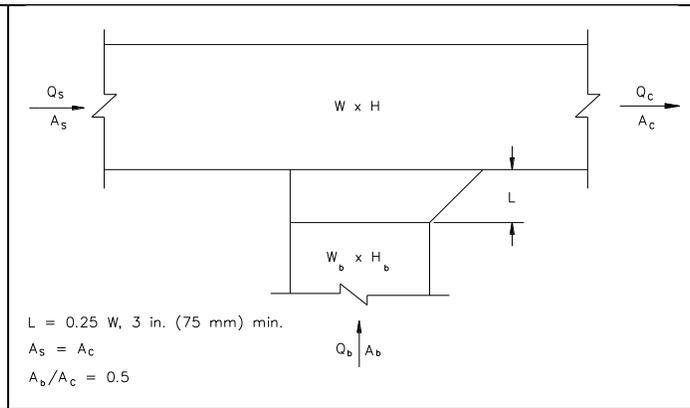
Rectangular Wyes and Tee's – Supply Ductwork (see Table 5 in Part 3)

<p>$A_s = A_b \geq A_c$ $r/W_b = 1.0$</p>	<p>$L = 4 \text{ in. (100mm)}$</p>
<p>SR5-1</p> <p>$L = 0.25W_b, 3 \text{ in. (75mm) min.}$</p>	<p>SR5-12</p> <p>$r/W_c = 1.5$ $Q_{b1}/Q_c = Q_{b2}/Q_c = 0.5$ $W_{b1} = W_{b2} = W_b$</p>
<p>SR5-13</p> <p>$r/W_c = 1.5$ $Q_{b1}/Q_c = Q_{b2}/Q_c = 0.5$ $W_{b1} = W_{b2} = W_b$</p>	<p>SR5-14</p> <p>SMACNA Fig. 4A/4B</p>

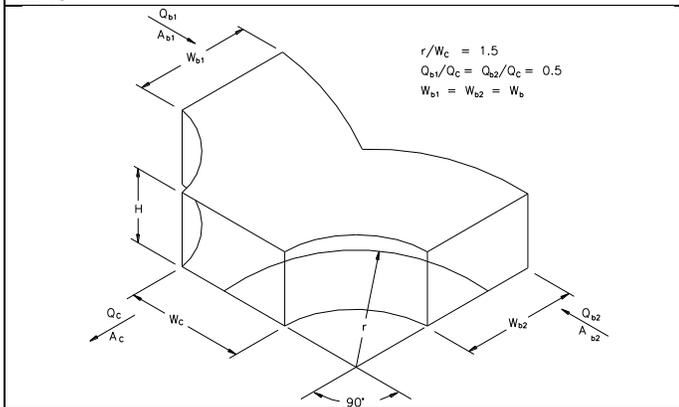
Rectangular Wyes and Tee's – Return/Exhaust Ductwork (see Table 5 in Part 3)



ER5-1

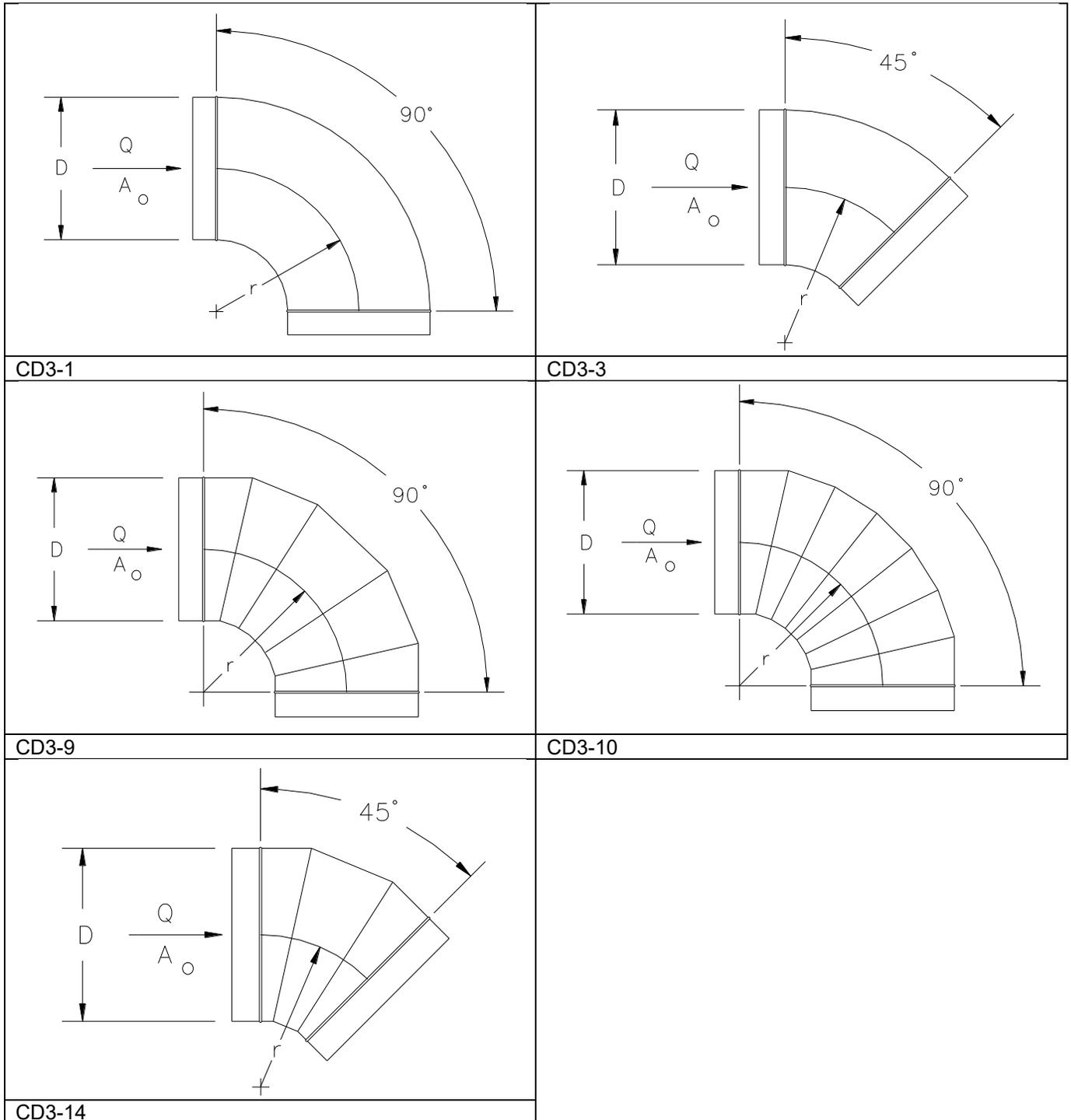


ER5-3

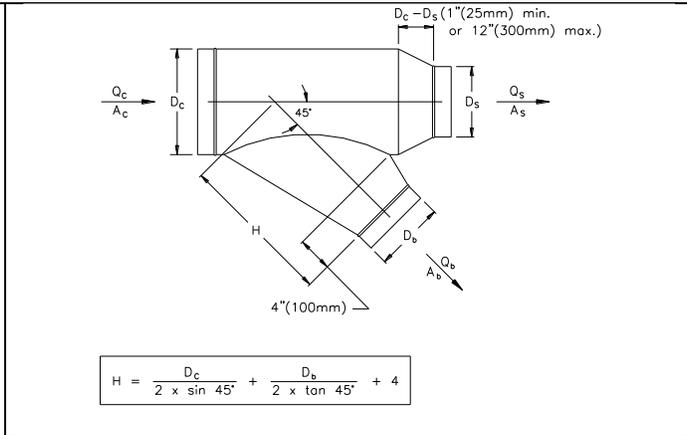
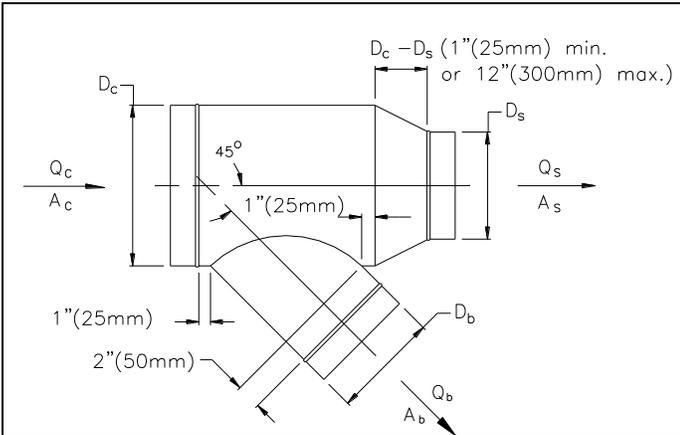


ER5-4

Round Elbows (see Table 6 in Part 3)

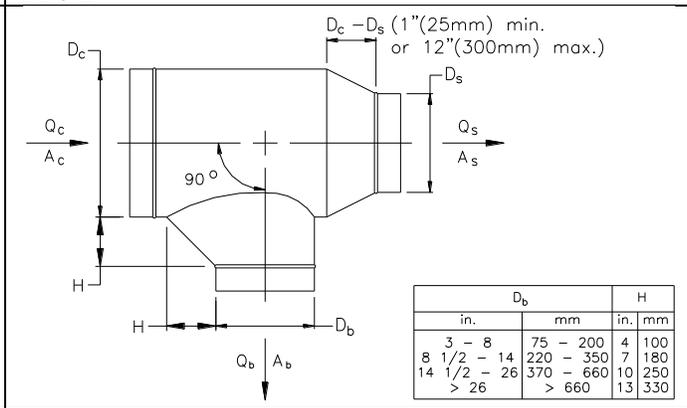
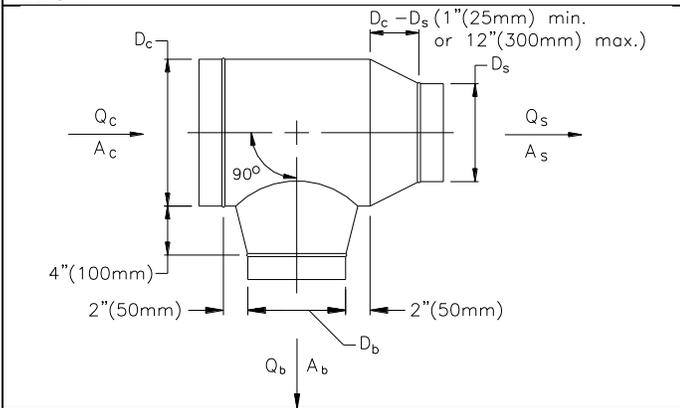


Round Wyes and Tees (see Table 7 in Part 3)



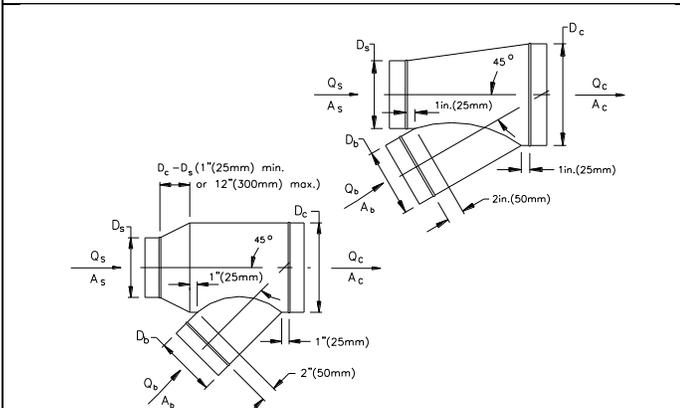
SD5-1

SD5-2



SD5-10

SD5-12



ED5-2

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 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)

2.2 Tape

- .1 Polyvinyl treated open weave glass fibre tape, 50mm (2") wide.

2.3 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

2.4 Access Doors for Plenums

- .1 Shop fabricated doors:
 - .1 double-wall construction, fully encapsulating 25 mm (1 in.) thick glass-fibre insulation,
 - .2 same material as duct, with both inner and outer panels of same thickness as associated plenum wall but not less than 0.6 mm (26ga.) thick,
 - .3 door frame: structural angles, galvanized steel minimum 2.0 mm (14 ga.) thickness, with continuous welded joints,
 - .4 gasket: automotive-style Neoprene gaskets bonded to door frame,
 - .5 door size: 500 mm wide x 1370 mm high (20 in. x 54 in.) except as otherwise shown,
 - .6 door swing:
 - (a) inwards for positive pressure plenums,
 - (b) outwards for negative pressure plenums.
- .2 Door hardware:
 - .1 hinges: continuous piano hinge, zinc-plated steel or stainless-steel,
 - .2 handles: two (2) handles operable from both sides.

Standard of Acceptance

- Duro-Dyne - fig. SP-20 (door handles)

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 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

3.2 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
Fire dampers - replaceable thermal link type	Either side of damper
Motorized fire dampers, smoke dampers and combination smoke fire	On actuator side of damper
Motorized Dampers	Either side of damper
Duct smoke detectors	Across from or beneath sensor tube
Bottom of duct risers	Bottom of duct riser, or on backside of elbow

- .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.

3.3 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 ducted inlets to roof and wall exhausters,
 - .2 at inlet to and outlet from other fan systems, and
 - .3 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 outside air intakes,
 - .2 at inlet and outlet of coils, and
 - .3 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

DAMPERS - OPERATING

23 33 13.13

1 GENERAL

1.1 Scope

- .1 Provide motorized control dampers 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 25 30 13 Building Automation Actuators and Operators
 - .2 25 30 23.13 Building Automation Control Dampers

1.3 Applicable Codes and Standards

- .1 Product standards:
 - .1 AMCA 511 Product Rating Manual for Air Control Devices

1.4 Submittals

- .1 Submit product data sheets for materials specified herein and include:
 - .1 performance charts, pressure drop vs approach velocity for range of blade angles from 0 to 90°,
 - .2 torque requirements,
 - .3 construction details.

2 PRODUCTS

2.1 Multi-Blade Operatable Control Dampers

- .1 Performance:
 - .1 control dampers listed to AMCA 511.
 - .2 leakage in closed position: AMCA Class 1A at 250 Pa (1 in.wc.) and Class 1 at 1000 kPa (4 in.w.c.).
 - .3 pressure drop in open position: maximum 12 Pa (0.05 in wg) differential at 5 m/s (1000 fpm).
 - .4 operating temperature range: -40 to 100°C (-40 to 212°F)
- .2 Construction:
 - .1 non-insulated dampers:
 - (a) blades: extruded aluminum interlocking blades,
 - (b) frame: extruded aluminum,
 - .2 insulated dampers:
 - (a) blades: extruded aluminum interlocking double thickness insulated blades,
 - (b) frame: extruded aluminum, thermally broken,
 - .3 seals: extruded vinyl seals, and spring stainless steel side seals,

- .4 bearings: Celcon or similar inner bearing with polycarbonate outer bearing,
- .5 maximum blade width: 150 mm (6 in),
- .6 maximum blade length: 1200 mm (4 ft).
- .7 blade linkage: aluminium and zinc-plated steel tie rods, brass pivots and steel brackets, for parallel blade and opposed blade operation as required for damper control operation.

3 EXECUTION

3.1 Damper Movement Style Selection

- .1 Blade movement type (for control function other than recirculating air handling units):
 - .1 parallel blade style for two position operation.
 - .2 opposed blade style for modulating applications.

3.2 Installation

- .1 Secure dampers within ductwork, air handling units and at air inlets and exhaust outlets.
- .2 Caulk around frames and between multiple damper modules with UL listed silicone-free duct sealant.

3.3 Start-Up and Testing

- .1 Stroke dampers fully open and fully closed ten times. Check for free movement of damper blades. Check dampers full close along blade edge seals and end seals.

End of Section

DAMPERS - FIRE AND SMOKE

23 33 13.16

1 GENERAL

1.1 Scope

- .1 Provide fire dampers and ceiling fire stop flaps.

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 13.16 Wiring Requirements for Mechanical Services

1.3 Definitions

- .1 The following definitions apply for this specification section:
 - .1 **Damper:** means a smoke damper, motorized fire damper or combination smoke/fire damper.
 - (a) **Balancing damper:** : a damper with an electric actuator that is listed for operation as a modulating damper in normal service, to allow setting the damper at a position between open and closed, for system air balancing purposes.
 - (b) **Dynamic damper:** a fire damper rated to close with airflow through damper at specified air velocities and operating pressure.
 - (c) **Modulating damper:** a damper with an electric actuator that is listed for operation as a modulating damper in normal service, to allow modulating control of the damper in response to a normal (non-emergency) process control requirement.
 - (d) **Reopenable damper:** a motorized fire damper of combination smoke/fire damper that can be electrically re-opened by bypassing the primary heat detection device.
 - (e) **Static damper:** a fire damper rated only to close with essentially no airflow through the damper.

1.4 Applicable Codes and Standards

- .1 Installation codes and standards:
 - .1 NFPA 80 Installation, Testing, and Maintenance of Fire Dampers
- .2 Product standards:
 - .1 AMCA 500-D Laboratory Methods of Testing Dampers for Ratings.
 - .2 ANSI/CAN/UL/ULC 33 Heat Responsive Links for Fire-Protection Services
 - .3 CAN/ULC - S112 Standard Method of Fire Test of Fire Damper Assemblies
 - .4 CAN/ULC - S112.2 Standard Method of Fire Test of Ceiling Firestop Flap Assemblies
 - .5 ULC-S505 Standard for Fusible Links for Fire Protection Services

1.5 Submittals

- .1 Submit manufacturer catalogue cut-sheets for the following materials;
 - .1 fire dampers,
 - .2 fire stop flaps.
- .2 When requested by an AHJ for building safety, submit confirmation data that the fusible link is listed to ULC-S505 or ANSI/CAN/UL/ULC 33.

2 PRODUCTS

2.1 General

- .1 Approvals:
 - .1 Fire dampers listed to CAN/ULC-S112.
 - .2 Ceiling fire stop flaps listed to CAN/ULC-S112.2.
 - .3 Fusible links for fire dampers listed to ULC-S505 or ANSI/CAN/UL/ULC 33.

2.2 Fire Dampers - General Requirements

- .1 Curtain damper styles:
 - .1 Type A: blade pack and frames in airstream,
 - .2 Type B: blade pack out of airstream,
 - .3 Type C:
 - (a) blade pack and frame out of airstream,
 - (b) for rectangular, round and flat oval ductwork, and
 - (c) sleeve joints and damper/sleeve joints sealed.
- .2 Fire damper fire-resistance rating:
 - .1 Fire separation ratings 2 hr and less: 1-1/2 hrs.
 - .2 Fire separation rating 3 hr or more: 3 hr.
- .3 Installation orientation:
 - .1 Dynamic and static dampers suitable for installation in vertical and horizontal separations.
 - .2 Dampers that are only listed for one orientation are not permitted.
- .4 Rating class, dynamic dampers:
 - .1 Standard performance;
 - (a) air velocity, maximum 10 m/s (2000 fpm),
 - (b) operating static pressure, maximum 1000 Pa (4 in.w.c.)
 - .2 Extended performance ("EPxx");
 - (a) air velocity, maximum 15 m/s (3000 fpm),
 - (b) operating static pressure, maximum 1000 Pa (4 in.w.c.)
 - .3 High velocity performance ("HVxx");
 - (a) air velocity, maximum 20 m/s (4000 fpm),
 - (b) operating static pressure, maximum 1000 Pa (4 in.w.c.)
- .5 Manufacturers:

Standard of Acceptance

- Nailor
- EH Price (National Controlled Air)
- Ruskin

2.3 Fire Dampers - Curtain Type

- .1 Construction:

- .1 Frame: G60 roll formed galvanized steel frame.
- .2 Blades: curtain type, interlocking blades, G60 galvanized steel.
- .3 Sleeve:
 - (a) same material as damper frame, length to suit application with steel enclosure and transition collars, and retaining angles.
 - (b) for type B damper sleeves, top of sleeve is formed closely around top of damper; sleeve construction that leaves the blade pack in the airstream is not permitted.
- .4 Sleeve type: type A, B, or C as specified in Part 3.
- .5 Fusible link: 71°C (160°F) unless otherwise shown.
- .6 Notwithstanding the above, frame, sleeve, and blades to be stainless steel where damper is installed in a duct system which is stainless steel.
- .7 Dynamic dampers: fitted with stainless steel closure spring, and rated for velocity and operating pressure based on rating class.
- .8 Static dampers: fitted with stainless steel closure spring.

2.4 Fire Dampers - Multiblade Type

- .1 Construction:
 - .1 Type: dynamic.
 - .2 Frame: G60 galvanized steel hat channel.
 - .3 Blades: airfoil multiblade type, interlocking blades, G60 galvanized steel;
 - (a) Parallel blade for Open-Closed operation,
 - (b) Opposed blade for modulating control or balancing control.
 - .4 Blade linkage: plated steel, concealed in frame (out of airstream).
 - .5 Bearings:
 - (a) On-Off control, and balancing: self-lubricated oil-tight bronze,
 - (b) modulating control: stainless steel.
 - .6 Jackshaft: cadmium plated steel.
 - .7 Internal locking quadrant for balancing maximum opening position.
 - .8 Sleeve: same material as damper frame, length to suit application with steel enclosure and transition collars, and retaining angles.
 - .9 Sleeve type: type A, B, or C as per listing requirements.
 - .10 Notwithstanding the above, the frame, sleeve, and blades to be stainless steel where damper is installed in a duct system that is stainless steel.
- .2 Operator - fusible link:
 - .1 Torsion spring, with 74°C (165°F) fusible link unless otherwise shown.
- .3 Operator – electric damper actuator:
 - .1 Factory installed electric damper actuator in accordance with article on Damper Actuators as required
 - (a) by certification listing for large dampers/damper bank applications, or
 - (b) where otherwise shown.

- .2 Electric resettable heat detection switches, Normally Closed contacts opening on temperature rise above setpoint;
 - (a) setpoint temperature, non-reopenable damper: 74°C (165°F),
 - (b) setpoint temperature, reopenable damper:
 - i) primary switch: 74°C (165°F),
 - ii) secondary switch: 176°C (350°F).

2.5 Special Sleeve Modifications

- .1 Special sleeve and damper arrangements for:
 - .1 single-sided retention angle installation,
 - .2 sleeve mounting tags for air diffusers and grilles directly attached to fire damper sleeve and wall opening. Dampers positioned in sleeve to allow for balancing damper installed on back-side of grille or diffuser.

2.6 Fire Stop Flaps (Ceiling Radiation Dampers)

- .1 Construction:
 - .1 Galvanized steel frame and blades for round or square neck diffusers.
 - .2 Fitted with corrosion resistant steel springs and replaceable 71°C (160°F) fusible link.
 - .3 Supplied with thermal blanket cut to suit diffuser face plate dimensions and diffuser neck size.
 - .4 Labeled or listed and rated for both steel duct and flexible duct installations.
 - .5 Fitted with adjustable volume controllers where shown.

3 EXECUTION

3.1 Installation – General Requirements

- .1 Install fire dampers and fire stop flaps throughout supply, return and exhaust air systems in fire separations marked as having a fire resistance rating and as shown.
- .2 Install fire dampers in accordance with manufacturer's instructions, with sleeve, duct connections and angle supports to comply with terms and conditions of listing or classification and maintain integrity of fire wall and/or fire separation.
- .3 Install stainless steel dampers in stainless steel duct systems and/or wherever ductwork is specified to be watertight construction.

3.2 Fire Damper Selection

- .1 Select fire damper types as follows:
 - .1 "Dynamic" - all locations unless otherwise shown,
 - .2 "Static" - restricted to un-ducted transfer air openings.
- .2 Select curtain-type fire damper styles as follows:
 - .1 For dynamic and static dampers:
 - (a) duct height in the following tables is the duct dimension perpendicular to blade length orientation.

Damper Velocity Class	Duct Height mm	Curtain Damper Style
Standard Performance (≤ 10 m/s)	> 300	A
	≤ 300	B
Extended Performance (10 to ≤ 12.5 m/s)	> 200	B
	≤ 200	C
High Velocity Performance (> 12.5 m/s)	Any	C

Damper Velocity Class	Duct Height In.	Curtain Damper Style
Standard Performance (≤ 2000 fpm)	> 12	A
	≤ 12	B
Extended Performance (2000 to ≤ 2500 fpm)	> 8	B
	≤ 8	C
High Velocity Performance (> 4000 fpm)	Any	C

3.3 Fire Damper Installation

- .1 Where the duct size exceeds the maximum listing size of a multiple curtain damper assembly, provide multiblade fire dampers.
- .2 Where fire dampers are shown to be motorized, provide multiblade fire damper with electric operator.

3.4 Damper Sleeves

- .1 Provide factory-made damper sleeves in accordance with damper listing requirements, and as described herein.
- .2 For multiblade dampers, smoke dampers, and combination smoke/fire dampers, fabricate sleeve style based on damper size listing requirements.
- .3 Install damper sleeves with retaining angles in accordance with the damper manufacturer instructions.
- .4 Where a diffuser or grille is shown at a fire damper, smoke damper or combination smoke/fire damper, provide sleeves specifically listed for single sided retention angles and which provide brackets for securing of the grille or diffuser to the sleeve.
- .5 Where permitted by the damper manufacturer installation instructions, smoke dampers may be fastened directly to the duct without requiring the use of a sleeve.

3.5 Damper Access Doors

- .1 Provide duct access door at each fire damper to permit visual inspection and replacement of fusible link. Do not locate access doors in a vertical service space (shaft).
- .2 Provide duct access door at each smoke damper and combination smoke/fire damper, to permit visual inspection and service of fire detection/actuation mechanism. Provide such access doors even where dampers are provided with electrically supervised damper position indication.
- .3 For curtain-type fire dampers in vertical ducts, the preferred access location is from the floor above the damper.

- .4 For motorized fire dampers, smoke dampers and combination smoke/fire dampers installed in vertical ducts, position the damper actuator assembly so that it is not located in a vertical service space (shaft). Preferred position in order of priority and applicability are:
 - .1 above floor level in a service room,
 - .2 in the ceiling space below the bottom of a vertical service space.
- .5 Install damper actuator assemblies on the room side of a damper isolating the room from a corridor, except where the duct ends at a wall grill.

3.6 Fire Stop Flap Installation

- .1 Install fire stop flaps in accordance with manufacturers' instructions. Position supplied thermal blankets to cover ceiling diffusers.

3.7 Damper Power Supplies; Non-Controlled Dampers

- .1 This article applies to fire dampers requiring electric actuators due to the limitations of damper size in accordance with each manufacturer product listing, but are otherwise not remotely controlled.

3.8 Testing

- .1 Conduct installation tests of all fire dampers in accordance with NFPA 80, NFPA 90A and NFPA 105 as applicable to damper type and summarized as follows.
- .2 Field test all fire dampers and fire stop flaps as follows:
 - .1 operate dampers to demonstrate unobstructed operation of the damper from open-to-close-to open state. These tests are to be performed while the fan systems are not in operation (static test),
 - .2 for dynamic dampers, confirm air velocity through the open dampers under normal HVAC system operation, once air balancing is completed. Select dampers to confirm operation for ducts operating within 80% of the maximum air velocity of the damper listing,
 - .3 confirm accessibility to components of fire damper to permit maintenance and testing,
 - .4 where a damper is provided with an indicating device, confirm device functions and annunciates to the supervised location or system when the damper is in both the open and closed state, as applicable.
- .3 In addition, for multiblade fire dampers with electric operators, smoke dampers or combination smoke/fire dampers, cycle test dampers under normal HVAC operating conditions (dynamic test).
- .4 Record test results as per the attached test form or similar containing the same information, and submit to Owner and Consultant as part of the Operations and Maintenance manual.
- .5 Upon completion of testing, provide labour and resources necessary to conduct a demonstration re-test for up to 10% of curtain-type dampers on each floor as selected and witnessed by Engineer.

3.9 Test Form

- .1 Test form follows at the end of this section.

Fire Damper Test Record

<i>Project</i>							<i>System</i>		
<i>Testing Company</i>							<i>Technician Name</i>		
Damper location	Inspection Date YYYY-MM-DD	Damper Type ⁽¹⁾	Static Op. Test ⁽²⁾	Dyn Op. Test ⁽³⁾	Access Test ⁽⁴⁾	Air Flow ⁽⁵⁾	Confirmed/ Deficiencies	Deficiency Corrected	Damper Audited

- (1) Damper Type : FD, MFD, SD, or CSFD
- (2) Static Operating Test without airflow
- (3) Dynamic Operating Test with balanced airflow; multiblade FD, SD and CSFD only.
- (4) Damper and components are accessible for inspection and testing
- (5) Identify which damper air velocity is checked in accordance with the test selection criteria.

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,
 - .2 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 14 17 Building Automation Terminal Unit Controllers
 - .4 25 30 13 Building Automation Actuators and Operators

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
Low Voltage Transformers – Part 3: Class 2 and Class 3 Transformers
 - .5 CSA C22.2 No. 94.1 Enclosures for Electrical Equipment, Non-Environmental Considerations
 - .6 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: 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 ASHAE 130,
 - .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 (26 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 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,
 - (b) an additional protective overlay of perforated galvanized steel.

Standard of Acceptance

- Steri-Liner

.7 Access doors

- .1 factory installed access doors;
 - (a) field installation of access doors are prohibited.
- .2 where required:
 - (a) in unit cabinet after control damper,
 - (b) upstream of reheat coil,
 - (c) located on underside or side of unit depending on site conditions.
- .3 fabricated from galvanized steel, minimum 0.76 mm (22 ga) thickness,
- .4 19 mm (3/4") thick internal insulation, same material as liner,
- .5 size: 150 x 100 mm (6 x 4 in),
- .6 fastening: screws,
- .7 location: bottom of unit to allow access to damper assembly.

2.3 Silencer

- .1 Silencers used on all terminal units.
- .2 Construction:
 - .1 aero-dynamic shaped sound absorbing baffles, with perforated metal liners and acoustic media,
 - .2 acoustic media: fiberglass acoustic media, encapsulated within a Mylar or Tedlar film to separate acoustic media from the airstream,
 - .3 lengths:

(a) minimum 900 mm (36 in)

2.4 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.]

2.5 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.
- .2 Power supply for electric reheat coils to be provided under Division 26.

3.5 Leakage Testing

- .1 Terminal units and attenuators to be included in ductwork leakage testing as part of the upstream ductwork pressure.

END OF SECTION

GRILLES, REGISTERS AND DIFFUSERS

23 37 13

1 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: [steel][aluminium]
- .5 Damper: [steel radial opposed blade][duct mounted full-flow damper][none]
- .6 Specials: all aluminium construction for magnetic resonance imaging (MRI) rooms.

2.3 Plenum Slot Diffusers (ref. "PSD")

- .1 Application: supply air.
- .2 Style: linear diffuser with integral plenum for installation in a T-bar ceiling or drywall ceiling;
 - .1 side-inlet with circular duct connection,
 - .2 1, 2, 3 or 4 linear slots with intermediate aluminium Tee, number of slots as shown,
 - .3 slot width as shown,

- .4 center notch where diffusers span across a cross Tee,
- .5 suitable for lay-in to T-bar or into a drywall ceiling plaster frame.
- .3 Frame: none.
- .4 Material: painted steel.
- .5 Pattern controller: [pincer][curved][blade][as shown].
- .6 Damper: none.
- .7 Insulation: diffuser externally insulated with 12 mm (1/2 in.) foil-backed fibreglass insulation.
- .8 Specials: aluminium plaster frame for dry-wall ceiling installation.

2.4 Hospital-Grade Louvred Grille (type "LG-H")

- .1 Application: supply, return and exhaust air.
- .2 Style: rectangular louvred with frame and removable core;
 - .1 removable louvre and border assembly with quick-release fasteners,
 - .2 fixed single-deflection louvres,
 - .3 louvres and frame materials: stainless steel,
 - .4 blade spacing: 13 mm (1/2 in.) unless otherwise shown,
 - .5 deflection: 45°.
 - .6 blade orientation: horizontal for vertical grilles, parallel to the long dimension for horizontal grilles,
 - .7 border: nominal 32 mm (1-1/4 in.) flat face for surface mount, unless otherwise shown,
- .3 Frame: 9mm (3/8 in.) flat border.
- .4 Fasteners: retained quick-release type.
- .5 Finish:
 - .1 blades: No. 2B finish
 - .2 frames: No. 4 finish
- .6 Damper:
 - .1 supply air: opposed blade damper, stainless-steel with mill finish, with manual operator.
 - .2 Return air and exhaust air: none.
- .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][opposed blade damper with manual operator].
- .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

HYDRONIC DUCT-MOUNTED AIR COILS

23 82 16

1 GENERAL

1.1 Scope

- .1 Provide hydronic duct-mounted heat transfer coils (reheat coils) and accessories as shown.
- .2 This section applies to:
 - .1 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

- .1 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 (0.20 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.

3.2 Ductwork Installation

- .1 For terminal unit reheat coils, make duct connections to coil at full size of coil connections.
- .2 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 for associated requirements.

END OF SECTION

BUILDING AUTOMATION COMMON WORK RESULTS

25 05 01

1 GENERAL

1.1 Scope

- .1 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.
- .2 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.
- .3 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.
- .4 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.
- .5 Controls Contractor must use previously agreed "Open Book Pricing" for this Project. Consultant will request confirmation of this.

1.2 Dependent Sections

- .1 The BAS Work is further defined in the following specification sections:

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 19.13	Building Automation Control Valves
25 30 19.16	Building Automation PICV and Energy Valves
25 30 23.13	Building Automation Control Dampers
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 20 08 11 Testing of Mechanical Life Safety and Fire Protection Requirements
 - .3 23 36 13 Terminal Units

1.4 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 to be installed in piping systems,
 - .3 temperature wells for controllers and sensors provided under this Section, for installation in piping systems,
 - .4 instrumentation including air flow stations to be installed in ductwork systems,
 - .5 motorized dampers.

1.5 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.

1.6 Equipment Provided under Other Divisions

- .1 The following equipment is provided under other Sections of Division 20;
 - .1 manual dampers, non-motorized fire 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

- 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.
- .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;
 - (a) extend existing.

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

- .1 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 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 stable 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,
 - .2 allow for three (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.

- .2 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

1 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 Refer to specification section 25 05 01.

1.5 Design Criteria

- .1 Existing BAS networks:
 - .1 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) thermocouple wells,
 - (d) freezestats,
 - (e) firestats,
 - (f) limit, end, or level switches and air or liquid flow switches,
 - (g) static pressure sensors and controllers,
 - (h) wiring and conduit for safety controls and I/O points,
 - (i) relays,
 - (j) cabinets,
 - (k) 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 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.

1.7 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 Additional Requirements for Outdoor Panels

- .1 The following additional requirements apply where control panels are installed outdoors, or indoors in unheated spaces.
- .2 Enclosure: type 4, 4X or 12 to CSA C22.2 No. 94.1 (NEMA 4, 4X or 12),
- .3 Thermally insulated on all interior surfaces
 - .1 minimum thickness: 25 mm (1 in) at a maximum thermal conductivity of 0.0365 W/mK (0.0211 Btuh/ft²F) , or equivalent minimum RSI= 0.68 m²K/W (R = 3.86 ft²F/BTUH).
- .4 Mount GUI and other front-mount devices on inner front panel behind main panel door.
- .5 Electric resistance panel heater:
 - .1 electric resistant heaters listed to CAN/CSA C22.2 No. 72,
 - .2 sized to maintain panel interior temperature at not less than 4.5°C (40°F), at the ambient design temperature.
 - .3 integral or line mounted thermostat control, set with a temperature deadband of ON at 4.5°C (50°F) and OFF at 12°C (55°F).

2.8 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

Master revised: July 15, 2021

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 01 Building Automation Common Work Results
 - .3 25 05 12 Building Automation Control Panels and Wiring
 - .4 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 in accordance with specification section 25 05 01.
 - .2 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.

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) patient rooms,
 - (j) protective isolation rooms,
 - (k) airborne isolation rooms,
 - (l) operating rooms - organized by same minimum ACH rates,
 - (m) treatment rooms – organized by same minimum ACH rates,
- .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
 - .5 25 30 33 Building Automation Control Dampers

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-E60730-2-14 Automatic Electrical Controls - Part 2: Particular Requirements for Electric Actuators

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.*
- .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 Damper Actuators - General Purpose Electric/Electronic

- .1 General purpose damper actuators for air handling unit dampers and plenum/duct mounted dampers.
- .2 Listed to CAN/CSA-E60730-2-14.
- .3 Control action:
 - .1 electric/electronic operation for two position (OPEN-CLOSE) and proportional-modulating operation as shown,
 - (a) floating-point modulation not acceptable.
- .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 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 damper shaft,
 - (a) remote mounted with connecting linkage and with fastening clamp assembly are permitted only where there is insufficient space for mounting actuator directly onto damper shaft.
 - .5 electronic overload or digital rotation sensing circuitry to protect damper operator through entire range of rotation,
 - .6 angle of rotation adjustable between 0° to 90°,
 - .7 input control signals:
 - (a) proportional-modulation service: 0 - 10V, 2-10 V, or 0 - 20mA,
 - (b) two position service: power On-Off
 - .8 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
 - .9 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 manufacturer's instructions,

- .2 minimum torque rating for dampers: sufficient to operate damper to provide smooth response up to fan dead-head pressure plus 15%,

2.3 Damper Actuators - Specific Purpose Electric/Electronic for Emergency Equipment

- .1 Specific purpose damper actuators for ventilation dampers serving emergency equipment.
- .2 Type: as above for general purpose damper actuators and as follows.
- .3 Operating temperature: -40°C to + 50°C (-40°F to 122°F).
- .4 Control action:
 - .1 spring return to fail position on loss of power supply:
 - (a) combustion air dampers : fail-to-open
 - (b) ventilation inlet air dampers: fail-to-open
 - (c) recirculation air dampers: fail-to-close
 - (d) exhaust air dampers: fail-to-open.
 - .2 spring operating cycle time: <20 seconds at -20°C to 50°C (-4°F to 122°F)
- .5 Enclosure:
 - .1 integral heating element for low temperature operation, 24 VAC.
- .6 Operating control:
 - .1 combustion air dampers: two position open/closed
 - .2 all other dampers: proportional-modulating with 0-10VDC or 4-20 mA input signal

Standard of Acceptance

- Belimo - EFB24-S N4/EFB120-S N4 series for two position dampers
- Belimo - EFB24-SR-S N4 series for modulating dampers

2.4 Damper Actuators - Specific Purpose Electronic for Terminal Units

- .1 Specific purpose damper actuators for terminal units.
- .2 Listed to CAN/CSA-E60730-2-14.
- .3 Control action:
 - .1 proportional-modulating type control,
- .4 Enclosure:
 - .1 Type 2 to CSA C22.2 No. 94.1, or NEMA 2, for indoor applications,
- .5 Construction:
 - .1 gear drive, direct coupled type operators mounted to terminal box damper shaft with universal V-bolt clamp,
 - .2 selectable / reversible rotation direction,
 - .3 input type and range as suitable for interfacing to output of terminal unit controller,
 - .4 angle of rotation adjustable between 0 to 90° with adjustable mechanical limit stops,
 - .5 damper position indication visible without cover removal,
 - .6 manual override to set damper position without power applied to actuator,

- .7 electronic stall protection,
- .8 actuator running time of not more than 100 seconds,
- .9 failure mode on loss of power to the actuator:
 - (a) non-smoke control or smoke venting applications: fail in last position,
- .10 power supply: 24 VAC/VDC, 50/60 Hz.
- .6 Selection:
 - .1 sized and selected in accordance with terminal unit manufacturer's requirements.

2.5 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.

2.6 Valve Actuators - Specific Purpose Electric/Electronic for Large Valves

- .1 Specific purpose valve actuators for large rotary operation butterfly valves with high torque requirements.
- .2 Listed to CAN/CSA-E60730-2-14 or CSA C22.2 No. 24.
- .3 Ambient temperature: -40°C to + 40°C (-40°F to 104°F),
- .4 Control action:
 - .1 electric/electronic operation for two position (OPEN-CLOSE) and proportional-modulating operation as shown,
 - (a) floating-point modulation not acceptable,
- .5 Enclosure:
 - .1 die-cast aluminum alloy,
 - .2 Type 4X to CSA C22.2 No. 94.1 or NEMA 4 or 12.
 - .3 integral heating element for internal humidity control and low temperature operation, same voltage as actuator motor.
- .6 Construction:
 - .1 single or dual-winding bidirectional motor driven actuator,
 - .2 spring-return or electronically fail-safe to failed position,
 - .3 self-locking high alloy steel gear type mechanism,
 - .4 electronic interface control board, solid state drive,
 - .5 span and zero travel adjustment,
 - .6 adjustable motor rotation direction,
 - .7 mechanical position indicator,
 - .8 directly mounted to valve shaft,
 - .9 compatible for installation on ISO 5211 mounting pad,
 - .10 thermal or electronic overload to protect actuator through entire range of rotation,
 - .11 running time: < 60 seconds, independent of load,
 - .12 duty cycle:
 - (a) On/Off valves: minimum 30%
 - (b) Proportional valves: minimum 75%
 - .13 declutching handwheel override,

- .14 valve position indicator,
- .15 input control signals:
 - (a) 0 - 10VDC or 0 - 20mA for proportional-modulation control,
 - (b) power On-Off for two position service,
- .16 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
- .17 power supply:
 - (a) modulating service: 24 VAC/VDC or 120 VAC, 50/60 Hz.
 - (b) two position service: 120 VAC or 24 VAC, 50/60 Hz.
- .7 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%.

2.7 Valve and Damper Actuators - Pneumatic

- .1 Construction:
 - .1 piston and rolling diaphragm type or diaphragm type rated for operating pressure and not less than 140 kPa (20 psig).
 - .2 replaceable diaphragm: molded neoprene,
 - .3 pressure rating: 1030 kPa (150 psi)
 - .4 operating signal pressure range: 0-140 kPa (0-20 psi)
- .2 Enclosure (housing):
 - .1 housings: molded or die-cast from zinc or aluminum,
- .3 For sequencing terminal unit air control damper actuators and actuators on valves for radiation, radiant panels or terminal reheat coils;
 - .1 use spring ranges selected to prevent overlap, or use positive positioners.
- .4 Selection:
 - .1 selected in accordance with damper or valve manufacturer's instructions,
 - .2 of sufficient torque rating to operated damper or valve with smooth action at proper response speed,
 - .3 minimum torque rating for dampers: sufficient to operate damper to provide smooth response up to fan dead-head pressure plus 15%,
 - .4 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 EXECUTION

3.1 Application

- .1 Use electric/electronic actuators for damper and actuators.

3.2 Installation

- .1 General:
 - .1 Mount actuators and provide adapters according to manufacturer's recommendations.
- .2 Electric and Electronic Damper Actuators:
 - .1 Mount damper actuators directly on damper shaft or jackshaft; linkages may be used only where there is insufficient space to install and remove the actuator directly on the damper shaft.
 - .2 Mount valve actuator directly on shaft or with linkages according to manufacturer's recommendations.
 - .3 For low-leakage dampers with seals, mount actuator with minimum 5° travel available for damper seal tightening.
 - .4 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.
 - .5 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 Compressed Air

- .1 Provide compressed air service to each pneumatic actuator in accordance with specification section 25 35 26.
- .2 Provide a manual isolation valve for each actuator.

3.5 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

Master revised: May 10, 2021

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
 - .2 20 05 26 Pipeline Line Stopping
 - .3 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.*

- .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)
 - .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 ohms/ohm/°C (0.0212 ohms/ohm/°F),
 - (d) accuracy: ± 0.36 °C at 21°C (± 0.65 °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, [± 20 ohms (2%)] [± 2 ohms (0.2%)] at 21°C (70°F),
 - (c) temperature resistance coefficient: 5.4 ohm/°C (3.0 ohm/°F)
 - (d) accuracy: ± 0.18 °C at 21°C (± 0.34 °F at 70°F)
 - .3 Thermistor;
 - (a) non-linear negative temperature coefficient of resistance,
 - (b) reference resistance: 10,000 ohms at 25°C (77°F),
 - (c) accuracy: curve matched to ± 0.2 °C (± 0.36 °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 ± 0.25 °C (± 0.5 °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 100mm (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 m² (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 ¾) 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

- .1 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 Space temperature sensors with display and additional features (type TSD/x):
 - .1 Type TSD space temperature sensors with the following additional sensor elements, singly and in combination.
 - .2 Relative humidity sensor (type TSD/H)
 - (a) accuracy: $\pm 3\%$ RH of reading,
 - .3 Carbon Dioxide sensor (type TSD/C):
 - (a) dual beam, self-calibrating NDIR detection,
 - (b) range: 0 – 2000 ppm
 - (c) accuracy: ± 50 ppm + 2% of measured value at 25°C (77°F)
 - (d) stability: 20 ppm/year
 - .4 Occupancy sensor (type TSD/O):
 - (a) passive infrared motion sensor,
 - (b) range: 5 m (16 ft) minimum,
 - (c) sweep coverage: 100° horizontal.
- .5 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 Humidity Sensors – General Purpose

- .1 Sensor construction general requirements:
 - .1 measurement operating ranges of 10 to 100% R.H.
 - .2 sensor operating temperature range from -40°C to 121°C (-40°F to 250°F)
 - .3 solid state sensing element,
 - .4 accuracy of $\pm 3\%$ RH reading over range of 5 to 95% R.H.,
 - .5 independent, non-interactive span and zero adjustments,
 - .6 0-100% linear proportional output signal indicating relative humidity, 4-20 mA, 0-5 Vdc or 0-10 Vdc,
 - .7 strain minimizing construction,
 - .8 screwed terminal connector block.
- .2 Duct mount probe type humidity sensors:
 - .1 metal mounting plate,
 - .2 constructed with 304 stainless steel element enclosure,
 - .3 length such that sensing element is between 35% and 70% of duct width or diameter from duct wall.
- .3 Outside air type humidity sensors:
 - .1 weatherproof enclosure with cover,
 - .2 waterproof seal.
- .4 Space humidity sensors (not included as part of a space temperature sensor):
 - .1 surface mounted plastic guard with surface mounting plate and wall anchors
 - .2 guard secured to mounting plate by screws,
 - .3 analogue LCD humidity display.

2.7 Duct Type Combination Temperature and Humidity Sensors – General Purpose

- .1 Where both temperature and humidity are shown to be measured at same location or in same airstream, use of single measuring unit is permitted provided that features and performance of both the temperature sensor and the humidity sensor are in accordance with requirements of this specification.

2.8 [[High Accuracy Space Combination Temperature and Humidity Transmitter (type THTS)

- .1 For spaces requiring high accuracy measurement as shown.
- .2 Wall mounted humidity and temperature transmitter, with LCD display.
 - .1 traceable calibration certificate, to NIST, ISO 9001 or ISO 17025,
 - .2 field calibration adjustment through front cover, and by PC or service tool through service port connection,
 - .3 user replaceable temperature and humidity sensor modules.
 - .4 user selectable humidity parameters – relative humidity, dew point, mixing ratio, enthalpy, wet bulb temperature, absolute humidity.
- .3 Humidity sensor:

- .1 measurement range: 0 - 100% RH,
- .2 accuracy: $\pm 1.7\%$ RH over 0-90% RH range at a temperature of +10 to +40°C (+50 to 104°F)
- .3 stability: $\pm 0.5\%$ RH/year
- .4 Temperature sensor:
 - .1 measurement range: -5 to +55°C (+23 to +131°F)
 - .2 accuracy: $\pm 0.2^\circ\text{C}$ between +20 to +30°C ($\pm 0.36^\circ\text{F}$ between +68 to +86°F).
- .5 Service port: RS 485 for temporary connection for service.
- .6 Comm port: RS 485 (for network models only),
- .7 Enclosure: polycarbonate or ABS, with viewing window
- .8 Network connection: BACnet MS/TP and Modbus RTU.
- .9 Power: 24 VAC/VDC.]

Standard of Acceptance

- ° Vaisala - fig. HMW95D]

2.9 [High Accuracy Duct Temperature and Humidity Transmitter (type THTD)

- .1 For spaces requiring high accuracy measurement as shown.
- .2 Duct mounted humidity and temperature transmitter,
 - .1 traceable calibration certificate, to NIST, ISO 9001 or ISO 17025,
 - .2 field calibration adjustment through front cover, and by PC or service tool through service port connection,
 - .3 user selectable humidity parameters – relative humidity, dew point, frost point, mixing ratio, enthalpy, wet bulb temperature, absolute humidity.
- .3 Humidity sensor:
 - .1 sensor type: Pt1000 RTD,
 - .2 measurement range: 0 - 100% RH,
 - .3 accuracy:
 - (a) $\pm 1.5\%$ RH over 0-90% RH range at a temperature of 0 to +40°C (+32 to 104°F)
 - (b) $\pm 2.5\%$ RH over 90-100% RH range at a temperature of 0 to +40°C (+32 to 104°F)
 - .4 stability: $\pm 0.5\%$ RH/year
- .4 Temperature sensor:
 - .1 measurement range: -40 to +80°C (-40 to +176°F)
 - .2 accuracy: $\pm 0.1^\circ\text{C}$ at 20°C ($\pm 0.18^\circ\text{F}$ at 68°F).
- .5 Service port: RS 485 for temporary connection for service.
- .6 Comm port: RS 485,
- .7 Enclosure:
 - .1 cast aluminum,
 - .2 Type 4X to CSA C22.2 No. 94.1, or NEMA 4X or IP66,

- .8 Output:
 - .1 Analog output: 2 @ 0-10 V for temperature and humidity
- .9 Network communications: BACnet MS/TP and Modbus RTU.
- .10 Power: 24 VAC/VDC

Standard of Acceptance

- Vaisala - fig. HMD65]

2.10 [Remote Display for High Accuracy Combination Temperature and Humidity Transmitters (type REMD)

- .1 For remote display of duct mounted high accuracy combination temperature and humidity transmitter type THTD.
- .2 Suitable for clean room environments.
- .3 Construction:
 - .1 parameter selectable, two line LCD display,
 - .2 housing:
 - (a) low profile, sealed housing, without openings or grooves, for each surface cleaning,
 - (b) front panel materials: brushed stainless steel case with glass viewing window.
 - (c) backplane mount: polypropylene,
 - (d) suitable for cleaning with common detergents and disinfectants, as well as liquid and gasified hydrogen peroxide.
- .4 Inputs: RS485.
- .5 Power supply: 24 VDC, or dedicated power cable fed from associated temperature/humidity sensor.

Standard of Acceptance

- Vaisala - fig. RDP100]

2.11 [Outdoor Combination Temperature and Humidity Transmitter (type THT-OUT)

- .1 For building reference outdoor conditions.
- .2 Exterior wall mounted humidity and temperature transmitter;
 - .1 traceable calibration certificate, to NIST, ISO 9001 or ISO 17025,
 - .2 on-site field calibration by PC or service tool through service port connection,
 - .3 user selectable humidity parameters – relative humidity, dew point, enthalpy, wet bulb temperature.
- .3 Humidity sensor:
 - .1 sensor: HUMICAP 180R
 - .2 measurement range: 0 - 100% RH,
 - .3 accuracy:

Temperature Range	Humidity Range	Accuracy
-------------------	----------------	----------

-40 to -20°C (-40 to -4°F)	0 – 100% RH	±4% RH
-20 to +10°C (-4 to +50°F)	0 – 90%	±3% RH
	90 – 100%	±4% RH
+10 to +30°C (+50 to +86°F)	0 – 90%	±2% RH
	90 – 100%	±3% RH
+30 to +60°C (+86 to +140°F)	0 – 90%	±3% RH
	90 – 100%	±4% RH

- .4 stability: ±0.5% RH/year
- .4 Temperature sensor:
 - .1 sensor type: Pt1000 RTD,
 - .2 measurement range: -40 to +60°C (-40 to +140°F)
 - .3 accuracy: ±0.2°C at +20°C (±0.36°F at +68°F).
- .5 Calculated parameters:
 - .1 Built-in math processor calculates other air properties based on measured temperature and relative humidity.
 - (a) alternate properties selected by configuration settings.

Calculated Parameter	Range	Accuracy (at 20°C and 80% RH)
Dewpoint	-40 to +60°C (-40 to +140°F),	±0.7°C (±1.2°F)
Wet Bulb	-40 to +60°C (-40 to +140°F),	±0.5°C (±0.9°F)
Enthalpy	-40 to +460 kJ/kg (-10 to +190 BTU/lb)	±1.6 kJ/kg (±0.7 BTU/lb)

- .6 Ambient operating conditions:
 - .1 temperature: -40 to +60°C (-40 to +140°F),
 - .2 humidity 0- - 100% RH.
 - .3 maximum wind speed: 30 m/s (67 mph).
- .7 Service port: RS 485 for temporary connection for service.
- .8 Output: 2 @ 4-20 mA, one each for temperature and relative humidity,
- .9 Comm port: RS 485 (for network models only),
- .10 Housing:
 - .1 glass-reinforced polycarbonate, with rain shrouds and sun-shield,
 - .2 stainless steel wall mounting bracket with backing plate and hardware.

.11 Outputs:

- .1 2 @ 4-20 mA, loop powered transmitter.

.12 Power: 24 VAC/VDC

Standard of Acceptance

- ° Vaisala - fig. HMS110]

2.12 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 Ø8 mm (¼ 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.

2.13 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 $\varnothing 8$ mm ($1/4$ 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 .

2.14 **[[Carbon Dioxide Transmitters**

- .1 Carbon dioxide (CO_2) transmitter – spaces/rooms:
- .1 dual element, non-dispersive, thermally compensated lithium tantalite infrared detector,
 - .2 LCD display of ppm level, trip set point and time delay,
 - .3 LED's indicating normal operation and alarm,
 - .4 range: 0 to 2000 ppm CO_2 in air,
 - .5 accuracy: ± 40 ppm CO_2 + 2% of reading,
 - .6 drift: less than $\pm 5\%$ full scale over five years without calibration,
 - .7 repeatability; $\pm 1.0\%$ of full scale
 - .8 warm-up time: 30 minutes maximum to full specified operation,
 - .9 response time: less than 60 seconds at minimum of 63% of step change,
 - .10 operating temperature range; 0°C to 45°C (32°F to 113°F)
 - .11 operating humidity range; 0 to 85% RH non-condensing,
 - .12 output signals:
 - (a) 4-20 mA, 0-5 Vdc or 0-10 Vdc, and
 - (b) SPST relay, 0.5 A @ 30 VAC, with field adjustable trip point and adjustable time delay for remote alarm.
 - .13 power supply: 24 VAC/VDC,
 - .14 enclosure: polycarbonate or PVC, white finish,
 - .15 warranty: 3 years.

- .2 Carbon dioxide (CO₂) transmitter – duct mounted
 - .1 same as for room type CO₂ transmitter and with duct insertion sensor bar,
 - .2 suitable for duct air velocities up to 15 m/s (3000 fpm).]

2.15 Hazardous Gas Detection Transmitters

- .1 Hazardous atmosphere detection transmitter – spaces/rooms:
 - .1 for measurement of carbon monoxide (CO) and nitrogen dioxide (NO₂),
 - (a) single or combined gas sensors in one enclosure,
 - (b) if combined gases, the nitrogen dioxide sensor is supplied loosed for remote mounting,
 - .2 sensor type: electrochemical,
 - .3 LCD display of ppm level, trip set point and time delay,
 - .4 LED's indicating normal operation and alarm,
 - .5 audible alarm 65dBA at 1 meter (3 feet) and visual alarm,
 - .6 performance:

Parameter	Carbon Monoxide	Nitrogen Dioxide
Range	0 - 100, 0 - 150, 0 - 300, 0 - 400 ppm selectable	0 - 10 ppm
Response time	< 30 secs	< 30 secs
Accuracy	±5 ppm,	±0.2 ppm
Drift	<5% per year	Zero: < 2 ppm/yr Span: <2%/month
Sensor coverage area	7m ² (700 sq. ft)	7m ² (700 sq. Ft)

- .7 operating temperature range; -20°C to 50°C (-4°F to 122°F)
- .8 operating humidity range; 0 to 85% RH non-condensing,
- .9 output signals:
- .10 output signals:
 - (a) 4-20 mA, 0-5 Vdc or 0-10 Vdc,
 - (b) BACnet MSTP, and
 - (c) DPDT relay, 5 A @ 120 VAC, with field adjustable trip point and adjustable time delay for remote alarm.
- .11 power supply: 24 VAC/VDC,
- .12 enclosure: Type 4X to CSA C22.2 No. 94.1, or NEMA 4X or IP65.]

2.16 Occupancy Sensors

- .1 Passive infrared sensor with temperature compensated pyro-electric dual active element,
 - .1 ceiling or wall mounted,
- Issued For Tender

- .2 LED indication light(s),
- .3 digital time delay adjustable: from 30 seconds to 30 minutes,
- .4 area coverage: 200 m² (2000 ft²),
- .5 output: SPDT isolated output relay, rated for 1 A at 24 VDC/VAC,
- .6 power supply: 24 VDC,
- .7 with 120 VAC/24 VDC transformer power supply unit.

Standard of Acceptance

- Watt Stopper Model CX-100]

2.17 Air Flow Measuring Devices

- .1 Multiple head pitot tube type stations:
 - .1 diamond shape cross-section averaging Pitot tube-style sensor with multiple tube structure, averaging chambers and bidirectional flow sensing capability,
 - .2 sheet metal duct collars,
 - .3 selected for operating flow range, duct size and air temperature,
 - .4 integral differential pressure sensor with analog output signal proportional to differential pressure across sensor, 4-20 mA, 0-5 Vdc or 0-10 Vdc,
 - .5 accuracy: $\pm 1\%$ of actual value,
 - .6 repeatability: $\pm 0.1\%$ of actual value,
 - .7 flow turndown: greater than 10:1,
 - .8 differential pressure range: 0 to 1250 Pa (0 to 5 in wg),
 - .9 operating pressure: up to 34.3 kPa (5 psig),
 - .10 operating temperature rating: -4°C to 95°C (-20°F to 200°F),
 - .11 operating pressure rating: 1725 kPa (250 psig)
- .2 Thermal anemometer probe type airflow measuring stations:
 - .1 sensors mounted in sheet metal duct collars of [aluminum][stainless steel],
 - .2 each thermistor mounted in solid thermoplastic housing,
 - .3 probe length equal to greater of two inside dimensions of rectangular and oval ducts and equal to duct diameter for round ducts,
 - .4 minimum two sensing points per probe,
 - .5 independent averaging of multiple sensing points,
 - .6 averaging amplifier with adjustable offset and span for multiple probe applications,
 - .7 temperature compensated linear analog output signal indicating average velocity at station, 4-20 mA, 0-5 Vdc or 0-10 Vdc,
 - .8 velocity accuracy: $\pm 2\%$ of reading,
 - .9 temperature accuracy: 0.10°C (0.18°F),
 - .10 resolution: 0.4% of scale,
 - .11 repeatability: $\pm 0.2\%$ of reading,

- .12 velocity range; 0 to 25m/s (0 to 5000 fpm),
 - .13 maximum allowable pressure drop: 1.2 Pa at 10m/s (0.005 in wg at 2000 fpm),
 - .14 flow station operating temperature range: [0°C to 70°C (30°F to 160°F)][-29°C to 71°C (-20°F to 160°F)],
 - .15 electronics operating temperature range: 0°C to 70°C (30°F to 160°F),
 - .16 flow station operating humidity range: 0 to 99% RH non-condensing,
 - .17 dedicated electronic, solid state digital processing control panel with general purpose NEMA 2 enclosure,
 - .18 provided with upstream and/or downstream flow conditioning.
- .3 Thermal anemometer type airflow measuring stations for installation at fan inlets:
- .1 fan inlet bell mouth mounted with adjustable steel strut and mounting feet,
 - .2 minimum of two flow sensing thermistors and temperature sensors per station, two stations for DWDI fans,
 - .3 sensors mounted in aluminum casing and recessed within strut,
 - .4 independent averaging of multiple sensing points,
 - .5 temperature compensated linear analog output signal indicating average velocity at station, 4-20 mA, 0-5 Vdc or 0-10 Vdc,
 - .6 velocity accuracy: $\pm 2\%$ of reading,
 - .7 temperature accuracy: $\pm 0.2^\circ\text{C}$ (0.36°F),
 - .8 resolution: 0.4% of scale,
 - .9 repeatability: $\pm 0.2\%$ of reading,
 - .10 velocity range: 0 to 25m/s (0 to 5000 fpm),
 - .11 maximum allowable pressure drop: 1.2 Pa at 10m/s (0.005 in.w.c. at 2000 fpm),
 - .12 flow station operating temperature range: 0°C to 71°C (30°F to 160°F),
 - .13 electronic operating temperature range: 0°C to 71°C (30°F to 160°F),
 - .14 flow station operating humidity range: 0 to 99% RH non-condensing,
 - .15 dedicated electronic, solid state digital processing control panel with general purpose dustproof enclosure.
- .4 Provide mounting hardware for installation of airflow measuring stations by sheet metal contractor.

2.18 Air Flow Switches

- .1 For indication of air flow within duct.
- .2 Differential pressure activated, diaphragm type,
 - .1 snap-action SPDT switch, 10 A @ 120 VAC,
 - .2 field adjustable set point,
 - .3 minimum air velocity: 1 m/s (200 fpm),
 - .4 maximum air velocity: 10.2 m/s (2000 fpm),
 - .5 operating ambient temperature range: 0°C to 40°C (32°F to 104°F),
 - .6 dustproof enclosure with mounting plate and gasket seal.

2.19 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)][-34°C to 82°C (-30°F to 180°F)]
 - .3 operating liquid temperature range: [0°C to 121°C (32°F to 250°F)][-29°C to 121°C (-29°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).

2.20 Water Detection Devices

- .1 Leak Detection – Tape Type (type “WD1”):
 - .1 for detection of water included condensate from water vapour,
 - .2 sensor type: continuous tape 3 mil copper fiber, ¼” gap, with self-adhesive backing,
 - .3 sensor tape length: based on width of area being monitored,
 - .4 control type: two (2) relays, trouble and alarm,
 - .5 local indicator: red alarm pilot light,
 - .6 relay output rating: 1A @ 24 VAC/VDC, 0.5 A @ 120 VA,
 - .7 operating temperature: 0 to 70°C (32 to 158°F)
 - .8 enclosure: cast aluminum, type 4 to CSA C22.2 No. 94.1,
 - .9 power: 11 – 27 VAC/VDC, with associated 120/24 V power supply unit.

Standard of Acceptance

- Kele - fig. WD-2-T

- .2 Leak Detection – Float Level Switch (type “WD2”):
 - .1 for detection of water included condensate from water vapour,
 - .2 sensor type: stainless steel float, magnetically-coupled sealed reed-switch,
 - .3 control type: one (1) SPST switch, 50 VA contact rating,
 - .4 field-adjustable for normally open or normally closed contacts,
 - .5 power: 120 – 240 VAC

Standard of Acceptance

- Kele - fig. FS7-SS.

- .3 Leak Detection – Spot Leak Detector (type “WD3”)
 - .1 for detection of water containing mineral content including HVAC water and potable city water,

- .2 sensor type:
 - (a) conductivity sensing probe,
 - (b) for direct contact to surface with adjustable height between 0 to 4.8mm (0 to 0.19 in.),
- .3 control type: one (1) DPST relay,
- .4 relay output rating: 1A @ 24 VAC/VDC, 0.5 A @ 120 VA,
- .5 operating temperature: 0 to 50°C (32 to 122°F)
- .6 enclosure: cast aluminum, type 4 to CSA C22.2 No. 94.1, with mounting flanges to fasten to floor,
- .7 power: 24 VAC/VDC, with associated 120/24 V power supply unit.

Standard of Acceptance

- RLE - fig. SD-R01

.4 Leak Detection – Conductivity Cable (Rope) Type Leak Detector:

- .1 for detection of water containing mineral content including HVAC water and potable city water,
- .2 sensor type: conductivity style detection system consisting of:
 - (a) detector module,
 - (b) conductivity sensing cable,
 - (c) leader cable (as required).
- .3 sensor cable: conductivity for detection of water,
- .4 control type: two (2) DPST relays, trouble and alarm,
- .5 relay output rating: 1A @ 24 VAC/VDC, 0.5A @120 VAC,
- .6 local indicator: red alarm pilot light,
- .7 operating temperature: 0 to 50°C (32° to 122°F),
- .8 enclosure: ABS with hinged and gasket cover Type 3R or 4X to CSA C22.2 No. 94.1,
- .9 sensing cable length: as shown,
- .10 leader cable: FT-6 Plenum Rated,
- .11 power: 12 – 27 VAC/VDC, with associated 120/24 V power supply unit.

Standard of Acceptance

- Greystone - fig. WLDC
- RLE - fig. LD310
- Kele - fig. WD-2PR

2.21 Fuel Oil Detection Devices

- .1 Refer to Specification section 23 11 33.

2.22 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 Averaging duct temperature sensors:
 - .1 Use averaging sensors in the following locations:
 - (a) mixing plenums in front of the first downstream component,
 - (b) ducts with cross sectional area greater than 1.5 m² (16 sq. ft),
 - (c) downstream of the supply air leaving side of a thermal heat wheel, located approximately 200 mm (8 in) from leaving face of wheel.
 - .2 Install averaging sensors in serpentine manner vertically across duct. Support each bend with capillary clip. Provide sensor element length of 3 m per m² (1 ft per ft²) of plenum/duct cross sectional area.
- .2 Low-temperature switch:

- .1 Install mixing plenum low-limit temperature switches in serpentine manner horizontally across duct. Support each bend with capillary clip. Provide sensor element length of 3 m per 1 m² (1 ft per 1 sq. ft) of coil area.
- .3 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.
- .4 Space temperature and humidity sensors:
 - .1 Mount space temperature or combination temperature/humidity sensors / transmitters at 1200 mm (4 ft) above finished floor.
- .5 Humidity sensors:
 - .1 Locate humidity sensors adjacent to temperature sensors except as follows.
 - .2 Locate humidity sensors in the supply air downstream of a thermal heat wheel in a location that represents the average relative humidity when hand-measured at the upstream face of the next component in the air handling unit.
- .6 Outdoor temperature and humidity transmitters:
 - .1 Install outdoor air combination humidity and temperature transmitters on north facing wall, in a location readily accessible for maintenance access.

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
Private offices	TSD/O
Open plan offices	TSD
Meeting rooms, class rooms, private dining rooms, faith congregation spaces, gymnasias	TSD/C/O
Public dining areas, libraries, art galleries	TSD [TSD/C]

Service rooms, corridors, data centers, distributed electrical and data rooms, janitorial rooms, loading docks, storage rooms	TS
Building entrances, lobbies, elevator lobbies, stairwells	TS
Kitchens, laundry rooms	TS [TSD]
Maintenance workshops	TS
Non-specific process spaces	TS
Healthcare operating rooms	TSD/H
Healthcare treatment rooms and procedure rooms	TSD [TSD/O]
Laboratories	TSD [TSD/O]
Mental health patient rooms, secure rooms	TSS
All other spaces not identified above	TS [TSD]

3.5 [High Accuracy Temperature and Humidity Transmitters

- .1 Provide high accuracy space temperature sensors in space types in accordance with the following table unless otherwise shown on drawings or in control sequences:

Space Types	Temperature Sensor Type	Remote Display Unit
<<>> laboratory	THTS	---
<<process department>>	THTS	---
Level 3 and 4 Biological containment rooms	THTD	REMD
Clean rooms	THTD	REMD

]

3.6 Differential Air Static Pressure Sensors

- .1 Install duct static pressure sensors rigidly to side of duct to ensure duct probe is at 90° to the direction of airflow.
- .2 Supply duct static pressure;
- .1 pipe high-pressure tap to duct using pitot tube,
 - .2 make pressure tap connections according to manufacturer's recommendations.
- .3 Return duct static pressure;
- .1 pipe high-pressure tap to duct using pitot tube,
 - .2 make pressure tap connections according to manufacturer's recommendations.

- .4 Building static pressure;
 - .1 pipe pressure sensor's low-pressure port to static pressure port located on outside of building through high-volume accumulator,
 - .2 pipe high-pressure port to location behind thermostat cover.
- .5 Piping to air pressure transducer pressure taps to contain capped test port adjacent to transducer.
- .6 Install duct differential pressure sensors across fans, filters and other devices as shown.
- .7 Trim impulse lines to use the shortest length while maintaining adequate bending radius without kinking impulse tubes.
- .8 Locate air pressure transducers, except those controlling terminal unit boxes;
 - .1 in control panels, not on monitored equipment or on ductwork,
 - .2 mount transducers in vibration-free location accessible for service without use of ladders or special equipment.

3.7 Airflow Measuring Stations

- .1 Provide transducers, relays, and interconnection wiring to perform Sequences of Operations as detailed and Monitoring in accordance with Controls Schematics.

3.8 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.

3.9 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.

3.10 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

3.11 [Air Quality Instrumentation

- .1 Carbon dioxide sensors:
 - .1 install CO₂ sensors at between 900 - 1200 mm above floor level.
- .2 Carbon monoxide transmitter:
 - .1 install CO sensors at 900 - 1200 mm above floor level,

- .2 adjust CO alarm setpoints:
 - (a) warning: 40 ppm
 - (b) alarm: 70 ppm
- .3 Nitrous Dioxide transmitter:
 - .1 install NO₂ sensors at 300 to 450 mm above floor level,
 - .2 adjust NO_x alarm setpoints:
 - (a) warning: 0.5 ppm
 - (b) alarm: 1.0 ppm.]

3.12 Occupancy Sensors

- .1 Install occupancy sensors in ceiling as shown.]

3.13 Leak Detection Devices

- .1 Provide leak detection devices where shown.
- .2 Unless otherwise shown, select leak detection types as follows:

Location	Fluid Detected	Type	Limits
HVAC condensate trays (beneath trays)	Condensate water	WD1	Locate tape beneath and along length of tray overflow
HVAC condensate trays (inside of tray)	Condensed water	WD2	One detector per tray set at highest detection level, to detect water at a depth of 25 mm (1 in.)
Containment trays beneath CRAC, CRAH units	HVAC water (unit leaks)	WD3	Containment area ≤ 1.2 m ² (12.9 ft ²): two detectors per containment area.
		WD4	Containment area > 1.2 m ² (12.9 ft ²): Continuous cable around containment perimeter
HVAC water piping (along length of pipe)	HVAC water (pipe leaks)	WD4	Installed on bottom of pipe underneath insulation.
Raised floors, along path of water piping (beneath piping)	HVAC water (pipe leaks) and condensate water	WD1	Continuous tape applied to floor beneath pipes.
Piping trench	HVAC water, city water, ground water	WD4	Locate cable on side of trench, mounted 12 mm (0.5 in.) above bottom of trench

- .3 Install leak detection devices in accordance with manufacturer's instructions and as follows:

- .1 for type WD1 (tape), do not fold, bend or cross the tape over itself,
 - .2 for type WD2 (float), provide a support bracket to suspend the float to activate at the indicated depth,
 - .3 for type WD3 (spot), attach the device directly to the floor,
 - .4 for type WD4 (cable), use plastic clips on 200 mm (8 in.) centres to keep cable straight, without sags or offsets. Route cable at corners using the required minimum bending radius as specified by the manufacturer.
- .4 Test each device for operation at indicated water depth. Use water of the type appropriate to the device as follows:
- .1 for type WD1 and WD2, use distilled or similar pure (demineralized) water – do not use potable city water,
 - .2 for type WD3 and WD4, use HVAC or potable city water.

3.14 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

Master revised: July 24, 2023

BUILDING AUTOMATION CONTROL VALVES

25 30 19.13

1 GENERAL

1.1 Scope

- .1 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
 - .2 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
 - .3 CSA B242 Groove and Shoulder Type Mechanical Pipe Couplings

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,

2.7 Steam Valves

- .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: globe.
- .4 Valve size:
 - .1 two-position service;
 - (a) pressure drop at design flow equal to 10%-20% of inlet steam gauge pressure.
 - .2 modulating service at inlet steam gauge pressure of 100 kPa (15 psig) or less;
 - (a) pressure drop at design flow equal to 80% of inlet steam gauge pressure.
 - .3 modulating service at inlet steam gauge pressure of 101-350 kPa (16-50 psig);
 - (a) pressure drop at design flow equal to critical pressure drop (45% of absolute inlet pressure).
 - .4 modulating service with inlet steam gauge pressure over 350 kPa (50 psig);
 - (a) pressure drop as shown.
 - .5 modulating steam loads greater than 570 kW (2000 lbs/hr) at all pressures;
 - (a) provide two valves, connected in parallel and controlled in sequence, with first valve in opening sequence sized for 1/3 and second for 2/3 of steam load.
- .5 Valve flow characteristic:
 - .1 equal percentage flow characteristics.
- .6 Actuator and trim:
 - .1 conform to section 25 30 01 and as specified herein.
 - .2 selected for close-off pressure rating equal to 150% of operating (inlet) pressure.

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.

1.6 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,

- .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 Pressure Independent Control Valve

.1 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,

Standard of Acceptance

- 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: EDPM.
- .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.

2.2 Energy Valve

- .1 General
 - .1 two-way pressure-independent control valve as previously specified,
 - .2 flow measurement:
 - (a) integrated ultrasonic or electromagnetic flow meter, or
 - (b) calculated flow value based on control valve position and differential pressure.
 - .3 matched supply and return water temperature sensors, platinum 1000 ohm, RTD type,
 - (a) temperature sensors shipped loose for field installation,
 - (b) one sensor may be factory integrated with valve assembly,
 - (c) includes bronze temperature sensor wells with NPT pipe attachment.
 - .4 integrated microprocessor based direct-digital controls,

- .5 manufacturer to provide training for the BAS contractor in the integration and operation of the valve.

Standard of Acceptance

- Belimo - fig. Energy Valve
- Danfoss - fig. AB-QM

.2 Controller:

- .1 direct digital controller, BTL Listed as a BACNet Application Specific Controller,
- .2 power supply: 24 VDC or 24 VAC.
- .3 Building Automation System integration:
 - (a) Analog Input/Output: 2-10 VDC, 0-10VDC, and/or 4-20mA to control valve position and obtain valve position feedback, and
 - (b) BACnet MS/TP communications.
- .4 minimum BACnet MS/TP objects:

(a) Read Objects (to BAS):

- i) valve relative position,
- ii) valve absolute position,
- iii) valve flow rate,
- iv) supply water temperature,
- v) return water temperature,
- vi) valve thermal power,
- vii) delta T management status,
- viii) valve maximum possible flow rate,
- ix) configured alarms.

(b) Write Objects (to valve):

- i) valve control mode,
- ii) maximum desired flow rate,
- iii) select operating mode,
- iv) temperature difference setpoint,
- v) maximum thermal power setpoint,
- vi) minimum delta-T flow value setpoint,
- vii) delta T management flow saturation value.

.3 field selectable integrated control program functions:

.1 Position Control:

- (a) valve changes position in proportion to the analog signal being provided (non-pressure independent function),
- (b) default operating mode when minimum valve differential pressure is not achieved.

.2 Flow Control:

- (a) valve maintains a flow rate that is in proportion to the analog signal being provided (pressure independent function).
- .3 Power Control:
 - (a) valve maintains a thermal power output that is in proportion to the analog signal being provided.
 - (b) matched temperature sensors used to override valve position to manage thermal power output of the coil or heat exchanger,
 - (c) field selectable operating modes:
 - i) mode 1: controller overrides Flow Control function to maintain constant thermal power output at all times,
 - ii) mode 2: controller overrides Flow Control function to prevent thermal power output exceeding a set value,
- .4 Delta T Control:
 - (a) matched temperature sensors used to override valve position to manage temperature differential drop across the coil or heat exchanger,
 - (b) field selectable operating modes:
 - i) mode 1: controller overrides Flow Control function to maintain constant temperature differential at all times,
 - ii) mode 2: controller overrides Flow Control function to prevent pressure differential decreasing below a set value,
- .5 field-settable minimum flow rate disable function (applies to thermal power and delta-T operation modes): thermal power or delta-T control is disabled when flow rate decreased below field set minimum flow value.

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 Provide PICV and Energy valves in accordance with the following table unless otherwise shown on drawings.

Service	Application	PICV	Energy Valve
Terminal box and duct mounted reheat coils	All	●	

3.2 Installation

- .1 Install PICV/Energy valves 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/Energy valve.
- .4 For Energy Meters, install the temperature sensors in thermowells on the pipeline, and connect sensors to controller.
- .5 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.
- .6 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 and Energy valve 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.

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 DAMPERS
25 30 23.13

1 GENERAL

1.1 Scope

- .1 Provide ductwork control dampers for building systems 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 23 33 13.13 Dampers - Operating
 - .2 25 30 13 Building Automation Actuators and Operators

1.3 Submittals

- .1 Submit product data sheets for materials specified herein.

2 PRODUCTS

2.1 Motorized Control Dampers

- .1 Construction:
 - .1 conform with section 23 33 13.13.
- .2 Actuators:
 - .1 conform with section 25 30 13.

3 EXECUTION

3.1 Coordination

- .1 Coordinate with the trade contractor under Division 23 to confirm control damper quantity, sizes, blade orientation, actuator position, and damper linkage.
Supply control dampers to the trade contractor under Division 23 for installation by that trade.

3.2 Selection

- .1 Select control damper type (parallel blade, opposed blade) in accordance with section 23 33 14.

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 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 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 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
CS171.01	Terminal Units with Reheat (Healthcare)

END OF SECTION

CS171.01 – Terminal Units with Reheat

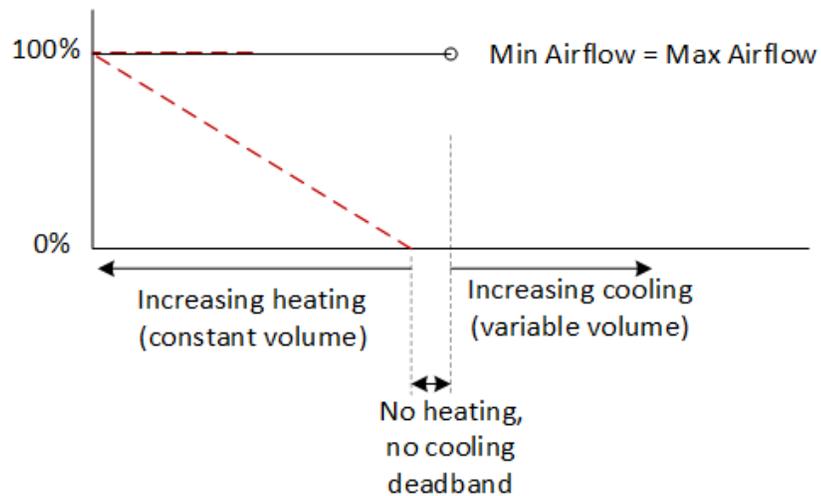
Reference: Refer to drawings.

Applicable System: Terminal units with reheat coils.

System Start: Terminal boxes are enabled when associated AHU system is commanded to start.

General: Terminal units are setup as constant volume operation at minimum airflow rate (“Qmin”) setting.

Maximum Airflow = Minimum Airflow (Constant Volume – Heating and Cooling)



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).

Space Temperature Control – $Q_{max} = Q_{min}$

Space temperature sensor (T1) modulates reheat valve (V) to maintain space temperature setpoint.

System Overrides: None.

Unoccupied Mode Override: None.

System Issued For Tender

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]

Monitoring: Monitor the following inputs and include in the graphics display:

- AI-F Terminal unit airflow
- AI-H Space humidity
- AI-T2 Duct supply temperature.

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 Life-Safety Standby
 Vital Delayed-Vital 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.

[2] "Minimum flow" means the minimum flow during occupancy. For airflow rate during unoccupied mode, refer to control sequence CS401.

End of Control Sequence

**Electrical
Specifications**
FOR
**Complex Malignant Hematology Consolidation
K Wing, 3rd Floor Centre
Sunnybrook Health Sciences Centre**
2075 Bayview Avenue
Toronto, Ont.
M4N 3M5

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LIST OF SECTIONS
26 00 01

DIVISION 26

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27 52 52 - CLOCK SYSTEM

DIVISION 28

28 08 15 - 3RD PARTY FIRE ALARM VERIFICATION
28 23 01 - SECURITY CCTV SYSTEM
28 23 10 - ACCESS CONTROL SYSTEM
28 31 13 - FIRE ALARM SYSTEM

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

- Thomas & Betts - Flame-safe
- Nelson/Wieland (Electrovert) - Flameseal
- Double A/D Distributors Ltd. - Firebarrier Firestopping
- 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

- Thomas & Betts Ltd. - Series 401
- 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 lamicoïd plate designating panel name.
- .11 Typical Identification Standards
 - .1 Lighting, Receptacle an Power panels to each be identified with an engraved lamicoïd plate secured to top interior trim as:
 - (a) LP-1A 12 mm (½") high lettering
 - (b) 120/208 volts 5 mm (¼") high lettering
 - (c) Fed from PP 'AA' 5 mm (¼") 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")
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")

Description	General Area	Barrier Free
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 \times 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 Built, expendable small tools, financing costs, coffee breaks, site facilities, general clean up and disposal, security, storekeeper, and all other non-productive labour.
- (b) Contractor is allowed a combined overhead and profit fee of 15% for work to be performed by his own forces.
- (c) Contractor is allowed an overhead and profit fee of 5% for work performed by a Sub-Contractor

- (d) Sub-Contractor is allowed an overhead and profit fee of 0% for work performed by a Sub-Subcontractor.

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 WARRANTEE.**

- .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 warrantee to cover contract duration plus the standard warrantee 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 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 (1¹/₄") for receptacles; 73 mm (3") for communication equipment.

- .2 Adjustable, watertight, concrete tight, cast floor boxes with openings drilled and tapped for 12 mm (1/2") and 19 mm (3/4") 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 (1¹/₂") 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 (1/4") 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

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

ELECTRICAL COMMISSIONING

26 08 15

GENERAL

SCOPE

The Hospital will retain an Independent Commissioning Agent (CA) who will provide actual Commissioning Services including witness Testing and Commissioning Services as required.

PART - 1

1.1

.1

Include all labor and material as required to participate in the commissioning process, as outlined in this section, for equipment installed under Division 26.

WORK INCLUDED

.2

Commissioning work of Division 26 includes, but is not limited to:

1.2

.1

.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

.7

Providing equipment, materials, and labor as necessary to correct construction and/or equipment deficiencies found during the commissioning process.

.8

Providing operation and maintenance manuals, and as-built drawings to the Commissioning Authority for verification in a timely manner.

.2

Providing training and demonstrations for the systems specified in this Division prior to turnover to Owner.

.1

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:

.3

.4

Fire Alarm System Verification

Nurse Call System Verification

Security System Verification

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.

PRODUCTS (NOT USED)

EXECUTION

COMMISSIONING MEETINGS

PART - 2

Participate in periodic commissioning team meetings, and trade commissioning meetings.

PART - 3

3.1

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,
 - .1
 - .2 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

COMMISSIONING PROCEDURES

3.2

- .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
 - .2 Document sign-off
 - .3 Pre-start and Initial test
 - .4 Installation Verification - Equipment
 - .5 Installation Verification - Systems
- .3
 - .1 Performance Validation

Document Sign-Off:

each completed procedure is signed off by the following parties:

- .4
 - (a) Contractor, for testing,
 - .1 (b) Commissioning Consultant, for review and witnessing,
 - (c) Owner, for test acceptance.
- .2

Installation Verification - Equipment

Checklists to verify the installation of equipment, including: design specification requirements, drawing requirements, manufacturer installation requirements, and other experience-related items.

Use of pre-printed manufacturer installation and start-up checklists are permitted and encouraged; however, the commissioning procedure checklists may contain supplemental items.

Installation Verification - System: Checklists to verify the installation of the system associated with the equipment.

Performance Validation: Specific test procedures and record documentation requirements for performance measurements of the various systems.

COMMISSIONING TEST METHODOLOGY

- .5
 - .6
 - 3.3
 - .1
 - .2
 - .3
 - .4
- 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.
- 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.
- 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.
- 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.

COMMISSIONING IMPLEMENTATION

- 3.4
 - .1
 - .2
 - .3
- Conduct operating tests and checks to verify that all components, equipment, systems, and interfaces between systems, operate in accordance with contract documents.
- 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.

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

OPERATING CHECKS

The Commissioning Consultant witnesses selected equipment and system tests on an audit basis.

Set the system equipment into operating mode to be tested including but not limited to:

- 3.5
 - .1 Normal start up, operation, and shut-down
 - .2 Normal auto position
 - .2 Normal manual position
 - .1 Unoccupied cycle
 - .2 Emergency power operation, including transition states.
 - .3 Status and Alarm conditions
 - .4
 - .5 Inspect and verify the position of each device and interlock identified on the checklist.
 - .6 Repeat the above tests for each operating mode that applies to the system being tested.
 - .3
 - .4 For failed test items, provide appropriate comments to the checklist data sheet and classify whether it is a "Major" or "Minor" deficiency.
 - .5
 - .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
 - .3 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.
- 3.6
 - .1 The Owner will make the final acceptance of test results.

PERFORMANCE VALIDATION TESTING

- .2
 - .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:
 - 3.7
 - .1 Conduct acoustic measurement tests outside the building when generators are running, in accordance with local noise by-law procedures.
 - Conduct acoustic measurement tests inside of generator room when generators are running.

PROBLEM RESOLUTION

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.

The Owner has final approval over any additional work required to achieve the required level of performance.

Complete corrective work in a timely fashion to permit the completion of the commissioning process.

ACCEPTANCE

.2

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.

.3

3.8

.1

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.

.2

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

POST-SUBSTANTIAL PERFORMANCE COMMISSIONING

3.9

Provide commissioning after Substantial Performance:

.1

Performance testing which is weather or live-load dependent;

.1

.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

.4

Infra-red thermal imaging of equipment under peak building live-load conditions,

.5

90 day security system testing,

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

.1

ADDITIONAL COMMISSIONING

3.11

.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.

.2

SYSTEMS OPERATING MANUALS

.1

Provide Operating and Maintenance Manuals in accordance with the requirements of section 16010.

The Systems Operating Manuals (SOM) are in addition to the Operating and Maintenance Manuals (OMM) required under Section 16010.

Provided by Commissioning Authority and/or Consultant.

TRAINING

Equipment Training:

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.[]

3.12

Systems Training:

.1

.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.

.1

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.

.2

.3

Training topics to include:

.4

- (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

.6

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.

.7

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.

.8

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.

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.

Training Manuals

Provide training material hand-outs for each session.

Collect training material and bind into separate binders.

END OF SECTION

.3

.1

.2

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:	<input type="checkbox"/> Reviewed <input type="checkbox"/> <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:	<input type="checkbox"/> Reviewed <input type="checkbox"/> Incomplete or deficient - resubmit
Signed:	
Date:	

END OF SECTION

HEADWALL UNITS

26 26 26

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

- .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".

1.3 WORK INCLUDED

- .1 Work to be done under this Section shall include furnishing of materials and equipment required for the units as shown, as specified and as otherwise required.
- .2 **A quantity of eight (8) Service Consoles Type 'A' (Wall mounted horizontal Headwall Units) are required**

1.4 GENERAL

- .1 Service consoles, as shown on the drawings, shall provide grouped services at typical single bed locations, extending wall to wall at +/- 48" above the floor. They shall be wiring suitable for electrical feeds to built-in and remote receptacles, pre-wired electrical and pre-piped medical gas outlets and space for nurse call system as specified elsewhere, cardiac arrest call system, monitor system etc., all as specified elsewhere.
- .2 Colour of front panel will be selected at a later date. A standard range of colour chips shall be submitted.
- .3 Gas piping shall be designed for connection, at top of unit, by Mechanical Division 15.
- .4 Medical gas piping shall conform to latest edition of CSA Standard Z305.1.
- .5 Overall unit shall have CSA approval or carry Special Hydro Approval label.

PART - 2 PRODUCTS

- .1 Service consoles shall be complete with structural frame, service panels, service chases, covers and other equipment as required.
- .2 Service consoles shall include wiring for electrical feeds from remote power services as detailed.
- .3 Consoles shall have a primed and painted cold rolled steel base of unit construction. Base shall be complete with barriers and support members as required.
- .4 Consoles shall be supplied as a complete unit with removable front panels. Consoles shall have all devices, except where noted, pre-wired and pre-piped to the top of the unit. Wiring shall be terminated on junction boxes or terminal strips. Medical gas piping shall

- extend 6" above the top of the unit and shall be fitted with plastic caps to prevent dirt from entering piping.
- .5 Front panels shall be formed in one piece to fit the base channel and shall have openings to receive electrical and medical gas outlets as required. Front panels shall be sectionalized to allow access to services.
 - .6 Unit shall be complete with mounting holes for fastening to wall structure at top and bottom of unit.
 - .7 Channels or barriers shall be provided to separate power and communication systems wiring.
 - .8 Cover plates shall be Type #302 stainless steel with a #4 finish.
 - .9 Electrical components shall be as follows:
 - .1 Receptacles shall be "Decora Style, "Hospital Grade type, brown for normal power and red for emergency power.
 - .2 Switches shall be Lutron Type (LED compatible and white coloured)
 - .3 Outlet for Rauland 'Responder 5' Nurse Call (Nurse Call components and wiring are provided by Electrical Contractor on site)
 - .4 Outlets for Telephone, Data & Monitor Jacks (Network components and wiring are provided by Electrical Contractor on site)
 - .10 Components shall be mounted in suitable backboxes and shall have a common cover plate for services shown horizontally
 - .11 Receptacles and other equipment shall be connected to two pole breakers in the associated Electrical Panel with 1000 volt, 90°C. X-link copper wiring. Substitute insulation will not be permitted.
 - .12 Medical gas piping shall be hard temper Type "L" with wrought copper fittings. Joints shall be brazed with a silver solely conforming to the American Welding Society Specification BCUP5. Flux shall not be used. During brazing operation the pipe shall be filled with nitrogen to eliminate inside piping scaling.
 - .13 The tail pipe of the medical gas outlets shall be increased immediately from ¼" as follows:
 - .1 to ½" for oxygen and medical air
 - .2 to ¾" for medical vacuum
 - .14 Upon completion of piping the piping shall be pressure tested to 150 psi and checked for leaks for means of an oxygen compatible commercial leak detector.
 - .15 Medical gas outlets shall be DISS type as follows:

Gas	Almed	Puritan-Bennett	Medigas
Oxygen	9603-1250-5	125100	1124
Vacuum	9603-1255-5	125103	1122
Air	9603-1265-2	125102	1116

- .16 Outlets shall be provided on the front of the unit for each of the following services: nurse call, code blue, telephone, monitor, etc.. For each of the foregoing a separate junction box shall be provided.

- .17 Standard equipment to be supplied shall be as follows (confirm exact requirements and quantities on site):
 - .1 adjustable accessory track system
 - .2 junction box and conduit for monitor output to central monitor station
 - .3 track and monitor shelf, adjustable with slide bracket
 - .4 Sphygmo mount with cuff basket (provide 1 per unit)
 - .5 pivoting arm bracket (provide 2 per unit)
 - .6 infusion pump support mount (provide 2 per unit)
 - .7 utility mount, slide type (provide 2 per unit)
 - .8 universal holders (provide 2 per unit)
 - .9 pivoting storage basket, with liner (provide 1 per unit)
 - .10 waste basket, with liner (provide 1 per unit)
 - .11 small storage basket (provide 1 per unit)
 - .12 adjustable shelf with bumper (provide 1 per unit)
 - .13 Vacuum bottle slides conveniently located to accept bottle bracket (provide 2 per unit)
- .18 For overall arrangements of the Headwall Units, refer to drawing details.
- .19 **Acceptable manufacturers/ suppliers are:**
 - Class 1 Inc. contact Tricia Blondin**
 - Director, Sales & Project Management
 - T: (519) 650 2355 x235 | C: (519) 501 9260 | tricia.blondin@class1inc.com

PART - 3 EXECUTION

- .1 Provide service consoles as shown and as specified. Provide accessories as scheduled.
- .2 Verify final overall height prior to ordering.
- .3 Connect each isolated power centre to the incoming power supply, including 1 #8 insulated green ground conductors to be run with the circuit conductors and connected to the ground bar of the breaker panel in the console.
- .4 Secure units to walls in accordance with the recommendations of the manufacturer.
- .5 Co-ordinate the nurse call space requirements with the equipment supplier.

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 Where panels exceed 42 circuits, use multi-section panel with main cross-over solid bus bars. Main bus capacity of each section shall be full size to match cross-over bus. Cross-over bus shall be concealed by panel trim. Separate covers are not acceptable.
- .12 Breakers shall have bolted type connections.
- .13 **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.**
- .14 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.
- .15 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 WIRING DEVICES

- .1 Wiring devices: as indicated, to Section 26 27 26 - Wiring Devices including specified stainless steel cover plates.

2.3 GROUNDING

- .1 Ground system through raceway separate insulated conductor.

2.4 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.

END OF SECTION

WIRING DEVICES 26 27 26

GENERAL

REFERENCES

CSA C22.2 No. 111-M1986 Switches.

PART - 1 CSA C22.2 No. 42-M1984 Receptacles.

1.1 Section 26 28 19 - Ground Fault Circuit Interrupters.

.1
.2
SHOP DRAWINGS AND PRODUCT DATA

.3 Submit shop drawings and product data in accordance with 26 05 01 Electrical General Requirements.

1.2

.1
IDENTIFICATION

1.3 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:

.1

(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

.1
PRE/ POST OCCUPANCY PROVISIONS

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) **five (5) Emergency Power 15 amp, 120 volt Duplex Receptacles**
b) **five (5) Normal Power 15 amp, 120 volt Duplex Receptacles**
c) **five (5) 15 amp, 120 volt direct connection outlets**
.2 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**

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.

PRODUCTS

SWITCHES

20 A, 120 V, silent, AC type, CSA listed, single pole, double pole, three-way, four-way switches “decorative type”.

PART - 2

Manually-operated general purpose ac switches with following features:

2.1

Terminal holes approved for No. 10 AWG wire.

.1

Silver alloy contacts.

.2

Urea or melamine moulding for parts subject to carbon tracking.

.1

Suitable for back and side wiring.

.2

White coloured “rocker” toggle.

.3

.4

.5

Toggle operated fully rated for tungsten filament and fluorescent lamps, and up to 80% of rated capacity of motor loads.

.3

Switches of one manufacturer throughout project.

.4

Catalogue numbers listed below have been used for convenience only to indicate quality standards:

.5

TYPE	APPROVED CATALOGUE NUMBERS
	HUBBELL(120 VOLT)
SINGLE POLE	HBL2121WA
DOUBLE POLE	HBL2122WA
THREE-WAY	HBL2123WA
FOUR-WAY	HBL2124WA

.6

.7

Combination switches shall have neon pilot light and jewel on stainless steel plate

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

DIMMER SWITCHES

Dimmers for use on LED Luminaires shall be equal to Lutron, "Nova Series", LED compatible as noted and white cover plates.

2.2 Matching switches shall be used adjacent to dimmers.

.1 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**

2.3 Receptacles shall be decorator style to be complete with following features:

- .1 urea moulded housing.
 - .1 Suitable for no. 10 AWG for back and side wiring
 - .2 Break-off links for use as split receptacles.
 - .3 Eight back wired entrances, four side wiring screws.
 - .4 Triple wipe contacts and rivetted grounding contacts.
 - .5
 - .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.
- .1 ◦ Bryant Electric
- Cooper Wiring Devices
- .2 ◦ Leviton

The receptacles listed below represent the most common configurations available and are not necessarily used on this project. Refer to drawings for types used.

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 gasketted 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

.1

FLOOR OUTLETS

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)

Service fitting for floor receptacle shall be complete with receptacle specified above, unless noted otherwise.

Standard of Acceptance

- .2
- Hubbell S3625, duplex screw cover (brass)
 - Hubbell S3825, duplex flap (brass)

COVER PLATES

2.5

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:

.1

- 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

.1

Cover plates for wiring devices. Cover plates from one manufacturer throughout project.

.2

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.

.3

.4

Cast cover plates for wiring devices mounted in surface-mounted FS or FD type conduit boxes.

.5

Weatherproof double lift spring-loaded cast aluminum cover plates, complete with gaskets for duplex receptacles as indicated.

Weatherproof spring-loaded cast aluminum cover plates complete with gaskets for single receptacles or switches.

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

GROUND FAULT CIRCUIT INTERRUPTERS

Units shall be CSA approved Type A.

2.6 Ground fault circuit interrupters (GFCI) shall be complete with receptacle, test feature and reset switch.

.1 Units shall include a 15A grounded duplex decora receptacle, a button to test operation of
.2 unit and current transformer and sensing mechanism. Unit to be complete with suitable outlet
box.

.3 Units in Hospitals to be hospital grade.

.4 Unless noted otherwise, unit shall trip at 6 mA.

.5 Where shown in outdoor locations, units shall be enclosed in weatherproof surface-mounted
.6 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

3.1

EXECUTION

.1

INSTALLATION

.1

Switches

.2

.3

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.

.1

Mount toggle switches at height specified in Section 26 05 01 - Electrical General Requirements or as indicated.

.2

.3

Receptacles

Install receptacles in gang type outlet box when more than one receptacle is required in one location.

Mount receptacles at height specified in Section 26 05 01 - Electrical General Requirements or as indicated.

For each type of receptacle 20 ampere or larger, supply and hand to Owner two heavy duty caps.

For each type of receptacle 30 ampere or larger, supply and hand to Owner two heavy duty caps.

Connect receptacle grounding terminal to the outlet box with an insulated green ground strap.

Exact position of service fittings shall be verified to suit furniture layout.

.4 Do not mount receptacles directly on a column, unless column has been
.5 appropriately furred, to avoid breaking fire barrier.

Cover Plates

.6 Protect stainless steel cover plate finish with paper or plastic film until painting and
.7 other work is finished.

.3 Install suitable common cover plates where wiring devices are grouped.

.1 Do not use cover plates meant for flush outlet boxes on surface-mounted boxes.

.2 Install explosion proof wiring and devices in hazardous locations of Class, Division and Group
.3 as indicated on Drawings.

.4 Ground fault circuit interrupters:

.5 Mount receptacles at height indicated in Section 26 05 01 - Electrical General
.1 requirements or as indicated.

Outlets in Movable Partitions

.6 Co-ordinate installation of outlet boxes and conduits with the particular trade
.1 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, I²t (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	<p>Recessed 2'-0" x 2'-0" LED Ambient luminaire. Luminaire shall be complete with one piece lens door assembly. Luminaire shall be suitable for a 'T'-bar ceiling.</p> <p>Luminaire shall be suitable for a "T-bar ceiling.</p> <p>Luminaire shall include dimmable LED Driver</p> <p>Voltage: 120 volt</p> <p>Manufacturers: Focal Point FAML-22-ACR-4000LH-35K-1C-120-LDI-G-WH</p> <p>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</p>	45 Watt, 3500 K integral LED
LA1	<p>Recessed 1'-0" x 4'-0" x 4-3/4" D (maximum) direct/indirect LED luminaire. Luminaire shall be complete with one piece lens door assembly. Luminaire shall be suitable for a 'T'-bar ceiling.</p> <p>Luminaire shall include dimmable LED Driver</p> <p>Voltage: 120 Volt</p> <p>Manufacturers: Focal Point #FAM2-14-ACR-4000L-35K-1C-120-L11-G-WH</p>	34 Watt, 3500K LED
LA2	<p>Recessed 2'-0" x 4'-0" x 4-3/4" D (maximum) direct/indirect LED luminaire. Luminaire shall be complete with one piece lens door assembly. Luminaire shall be suitable for a 'T'-bar ceiling.</p> <p>Luminaire shall include dimmable LED Driver</p> <p>Voltage: 120 Volt</p> <p>Manufacturers: Focal Point #FAM2-24-ACR-4000L-35K-1C-120-L11-G-WH</p>	34 Watt, 3500K LED

Title	Description	Lamp Schedule
LB	<p>Recessed 4" (nominal) round LED downlight complete with clear polycarbonate lens and 0-10 volt dimming driver digitally controlled dimming driver.</p> <p>Luminaire shall be suitable for a drywall or T-bar ceiling.</p> <p>Luminaire shall include dimmable LED Driver</p> <p>Voltage : 120 volt</p> <p>Manufacturer:</p> <p>Kenall #MDL4-DCFW-28L-35K8-CSS-RIG4-120-DIM</p> <p>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</p>	28 Watt, 3500K LED
LC	<p>Recessed 4" wide x 6'-0" long linear LED with direct distribution, standard flush mounting and white diffuser</p> <p>Luminaire shall include dimmable LED Driver and suitable for installation in lay-in t-bar ceiling</p> <p>Manufactures :</p> <p>Finelite #HP-4-R-4ft-S-F-96LG-120-FC-10%-SF-GE</p>	3500K LED
LC1	<p>Recessed 4" wide x 8'-0" long linear LED with direct distribution, standard flush mounting and white diffuser</p> <p>Luminaire shall include dimmable LED Driver and suitable for installation in lay-in t-bar ceiling</p> <p>Manufactures :</p> <p>Finelite #HP-4-R-4ft-S-F-96LG-120-FC-10%-SF-GE</p>	3500K LED

Title	Description	Lamp Schedule
LC2	<p>Recessed 4" wide x 4'-0" long linear LED with direct distribution, standard flush mounting and white diffuser</p> <p>Luminaire shall include dimmable LED Driver and suitable for installation in linear metal ceiling</p> <p>Manufactures : Finelite #HP-4-R-4ft-S-F-96LG-120-FC-10%-SF-GE</p>	3500K LED
LC3	<p>Recessed 4" wide x 2'-0" long linear LED with direct distribution, standard flush mounting and white diffuser</p> <p>Luminaire shall include dimmable LED Driver and suitable for installation in linear metal ceiling</p> <p>Manufactures : Finelite #HP-4-R-4ft-S-F-96LG-120-FC-10%-SF-GE</p>	3500K LED
LD	<p>Recessed 2'-0" x 2'-0" LED Patient luminaire. Luminaire shall be complete with one piece lens door assembly. Luminaire shall be suitable for a 'T'-bar ceiling.</p> <p>Luminaire shall be suitable for a "T-bar ceiling.</p> <p>Luminaire shall include dimmable LED Driver</p> <p>Voltage: 120 volt</p> <p>Manufacturers: Kenal #MAC-22-FA-45L-35K-DCC-120-AC-AMF</p> <p>Note: Include in the Contract an additional ONE (1) spare Type 'LD' luminaire 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</p>	3500K LED

Title	Description	Lamp Schedule
LE	<p>Recessed 2'-0" x 2'-0" LED luminaire with antimicrobial finish on exposed surfaces, smooth diffused acrylic lens securely fastened in a stainless steel frame with internal hinge design and captive mounted head stainless steel fasteners. The lens frame shall be gasketed with a closed cell silicone gasket that seals the lens to the frame of the housing.</p> <p>Luminaire shall provide a wide symmetrical diffused DR acrylic Optics (KORE Technology)</p> <p>Luminaire shall be suitable for a drywall ceiling.</p> <p>Luminaire shall include dimmable LED Driver</p> <p>Voltage: 120 Volt</p> <p>Manufacturers: Kenall #MPCADE-22-G-25L/45L-35K8-DCC-120-AC-AMF</p> <p>Note: Include in the Contract an additional ONE (1) spare Type 'LE' luminaire 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</p>	48 Watt, integral LED

Title	Description	Lamp Schedule
LF	<p>Recessed 6" (nominal) round LED downlight complete with clear polycarbonate lens and 0-10 volt dimming driver digitally controlled dimming driver.</p> <p>Luminaire shall be suitable for a drywall or T-bar ceiling.</p> <p>Luminaire depth shall not exceed 5.5"</p> <p>Luminaire shall include dimmable LED Driver</p> <p>Voltage : 120 volt</p> <p>Manufacturer: Kenall #M4DL6-R-DCFW-33L-35K9-W-CSS-RSI6-120-DIM1</p> <p>Note: Include in the Contract an additional TWO (2) spare Type 'LF' 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</p>	28 Watt, integral LED

Title	Description	Lamp Schedule
LG	<p>Recessed 4'-0" x 4'-0" LED, "Luminous SkyCeiling" luminaire with smooth, acrylic graphic "SkyTile" lens / .125" acrylic exam lenses, securely fastened in an aluminum regressed frame with internal hinge design. The lens frame shall be gasketed with a closed cell silicone gasket that seals the lens to the frame of the housing.</p> <p>The lens included in the ceiling scene element shall have an art pattern electronically printed on it to provide an illuminated "picture". Final image to be selected by the Architect.</p> <p>Luminaire shall be suitable for a drywall ceiling.</p> <p>The "Luminous SkyCeiling" Light portions shall be dimmable</p> <p>Luminaire to be complete with Sky Factory 24PS-HGL Dimmable Power System</p> <p>Voltage: 120 volt</p> <p>Manufacturers:</p> <p>Sky Factory #EP44-RVN-EP44-hard ceiling installation</p> <p>Notes:</p> <p>1: The Division 26 Contractor is to confirm co-ordination of luminaire and ceiling.</p> <p>2: Contact at Sky Factory is : Aaron Birlson, SkyDesigner, SKY FACTORY p: <u>+1 (866) 759 3228</u> ext 210 e: <u>aaronb@skyfactory.com</u></p>	integral 6500K LED as required

Title	Description	Lamp Schedule
LG1	<p>Recessed 4'-0" x 6'-0" LED, "Luminous SkyCeiling" luminaire with smooth, acrylic graphic "SkyTile" lens / .125" acrylic exam lenses, securely fastened in an aluminum regressed frame with internal hinge design. The lens frame shall be gasketed with a closed cell silicone gasket that seals the lens to the frame of the housing.</p> <p>The lens included in the ceiling scene element shall have an art pattern electronically printed on it to provide an illuminated "picture". Final image to be selected by the Architect.</p> <p>Luminaire shall be suitable for a drywall ceiling.</p> <p>The "Luminous SkyCeiling" Light portions shall be dimmable</p> <p>Luminaire to be complete with Sky Factory 24PS-HGL Dimmable Power System</p> <p>Voltage: 120 volt</p> <p>Manufacturers:</p> <p>Sky Factory #EP44-RVN-EP44-hard ceiling installation</p> <p>Notes:</p> <p>1: The Division 26 Contractor is to confirm co-ordination of luminaire and ceiling.</p> <p>2: Contact at Sky Factory is : Aaron Birlson, SkyDesigner, SKY FACTORY p: <u>+1 (866) 759 3228</u> ext 210 e: <u>aaronb@skyfactory.com</u></p>	

Title	Description	Lamp Schedule
LG2	<p>Recessed 4'-0" x 6'-0" LED, "Luminous SkyCeiling" luminaire with smooth, acrylic graphic "SkyTile" lens / .125" acrylic exam lenses, securely fastened in an aluminum regressed frame with internal hinge design. The lens frame shall be gasketed with a closed cell silicone gasket that seals the lens to the frame of the housing.</p> <p>The lens included in the ceiling scene element shall have an art pattern electronically printed on it to provide an illuminated "picture". Final image to be selected by the Architect. (Image could be different from Luminaire Type 'LG1')</p> <p>Luminaire shall be suitable for a drywall ceiling.</p> <p>The "Luminous SkyCeiling" Light portions shall be dimmable</p> <p>Luminaire to be complete with Sky Factory 24PS-HGL Dimmable Power System</p> <p>Voltage: 120 volt</p> <p>Manufacturers:</p> <p>Sky Factory #EP44-RVN-EP44-hard ceiling installation</p> <p>Notes:</p> <p>1: The Division 26 Contractor is to confirm co-ordination of luminaire and ceiling.</p> <p>2: Contact at Sky Factory is : Aaron Birlson, SkyDesigner, SKY FACTORY p: <u>+1 (866) 759 3228</u> ext 210 e: <u>aaronb@skyfactory.com</u></p>	integral 6500K LED as required

Title	Description	Lamp Schedule
LH	<p>Ceiling mounted, aimable, dimmable, high intensity Adjustable LED Lighting System. Luminaire shall be complete with gasket between the lens and lens-frame. Luminaire shall be complete with “Antimicrobial Finish”</p> <p>The luminaire is to be equipped with an optical sensor, to permit the positioning of the lighthouse, for additional intensity or where angular lighting is desirable, by a <u>hand held</u> remote control.</p> <p>The system should also include a flush mounted “wall controller” intensifier that provides individual positioning of each lighthouse as well as uniform intensity adjustment for all lighthouses.</p> <p>The luminaire is to produce a minimum of <u>2,500 footcandles per lighthouse</u> at a colour temperature of 3,500 Kelvin. Each unit is to provide cool, colour-corrected light that diffuses evenly.</p> <p><u>The lighting unit may require an in-ceiling support system provided by other Divisions.</u> However, this Division is responsible for fully coordinating the installation. Retain the services of the light supplier to assist in on-site coordination and to supervise the installation of each unit.</p> <p>Luminaires shall be suitable for Drywall Ceiling.</p> <p>The exact location of the examination lights to be determined as per manufacturer’s recommendations prior to installation. Installation of these Lights will require full coordination on site.</p> <p>Provide one wand plus one spare wand.</p> <p>Voltage: 120 volt</p> <p>Manufacturer: Kirlin (InfraLED Series) #PRO-19045 -35K-47</p>	Provided with the Luminaire
LJ	<p>Suspended or Surface Mounted, industrial type luminaire (+/- 50” long x 8” wide). Luminaires shall be suspended from ceiling/structural steel at a height that avoids interference with mechanical/electrical equipment. Mount luminaires with a chain suspension system.</p> <p>Manufacturers: Pioneer #STO-0850-5.4L-3500-UNV Lithonia #VAP-4000LM-PCL-MD-120V-35K-90CRI</p>	39 watt, Integral 3500K LED

Title	Description	Lamp Schedule
LK	<p>Surface mounted LED undercabinet luminaire. Luminaire shall be 48" long suitable secured to the underside of the metal shelf, Extruded aluminum housing, soft focus lensing and 350mA operating current. LED spacing is 100mm along length of extrusion. Nominal dimensions of 22mm width x 8mm height. Run lengths shown on drawings, install as per manufactures instructions for even illumination on task surface.</p> <p>Luminaire to be complete with Remote Driver. Electrical Contractor to locate the power supply in an inconspicuous location and to coordinate driver location with architect and manufacturer, and shall provide all mounting hardware and assembly requirements for installation</p> <p>Voltage: 120 volts</p> <p>Manufacturers: Capri #CUCL Series Revlite Technologies Inc. # Series 5 - #3014X Danalite: # DL100 Series</p>	1.2 Watt LED 3000 K
LL	<p>Continuous length of +/- 20'-0" consisting of 20 x 12" modules that "join" to make up the total length (length to be confirmed on site) Slim-Line (+/- 2" wide x 1.5" deep) Linear LED Accent Lighting bracket mounted in recessed light cove</p> <p>Luminaire installation requires remote "Power Units" as required</p> <p>GVA Lighting "STR-SLIM-CM-320-3500K-X-ELV48 (120volt)</p> <p>Notes: 1/ Luminaire is to include a five (5) year warranty 2/ Include in the Contract an additional FOUR (4) spare 12" lengths of Type 'LS1' luminaires AND four (4) spare Power Units 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</p>	

Title	Description	Lamp Schedule
LM	<p>Existing Cove Lighting modernization. Contractor is to remove the existing cove louvre and fluorescent striplights and install new linear LED Lighting and new cube louvre</p> <p>Re-connect new lights to existing circuiting</p> <p>Voltage: 120 volt</p> <p>Manufacturer: LinmoreLED #AL-STI-3/4-35K-36W-DF</p> <p>New louvre shall be a continuous (assume 60" length but confirm on site) combination panel of 12" wide (confirm width on site), 1" x 1" x 1" major cell and 1/2" x 1/2" x 1/2" high minor cell white metal interleaf louvre with 45° cut-off for the entire cove. Supports supplied under another Division.</p> <p>Manufacturers: Electra "Luma Mod" or Intalite "Check-Cel"</p>	
X	<p>L.E.D. edge lit exit sign. RECESSED trim plate shall be constructed of brushed aluminum.</p> <p>Two styles of faceplates will be required:</p> <ul style="list-style-type: none"> - stencil without arrows - stencil with universal arrows <p>Voltage: 120 volt</p> <p>Manufacturers:</p> <p>Beghelli "Guida Series" Lumacell "LER 1100 Series" Emergi-lite, Uniglo, Ready-Lite, Dual-lite, Stanpro & Aimlite equal</p> <p>Notes:</p> <ol style="list-style-type: none"> 1. Double face exit sign shall not exceed 5 watts (including transformer). 2. Exit lights shall be listed to CSA Standard #C860. <p>Note:</p> <p>Include in the Contract an additional FIVE (5) 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</p>	-

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

- o Emergi-Lite
- o Lumacell Inc.
- o 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
- 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
- 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:
 - Two (2) typical Data/ VoIP outlets
 - One (1) Building Automation System Network Connection outlets
- .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**

.5 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

.6 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.

.2 "FIBRE PATCH CORDS"

All fibre Patch Cords are to be "single mode type". Delete all references to "multimode type patch cords"

1.3 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:
 - Two (2) typical Data/ VoIP outlets
 - One (1) Building Automation System Network Connection outlets
- .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.

1.4 **INSTALLATION STANDARDS**

- .1 The following are typical outlet types used on this project:
 - Emergency Telephone 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 **TV drops** will terminate on dedicated TV system 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.
- .11 All drop locations and quantities to be confirmed prior to the start of the installation.
- .12 "Cabletalk" heavy duty 19" x 84" floor mounted communications racks with two (2) vertical managers shall be used. Two 12-outlet power bars shall be installed on the back of each rack.
- .13 The Racks shall be bolted to the floor. New Racks are required in the new Hub Room. Refer also to Drawing Details.
- .14 Rack mounted vertical cable managers are to be manufactured by Cabletalk, and a minimum of 6" wide with a swing-out door.
- .15 Horizontal rack mount cable managers are to be manufactured by Cabletalk, 2u wide for 19" Communications Racks with a swing-out door. Provide one (1) horizontal cable manager for each patch panel (copper and fibre).
- .16 Telecommunications racks shall be grounded as per the electrical code to the Telecommunications Ground Bar (TGB). #6 AWG green grounding cable shall be used.
- .17 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.
- .18 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.
- .19 The fibre optics panels for the incoming fibre backbones shall have a slide out shelf or swing out drawer for access to the fibres. The fibre optics panels shall provide bend radius control and use a strain relief to accommodate the fibre optics cables. Use NORDX FIBEREXPRESS 19" shelf manager with 12 modules. See drawings for details.

- .20 The Fibre Patch cords shall be included in the base bid price. The quantity of the cords is 12duplex SC-SC type 10' M/M, and 4 duplex SC-SC type 10' S/M for each telecommunications closet. Factory assembled only. Site prepared will not be accepted.
- .21 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.
- .22 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.
- .23 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**.
- .24 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.
- .25 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.
- .26 All Patch Cords shall be factory assembled and not site prepared.

1.5 **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.

1.6 **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.

1.7 **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)
 - .6 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 hangars, 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 TTPMD 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 **BACKBONE SUBSYSTEM**

- .1 Multi-strand 50/125:µm Multi-mode fibre run between the existing Network Rooms as shown on the plans and the new Telecommunications Room. Terminations shall be on NORDX FIBEREXPRESS 19" fibre patch panels, 2u, complete with 4x 3 SC-duplex Universal Connector Modules. Multimode SC fibre pigtailed are to be fusion spliced for termination. Install one patch panel in each telecommunications closet and four (4) in the POP room. See drawings for details.
- .2 Optical fibre cable to be as follows:
 - 1 The fibre cable shall be enclosed in a CSA , FT4 rated overall jacket. The all fibre runs shall be installed inside orange inner-duct tube for additional physical protection or inside empty conduit provided by electrical contractor.
 - 2 Attenuation shall be measured in accordance with EIA optical fibre test procedure EIA/TIA-456-46, -61, OR-53 (Ref B1.39). Information transmission capacity shall be measured in accordance with EIA/TIA-455-51, or -30 (Ref B1.39).
 - 3 The fibre cable shall meet the NEC requirements for OFNR or OFNP and comply with Bellcore. FDDI. GIGABIT ETHERNET, EIA/TIA-568 and ICEA standards.
 - 4 The optical fibre shall be multimode and single mode optical fibre with a nominal 62.5/125 [9/125] micron core/cladding diameter. The fibre shall comply with ANSI/EIA/TIA-592AAA (Ref B1B) and also with ANSI/TIA/EIA 568A (future CAN/CSA-T529) on Mechanical Terminations.
 - 5 Multi-mode backbone optical fibre cables should be of all dielectric construction and with the following characteristics:

Multi-mode Fibre Cable	850:m	1300:m
Attenuation - dB/km	3.75	1.5
Minimum Bandwidth - Mhz.km	3500	500

6 Each fibre shall be buffered with colour-coded PVC. The fibre cable shall meet the following specifications:

1 Fibre Dimensions:

Multi-mode Optics Cable	Fibre	50m – core
	1	25:m. – cladding
	2	50mm – coating
		900:m – buffering

.2 Cable Minimum Bending Radius:

During Installation: 15 times cable diameter (Short term load).	
Multi-mode Fibre Optics Cable	7.9" (20.1 cm)
After Installation: 10 times cable diameter (long term no load).	
Multi-mode Fibre Optics Cable	5.3" (13.4cm)

- .3 Buffered Fibre Minimum Bend Radius: .75 in. (1.91 cm)
- .4 Operating Temperature Range: -20°C to 70°C
- .5 Storage Temperature Range: -40°C to 80°C
- .6 Numerical Aperture: 0.275

- .7 UL Listed
- .8 The optical cable shall be fully dielectric, with no metallic elements in the cable.
- .9 The optical cable shall have decreasing sequential print on cable jacket of remaining cable length.
- .10 The optical cable shall have a crush resistance of 2000 N/cm.
- .11 The optical cable shall have an impact resistance of 2000 impacts with 1.6 N/m.
- .12 The optical cable shall have a minimum Flexure rating of 2000 cycles.

- .13 All Data Fibre Optic Distribution Panels shall be complete with Rack Mountable Fibre Optic Distribution Centre complete with the following:
 - .1 Cabinet to accommodate up to 6 x 12 fibre connectors and minimum of two separate tight buffered cables.
 - .2 Spools for storing patch cord slack and mechanism to control bend radius of fibres within cabinet.
 - .3 Hinged front or shelf providing easy accessibility to connectors and splices.
 - .4 12 Connector Panel Modules each with 6 LC-compatible interconnection sleeves. See drawings for details.

- .3 For a multi mode, 50/125:µm fibre optics cable factory made pigtail cables to be “fusion method” spliced in the field and used. All connectors shall have the following minimum performance specification:

Parameter	Specification
Max. Attenuation	0.3 dB
Typical Attenuation	= <0.2 dB
Connector Durability	<0.2 dB increase/1000 matings
Reflectance (Db)	-20

4.3. ADMINISTRATION SUBSYSTEM

1. The Administration Subsystem links all of the subsystems together. It consists of labelling hardware for providing circuit identification and jumper wire used for creating circuit connections at the cross connects.
2. The administration subsystem shall consist of wiring blocks for termination of copper cables and fibre patch panels for the termination of optical fibres. All rack layouts to be approved prior to installation.

3. **EQUIPMENT RACKS**

- .1 The 19" equipment racks shall be supplied and installed in the new Hub Room. The Racks shall be manufactured by "Cabletalk" or approved manufacturer.
- .2 The Two Vertical managers shall be provided for each section of the rack. (Cabletalk CTR-CMS series) For two racks a horizontal wiring manager on the top of the racks shall be provided (Cabletalk CTR-CMS-2M)
- .3 Provide two power bars with 12 outlets each, mounted on 6" spacers in the back of the racks.
 - .1 The on/off switch on the power bars shall be factory disabled.
 - .2 The Rack shall be provided with two full size fold-up tray for Cable-talk rack.
 - .3 The racks usable space height shall be 80"
 - .4 The Racks shall be "Cabletalk" CRT-1984 or approved manufacturer
- .5 The XLBET NORDX/CDT QPBIX24A BIX Frame shall be provided for termination of cables inside point of Presence Room.
 - .6 The frame shall be provided with BIX mounts and blocks for termination of 4000 pairs of voice cables.
 - .7 The frame shall include a BIX frame end kit.

1.4 **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 Data Backbone Duplex Optical Fibre Patch Cords shall be comprised of dual multimode 50/125 um graded index, dual window fibres terminated on all ends with ceramic LC compatible connectors.
18. 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.
22. The panels shall accommodate LC type adapter sleeves. Rack mounted fibre patch panels shall be lockable & rugged enclosures that can accommodate both splices and field mountable connectors. Both sides of the connection shall be protected by the enclosures
23. The optical fibre distribution terminal with the highest density of fibre terminations while maintaining a high level of manageability shall be selected.
24. The fibre cladding shall be covered by aramid yam and a Jacket of flame-retardant PVC.

25. The fibre patch cord shall meet the following specifications:
 - a. minimum bend radius: 1.00 inch (2.54 cm)
 - b. operating temperature: -4 to 158° (-20° to 70°)
 - c. loss: 0.4 Db/mated connector
 - d. minimum bandwidth: 3500MHz-km at 850 nm
 - e. 500MHz-km at 1300 nm
26. The Fibre patch panels shall provide cross-connect, inter-connect, splicing capabilities and contain the proper troughs for supporting and routing the fibre cables/jumpers.
27. Fibre Panels should provide for a flexibility point for cross connection or inter connection of optical fibre cables for in-building applications.
28. The panels should accommodate LC type adapter sleeves. They should be rugged and provide for strain relief for fibre connections.
29. The patch/distribution panels should be adaptable to 19" wide equipment racks or allow for wall mounting where indicated.
30. The panels should also accommodate storage and management of at least two metres of slack per fibre.
31. The panels should provide for grounding (where non dielectric cables are used).
32. Fibre Connections can be made with fibre splices (fusion) and pigtails. Connectors are the LC type according to the TIA/EI!-568-B.
33. Fibre patch cords shall be equipped with appropriate connectors. They shall use either single or dual fibre cables. Buffered fibre overlaid with strength material, such as kevlar, and a second PVC jacket shall be used. The maximum loss values shall not exceed the manufacturer specified values.
 - a. Splice (mechanical/fusion) 0.30 dB
 - b. Connector (mated pair) 0.75 dB
 - c. Cross-Connect (two mated pairs) 1.5 dB
34. The length of cords shall be 10' for each telecommunication closet.
35. The Fibre patch panels shall consist of a modular enclosure with retainer rings in the slack storage section to limit the bending radius of fibres.
36. The fibre patch panels shall have a "window" section to insert connector panels for mounting of connected fibres (LC connectors).
37. LC connectors shall meet or exceed the following specifications:
 1. Operating Temperature: -40 to 185 degree F (40 to 85 degree C)
 2. Average Loss: 0.3 dB

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) Intra-building 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 their 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 manufacturer 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. All optical fibre shall be handled, installed, and supported as per the manufacturer recommendations. During the laying of the cable, installer shall take care not to stress the cable. After the cable is installed, the installer shall make sure that all parts of the cable are supported properly according to the manufacturer guidelines. There shall be acceptable (to the manufacturer) minimum physical stress on installed cables.
3 In order to achieve a level of reliability that approximates that of a factory manufactured connector, field installable connector shall have a factory physical contact (PC) polish. Every fibre shall be terminated with the appropriate pigtail cable with factory installed connector, tested and test results provided in writing to Purchaser. The fibre patch cord shall consist of two single, buffered, graded index fibres with a 50 micro-meter core and a 125 micro-meter cladding (or 9.0/125 :m for single mode fibres). All fibres will be run in metal raceway and terminated in the TC's with SC connectors rack or wall mounted fibre optic patch panels equipped with sufficient panels, couplers and jumper storage shelves to terminate and secure all fibres.
- 4 The fibre cable shall be protected by metal raceway or appropriate apparatus at all times. Each end of the fibre cable shall contain a slack storage box with approximately seven feet of cable slack.
- 5 Communication Contractor shall be required to supply #6 AWG for grounding all equipment including communication cable trays.
- 6 All fibre cable not run in conduit shall be enclosed in appropriate flexible spiral wrapping for maximum mechanical and environmental protection. This includes up communications rooms riser.
- 7 The spiral wrapping shall be installed 'buted' and shall meet all relevant codes.
- 8 Supply all materials and labour for the installation of the complete Riser Cabling system including all cables and terminations.

- 9 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.
- 10 Fibre cable inside Communications Room shall be protected with max 0.97" cross-sectional area innerduct FT4 rated. The installation must be done in compliance with OBC 3.1.5.19
- 11 Provide, install and terminate the indicated quantities of riser cables in the communications rooms.
- 12 Communication Contractor shall be required to supply #6 AWG for grounding all equipment including communication cable trays.
- 13 The spiral wrapping shall be installed 'butted' and shall meet all relevant codes.
- 14 Supply all materials and labour for the installation of the complete Communications Cabling system including all cables and terminations.
- 15 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.
- 16 Provide, install and terminate the indicated quantities of riser cables in the communications rooms.
- 17 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.
- 18 Installation shall be suitably tested and demonstrated to the Engineer consistent with standard industry practice.
- 19 Connect equipment is to closet ground bus with #6 AWG green grounding wire.
- 20 Submit shop drawings of all communications equipment, cabling, receptacles and miscellaneous hardware.
- 21 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).
- 22 All cables shall be neatly bundled and tie-wrapped. Secure cable bundles to vertical and horizontal supports in Communications rooms to support cable bundles.
- 23 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.
- 24 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.
- 25 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.

- 26 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. Tiewraps on Cat 5e cables must be of velcro type only (plastic cable ties are not acceptable)
- 27 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.
- 28 Inform the Consultant of any cable lengths in excess of 90 m in length prior to installation.
- 29 Each run of cable between the termination block and the data outlet shall be continuous without any joints or splices.
- 30 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.
- 31 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.
- 32 Where the Contractor is required to remove ceiling tiles, such Work shall not break or disturb grid or tiles.
- 33 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.
- 34 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.
- 35 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.
- 36 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.
- 37 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
- 38 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.
- 39 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.
- 40 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.

- 41 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.
- 42 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.
- 43 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.
- 44 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.
- 45 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.
- 46 Surface mount telecommunications outlets where indicated shall provide up to six telecommunications outlet/connectors.
- 47 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.
- 48 Terminated conductor ends shall be properly trimmed to assure a minimum clearance of 0.250 in. between the conductors of adjacent modules.
- 49 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.
- 50 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.
- 51 Telecommunications outlet/connector shall require (or specifically not allow more than) only one single connection to horizontal cable as per TIA/EIA-568-B.
- 52 Flush mounted face plates shall accommodate modular telecommunications outlet/connectors and be available in four connectors per single gang telecommunications outlet.
- 53 All telecommunications outlets shall be made of high impact plastic.
- 54 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.
- 55 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.
- 56 Each telecommunications outlet shall be uniquely labelled. The label shall form an integral part of the faceplate.

7 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

1. GENERAL

1.1 Conformance

- .1 Conform to Division 1 - General Requirements.
- .2 Conform to Division 26 - Electrical General Requirements.

1.2 Shop Drawings and Product Data

- .1 Submit shop drawings and product data sheets in accordance with Electrical General Requirements.

1.3 Work Included

- .1 A/V Supplier to provide a complete working system including equipment, low voltage wiring and power supplies, and rack hardware for: **Audio and Visual Systems**. System components shall consist of state-of-the-art components and associated controls.
- .2 Division 26 to provide all 120V power requirements, including empty conduits, backboxes, floorboxes with pull strings. Include a 12"x12" in-wall box at the rack location connected to the required conduit. Provide Data and Hospital network cabling and connections where required.
- .3 AV Integrator to supply the Display Back Boxes (Chief PAC 526) to Division 26, who will install in conjunction with the conduit installation.
- .4 G.C. to provide ¾" plywood backing support for display monitor. Coordinate with AV Integrator.
- .5 Furniture provider to provide cut-out in table for table box where required. AV Integrator to provide cut out template. Coordinate location of table box with AV Integrator.

1.4 Submittals

- .1 Submittals shall be of adequate depth to define fully the system in its expanded form.
- .2 Shop Drawings: Submit complete sets of shop drawings within 14 days following receipt of purchase order. Shop drawings shall include copies of dimensional drawings completely describing installation that will be performed with relation to the space available for installation.
- .3 Manufacturer's Data: Submit data in the form of catalogue cuts or special data sheets as prepared by the manufacturer.
- .4 Maintenance Data: Submit copies of parts, lists and preventive maintenance requirements for systems to be installed.
- .5 Service Contract: Supplier to provide the contact information for normal and emergency service for the system.
- .6 Deviations: 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.

- .7 Substitutions: The intent of these Specifications is to establish the quality of the materials and/or workmanship desired for this project. Unless stated "no substitutions", any substitutions shall be in conformance with the requirements indicated.

1.5 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.
2. Do not install sensitive equipment until the work site is cleaned and free from dust.

1.6 System Verification

1. Test and demonstrate the operation of the complete expanded system to the Owner. This shall include, but not be limited to:
 2. detailed test and demonstration of each operable device,
 3. detailed test and demonstration of overall system operation
4. On completion of the installation the supplier shall supply 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 GENERAL

- 1.9.1. The specifications for the Audio & Visual Systems are a description of the various components with the minimum requirements and the operational sequence.
- 1.9.2 The following is a general description of the components required in the **STAFF ROOM K3C00B and TEAM ROOM K3C00C**.
- 1.9.3 .1 The design and function is to be able to operate each room as their own separate system, or when the user opens the room divider, that both rooms will operate together as one single system.
 - .2 Each room will be controlled using a table mounted touch screen to turn each system on/off, select presentation sources, control video conferencing calls, and control the volume individually. When the divider is open, the system will be combined and operate as one single system. Either touch screen will be able to control the combined system in this mode.
 - .3 The A/V Supplier is to create a custom GUI that is intuitive and easy to operate. The touch screen will be a POE device that is connected directly to the control system.
 - .4 The head end equipment for each room will be located into it's own free standing equipment rack. The sources in the rack will be the video conferencing system, digital media distribution from the tables, and an Air Media that provides a wireless option to connect mobile devices such as smartphones and tablets.

- .5 Provide a complete A/V presentation control and signal routing system that integrates the control system, digital media switching, audio DSP, amplifier, wireless gateway, microphones, video conferencing system, PTZ cameras and camera switching system. Provide signal transmitters and receivers where required.
- .6 The A/V system is to be configured and connected to an AV VLAN to allow for security updates, firmware updates and maintenance. Configuration of network to be done by Hospital IT Dept.
- .7 Provide the required POE power and switching in the equipment rack.
- .8 Each Meeting Room is to have an 86" LED 4K commercial display. A Chief in-wall back box is to be provide to Division 26 for installation at same time as conduit.
- .9 Provide in-ceiling low profile speakers to play the audio from the various sources.

Provide in-ceiling microphone with next-generation array architecture for enhanced directional pickup anywhere inside the room.
- .10 The requirement is to be able to make video conferencing calls from any platform (ie: Teams, Zoom, Webex) in either Meeting Room. Telephone systems are not a part of this scope and any telephony equipment is provided by others.
- .11 Provide a voice-activated camera switching solution that brings the full multi-camera experience to meetings, and video conferencing. Camera switching and movement is done automatically based on the location of the active speaking participant. See who is speaking with close-up camera shots and also wide shot of all participants displayed simultaneously. Clean production-style camera switching provides a more engaging experience for remote participants or viewers. (3) compatible automated PTZ cameras are to be located above each display in each room. The system is to come with built-in recording and streaming capability along with outputs for video conferencing.
- .12 All PTZ cameras are to be certified for use with Microsoft Teams and support HD-SDI connectivity. Program cameras in conjunction with Crestron Automate VX auto camera switching.
- .13 Users can make Teams video conference calls without the need of bringing a laptop with them, however, the system will also have a connection at the table that provides the flexibility to use any conferencing software from their laptop to conduct calls. The cameras and microphones are to be configured work with the laptop in these scenarios.
- .14 Provide table connectivity in the center of the meeting room table. The connectivity from the table box will route through the floor box. It is suggested that the floor box be located inside or beside one of the table support legs for best esthetics and ability to hide cabling. An access door to the inside of the table supports is to be supplied by the table provider if applicable. Any AV transmitters and receivers are to be located inside the table support legs. If the design of the supports does not facilitate mounting equipment and routing cables inside, then locate under the table in a manner to minimize the equipment and cabling from plain site.
- .15 System to have a secure wireless connection. With Air Media technology, users can wirelessly present content from laptops, smartphones, and tablet devices via an external Wi-Fi wireless network. When no source is connected, the AM-3200 displays a customizable welcome screen on the room display with simple instructions for connecting and presenting. It must have Enterprise-grade security and content encryption protects privacy and ensures compliance with IT policies. Unit to have 2 network connections which can be programmed by IT (ie: one could be a

guest network).

- .16 AV Integrator to provide connectivity in table box for the following:
 - (2) Dual receptacles
 - (1) HDMI connection on a pull-out retractor cable. For a laptop (or any other HDMI source) to be shown on the display.
 - (1) USB-B for laptop BYOD mode
 - (3) Network connections. Male RJ-45 connector on pull -out retractor cables; (2) will be for Hospital Network or any network configuration as required by IT; (1) will be for the Crestron Touch Panel.
 - (2) USB charging ports (Connections for USB-A/B and USB-C format)
- .17 AV Integrator to wire manage and install cable from table box to floor box. It is recommended that the table provided should have wire management built into itself to hide the cabling from plain view. The table box shall feature a one touch lid that retracts and disappears when opened.
- .18 Division 26 to provide a Legrand Evolution Series floor box large enough to install two power receptacles, network connections, and A/V connections as required. Electrician must coordinate the make and model of floor box before installation to confirm compatibility with AV plates.
- .19 Provide all manufacturer recommended cabling and connectors.

1.9.4 PRODUCTS

- .1 Equipment Rack
 - .1 Provide a 19 space free standing rack with all required shelving, blank panels, power distribution, locking front door, wire management and thermal management hardware.
 - .2 Middle Atlantic BGR-19SA27MDK-XX.
 - .3 Coordinate top-side finish with owner.
- .2 Digital Media Distribution
 - .1 Crestron NVX encoders and decoders
 - .2 HDMI switchers as required
 - .3 NVX Compatible POE network switch
- .3 Touch Screens
 - .1 Crestron TS-1070
- .4 Speakers
 - .1 2-way In-ceiling recessed – white - Low Profile
 - .2 8 Ohms or 70V multi-tap
 - .3 6.5" woofer and wide dispersion
 - .4 QSC AD-C6T-LP or equivalent
- .5 Monitor Mounts
 - .1 UL Listed
 - .2 Chief RLXT3 or similar

- .6 Table Boxes
 - .1 As configured in 1.9.3.1.16
 - .2 Crestron FT2-1400-ELEC-PTL-B Series
 - .3 Coordinate finish colour with owner

- .7 Video Conferencing System
 - .1 Enterprise-Grade Security
 - .2 Present, call, conference, and collaborate using your own device's UC conference platform (BYOD) or the native Microsoft Teams Rooms platform
 - .3 3 years of Flexcare 24/7, year-round live Crestron support
 - .5 Crestron UC-CX100-T

- .8 Display Panels
 - .1 86" with 4K resolution
 - .2 18/7 rated duty cycle
 - .5 Sharp, NEC, Samsung or LG are acceptable

- .9 Monitor Back Boxes
 - .1 Stud mountable
 - .2 Knockouts for single gang outlets and 1.25", 1" and .5" conduit
 - .3 6 Receptacles with non-sacrificial multi-stage filtration and surge protection
 - .4 White flange
 - .5 UL listed
 - .6 Chief PAC526FWP6

- .10 Media Transport
 - .1 Crestron HDBaseT or NVX is acceptable

- .11 Multi-Camera Switching System
 - .1 Voice Activated
 - .2 Compatible with Shure MXA-920
 - .3 Include all hardware and required adaptors
 - .4 Crestron Automate VX

- .12 PTZ Cameras
 - .1 HDMI Output
 - .2 Full HD resolution
 - .3 IP or serial control
 - .4 Automatic Optimal Framing
 - .5 Compatible with Crestron Automate VX
 - .6 (2) 1 Beyond IV-CAMPPTZ-12-N-SLVR-1B
 - .7 (4) 1 Beyond IV-CAMPPTZ-20-N-SLVR-1B

- .13 Microphone System
 - .1 8 separate adjustable lobes
 - .2 Ceiling or in-ceiling mounting option
 - .3 Network Audio Encryption
 - .4 Shure MXA920 ceiling mic array

- .14 Control System
 - .1 Crestron CP4N

- .15 Wireless Collaboration Connectivity
 - .1 Crestron AM-3200
- .16 AV Network Switch
 - .1 AES67 compatible
 - .2 POE+
 - .3 30 port – 24 POE
 - .4 Layer 2 and Layer 3 managed switching functionality
 - .5 NVX Compatible
 - .6 Netgear CEN-SWPOE-30 or equivalent
- .19 Digital Signal Processor
 - .1 QSC CORE 110V2 or other Q-SYS Components
- .20 Audio Amplifiers
 - .1 Provide 2 channels of amplification per room
 - .2 Minimum of 50W per channel
 - .3 Acceptable Manufacturer's: QSC
- .21 HDMI Auto Switcher
 - .1 4K resolution
 - .2 2 HDMI inputs, 1 output
 - .3 Built-in scaler
 - .4 Quick switch HD Technology
 - .5 Crestron HD-MD4X1-4KZ-E as required

1.9.8 SUPPLIER

- .1 System shall be as **supplied by Aatel Communications (contact Mike Moore at 905-526-2393, email mikem@aatel.com)**
- .2 System installation will include the following:
 - .1 Supply and installation of control equipment.
 - .2 Supply and installation of all system equipment and devices.
 - .3 Supply and installation of all wiring required for complete system operation.
 - .4 All required device set-up and system programming, testing and verification including all user selectable functions set up to Hospital's desired settings. Review settings with Hospital prior to implementation.
 - .5 Complete instruction to Owner on system operation.
 - .6 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.
- .3 Operation and Maintenance Data
 - .1 Provide operation and maintenance data for incorporation into manual.
- .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.
 - .4 provide one (4) hour training session for Hospital Representatives

- .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.
- .5 The contractor shall provide a complete and fully functional Audio/Video system using materials and equipment of types, sizes, ratings, and performances indicated.
- .6 Materials and equipment shall comply with the referenced standards and the manufacturers' standards.
- .7 The contractor shall coordinate the features of the materials and equipment so that they form an integrated system with components and interconnections matched for optimum performance of specified functions.
- .8 All equipment, installation material and labour required to fulfill the functional and performance criteria of the Audio/Video System, as described in this Specification, shall be furnished whether or not enumerated herein or on this specification.
- .9 The systems and components shall be of modular design, completely solid state and be high quality professional audio and video products.
- .10 All equipment, wiring and wiring devices supplied shall meet the requirements of the authority having jurisdiction and shall be CSA and or Ontario Hydro approved. The total work specified herein shall comply strictly to the requirements of the latest edition of the Ontario Building Code or the Canadian Electrical Code, as appropriate. This code and any additional requirements of the Authority having jurisdiction constitute an integral part of this Specification, and in case of conflict, the Code shall take precedence over this Specification.
- .11 Conduit, raceways, floor boxes and associated J-boxes are to be provided by Division 26 Contractor. Audio video contractor shall inspect provided supporting AV infrastructure and provide all additional components required for installation of AV systems.
- .12 Final payment will be approved upon acceptance of the completed installation by the owner or the Engineer.

1.9.14.9 Submittals

- .1 The shop drawings shall include:
- .2 Block diagrams showing the proposed interconnection of all equipment and equipment racks.
- .3 Riser diagram(s) showing all system devices and their appropriate cable requirements, AC requirements, equipment rack locations, conduit sizes, loudspeaker types and locations, and sensing device locations etc.
- .4 Equipment rack drawings showing the Equipment layout.
- .5 Equipment catalogue sheets with the pertinent specified parameters highlighted.
- .6 Circuit diagrams, descriptive information and operating instructions for all custom equipment to be furnished, ie. control and switching equipment, special panels etc.

- .7 Fastening and mounting arrangements for all devices including loudspeakers.
- .8 The Engineer's review or approval of shop drawings does not relieve the Contractor from responsibility for providing a complete and operating system.
- .9 Notes or changes to the shop drawings by the Engineer are not intended to alter the value of the work. The Engineer shall be advised, in writing of any notation or change which will affect the Contract Price. Do not proceed with the subject work until officially notified.
- .11 Include an overall system schematic indicating the relationship of each system component on one diagram.
- .12 Drawings shall include wiring diagrams and installation details of hardware and cables indicating proposed locations, conduit, layout and arrangements, and other items that must be shown to ensure a coordinated and compliant installation.
- .13 Within 10 working days after final system acceptance, the contractor shall provide two electronic copies of "as-built" drawings, showing all "as-built" and "as-found" conditions pertaining to this work. One set shall be provided to the owner; one set shall be provided to the designated engineer.

3.0 EXECUTION

- 3.0.1.1 All work shall be done in a workmanlike manner by tradesmen skilled in the class and kind of work and shall be neat and clean when completed.
 - .2 All equipment shall be firmly held in place. Full range Cabinets and Ceiling speakers shall be fastened in an approved manner and speaker cabinets shall be firmly supported. All devices shall be fixed with fastenings and supports as specified.
 - .3 Mount all equipment, boxes, exposed wiring or other devices plumb and square. Moderate relocation of equipment, as is necessary to preserve a favourable appearance, shall be made without claim.
 - .4 Wiring shall be installed in EMT raceway provided by this contractor. If conduits are not provided, this contractor shall provide plenum rated cables and install cables using J hooks or other cable supports.
 - .5 If short cable runs must be run exposed, approval of routing and materials must be obtained from the Engineer before commencing the work.
 - .6 Conduits shall be routed and audio equipment shall be located to circumvent all interferences.
 - .7 All operating controls, switches, jacks, plugs and accessories shall be permanently marked in a clear logical manner utilizing embossed letters or lamicoïd plates.
 - .8 All wiring shall be properly identified in function boxes, at terminal blocks and where accessible.
 - .9 Include in the tender price all costs associated with using lifts or another equipment for installing wiring and speakers. No allowance will be made for extra cost as a result of site conditions and hardship claims will not be entertained.

.10 Electrical Interference

- .1 Adequate precautions shall be taken to prevent electromagnetic and electrostatic interference and hum.
- .2 Equipment rack wiring and other electronic equipment wiring shall be placed and terminated in screw-type terminals or approved plugs. Permanent rack wiring shall be made with resin-core solder.
- .3 Standard engineering practices for separation of power, loudspeaker, line level, DC control and microphone level circuits shall be adhered to in equipment rack assemblies.
- .4 Speaker lines and DC control lines shall be spliced, if required, only in accessible junction boxes. All shielded cables shall be run continuous without splices. Separate conduits for speaker, line level and microphone level circuits shall be utilized. All speaker terminations shall be made with insulated crimp connectors or spade type terminations to barrier style terminal blocks.

.11 Performance and Adjustment

- .1. Optimize the system performance within the limits of the specified equipment and device capabilities. Adjust the signal processing equipment, amplifiers, loudspeaker power, phasing and orientation to achieve performance satisfactory to the Consultant.
- .2 Verify that the complete system is free from R.F. pickup, parametric oscillations, hum, buzzes, rattles or distortion by:
- .3 If need for adjustment becomes evident during the acceptance testing, work shall be continued until the system installation operated as specified, without extra cost to the Contract.

.12 Demonstration and Training:

- .1 Demonstrate the system's operation, maintenance and service procedures to the Owner's designated personnel.
- .2 Provide one (4) hour training session for designated staff, demonstrating all functions of the AV system. Co-ordinate training times with Hospital.
- .3 Supply a hard copy "1-page quick guide" of the operation of the system for each room to the owner for future reference.

.13 Warranty

- .1 The total system shall be guaranteed for a period of (3) year on parts and labour. Extended material warranties, offered by any of the equipment suppliers, shall be provided to the Owner and indication of any such extension shall be noted in the maintenance service manuals to be provided.
- .2 If any materials or workmanship prove to be faulty during their guarantee period(s), without cost to the Owner between 08:00 and 16:30 hours (Monday to Friday), undertake the following:

- .1 Respond remotely within (4) hours to the service call if problem can be assessed remotely. It is the responsibility of Hospital to provide remote access for this purpose.
- .2 Respond to minor failures within the next business day. Examples of a minor failure are a remote control not working, or loose connections.
- .3 Respond to major failures within 8 hours. Example of major failures are blown projector bulbs or display panels not powering up.
- .4 AV supplier to provide a owner with a list of minor and major failure examples.
- .5 The instruction manual shall be prepared with detail description for operation and troubleshooting
- .6 Provide a maintenance and service contract for (3) years that includes a minimum of (2) site visits for the purpose of checking and adjustment of the system.
- .7 Provide owner with spare parts where described elsewhere in this section.

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 SPARE COMPONENTS

- .1 Include in the Bid the following additional components including installation (include an average of 100'0" of wire in conduit for each additional device and connection to an adjacent zone/ circuit). Assume, for bidding purposes, that these devices can be added at any time during construction including at the end of the construction and in any location as directed on site. Any devices not installed shall be turned over to the Hospital:

one (1) extra Code White Button c/w connection to the Code White System

1.5 **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 combination of both fixed location Code White Buttons and Wireless Receivers. The System shall be integrated to the existing Hospital Central Code White System. Receivers/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 in areas equipped with the Code White receivers to carry wireless pendants which, when activated, will 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.

The System Code White Pushbuttons shall permit the same operation

- .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 All supplied transmitters must be compatible with all supplied system receivers enabling staff to use any transmitter for Code White call placement wherever they may be provided the room is equipped with a Code White receiver. Systems which only permit a specific transmitter to be used with a specific receiver to provide discreet annunciation will not be acceptable. Systems which cannot prevent transmitter to receiver overlap and provide an accurate location where the call originated will not be acceptable.
- .6 Supply a quantity of 50 (fifty) lightweight battery operated wireless pendant style transmitters each unit shall weigh less than two ounces. Transmitters shall include a yellow low battery warning indicator LED that when lit indicates the transmitter requires battery replacement.

Transmitters shall use a standard 12 volt "N" type battery. Include with the system one spare battery for each transmitter supplied. Under normal usage the battery life expectancy will be six (6) months.

- .7 Calls originating by activating the wireless pendant shall be latching and can only be canceled by resetting the individual transmitter which was used to originate the call. Systems that enable remote reset of alarms will not be acceptable.
- .8 The Code White receivers shall be flush ceiling/ wall mounted on a brushed stainless
- .9 Manufacturers
 - .1 **The manufacturer for this system to be manufactured/ supplied by:**
 - **For Pushbuttons: Rauland**
 - **For Wireless: 'CENTRAK'**
 - **and all 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 Wireless Receivers 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

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 **Mobotix**
 - .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 3750X STACK 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.
- 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 System.

- .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
 - .1 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:
 - .1 Details for devices.
 - .2 Details and performance specifications for control, annunciation and peripherals with item by item cross reference to specification for compliance.
 - .3 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.
 - .1 Diagram is to indicate wiring quantities, sizes and colour code and to indicate conduit sizes.
 - .2 Riser Diagram is to be produced on AutoCad and is to be submitted as a Shop Drawing.
 - .3 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:
 - .1 Instructions for complete fire alarm system to permit effective operation and maintenance.
 - .2 Technical data - illustrated parts lists with parts catalogue numbers.
 - .3 Copy of approved shop drawings with corrections completed and marks removed except review stamps.
 - .4 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:
 - .1 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 Drawings
 - .2 Provide 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
 - .1 Necessary circuitry for operation of supervised valves and loss of power alarms for sprinkler system and auxiliary booster or special service pumps.
 - .2 Smoke detectors installed in Operating Rooms shall be Photoelectric/thermal combination with contact to drive the over the door dome light.
 - .3 The smoke detectors in corridors shall be of equal numbers of ionization and photoelectric and alternated along the corridor or be combination type detectors.

1.12 **SYSTEM OPERATION**

- .1 It is the intent to maintain the operation of the existing Fire Alarm System

1.13 SPARE COMPONENTS

- .1 Include in the Bid the following additional components including installation (include an average of 20'0" of wire in conduit for each additional device and connection to an adjacent zone/ circuit). Assume, for bidding purposes, that these devices can be added at any time during construction including at the end of the construction and in any location as directed on site. Any devices not installed shall be turned over to the Hospital:
 - 2 (two) addressable smoke detectors
 - 2 (two) speakers
 - 2 (two) addressable pull stations
 - 2 (two) strobe lights
- .2 Verification and any programming required by the installation of these components shall be included.

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:
 - .1 57.2°C (135°F), fixed temperature and -9.4°C (15°F) per minute, rate of rise
 - .2 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 IONIZATION SMOKE DETECTORS

- .1 Ionization type smoke detectors shall be constructed of solid state components and operate on ionization principle to detect visible and/or invisible products of combustion.
- .2 It shall be possible to check and change sensitivity of detectors. Smoke detectors shall be set for approved sensitivity.
- .3 Detectors shall be ULC listed.
- .4 Incorporate an LED or lamp latched circuit to indicate the signal operation of the unit.
- .5 Smoke detectors shall operate on 24 volts DC and be protected against electrical transients and electromagnetic interference.
- .6 Detectors shall be equipped with NO/NC contacts to operate ancillary devices where applicable.
- .7 Detectors shall be equipped with a fine mesh bug screen to prevent contamination of the detection chamber by insects.

- .8 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.
- .9 The detector shall filter out false alarms caused by intermittent aerosols or cigarette/pipe tobacco smoke.
- .10 Recessed smoke detector shall be complete with necessary shroud and flush mounting hardware.
- .11 Protect automatic smoke detectors during construction with a dust-bag, which shall be removed at the time of verification.

2.10 **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.

2.11 **DUCT MOUNTED SMOKE DETECTORS**

- .1 Duct-mounted smoke detectors shall consist of an ionization type smoke detector as described above, and an air tight housing assembly, mounted on the side of the duct complete with sampling tubes and supporting framework.
- .2 While fans are running, a continuous cross-sectional sampling of the air flows from the ventilation duct, through the detector, and then returned to the duct. Air stream velocity range from 2.5 m/sec minimum to 18 m/sec maximum be made to monitor, test and reset the detectors under actual air flow conditions. Unit shall be equipped with a test key switch and a reset key switch.
- .3 Remote alarm lamps or LED shall indicate the signal operation of the detector. Install Remote LED in an easily visible location to someone standing on the floor without requiring the use of ladders to see it.

- .4 Protect automatic smoke detectors during construction with a dust-bag, which will be removed at the time of verification.
- .5 Manufacturer shall include site visits to direct detailed locations of duct-mounted smoke detectors.

2.12 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.

2.13 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.

2.14 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.

2.15 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.

2.16 **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.

2.17 **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 DOOR HOLDERS/CLOSERS AND MAGNETIC LOCKS

- .1 Connect all door holders into the fire alarm system such that doors close automatically upon actuation of the fire alarm system.
- .2 Connect all magnetic locks so that they are released by the fire alarm system and wire directly to be released by the adjacent pull station on First stage alarm in all area of the hospital except psychiatric areas. Mag locks in psychiatric areas will open on second stage alarm. Confirm this operation with local fire department prior to installation or programming.

3.3 SPRINKLER/STANDPIPE SYSTEM CONNECTIONS

- .1 Connect contacts of sprinkler flow, supervisory and standpipe system switches to fire alarm zones indicated and verify correct zoning.
- .2 Connect contact voltage sensitive relay of sprinkler pump, auxiliary booster or special service pump to fire alarm zone indicated, for trouble condition.

3.4 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.

3.5 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:
 - .1 That the system is complete in accordance with Specifications.
 - .2 That the system is connected in accordance with Manufacturer's recommendations.
 - .3 That the regulations concerning the supervision of components have been adhered to
 - .4 That all equipment as part of the system is inspected for visible damage or tampering
 - .5 That adjacent speakers have been connected to alternate circuits.
 - .6 That the control functions have been tested for proper supervision, operation and annunciation of fan shutdown and all speaker control circuits

- .7 That all speakers are properly zoned.
 - .8 That all valves are properly connected and displayed correctly on each annunciator.
 - .9 That any subsequent changes necessary to conform to the above will be carried out with technical advice supplied by the Manufacturer.
 - .10 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.
 - .11 That all annunciators correctly pin-point the origin of any fire alarm.
 - .12 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.
 - .13 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:
- .1 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.
 - .2 verification records shall show the date on which all devices were verified.
 - .3 verification records shall show the date of all deficiencies encountered in the control equipment, wiring and field devices.
 - .4 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.

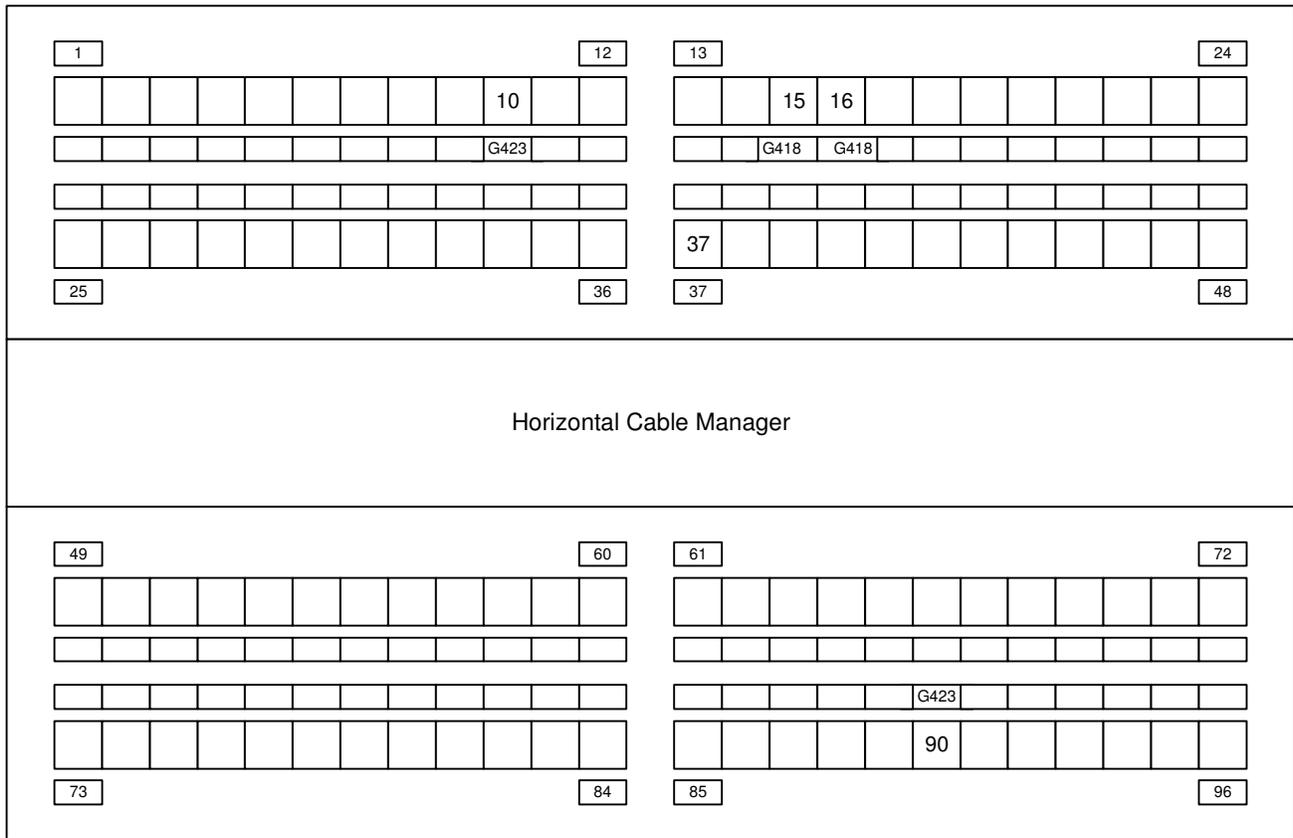
2. Most of the work can be done during normal business hours with the understanding that corridor traffic flow must not be compromised.
3. Access to all locked doors will be through Fire and Security Services. Be prepared to wait at times for access to any given room. All doors **MUST** be locked upon 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.

- 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 be 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

OWNER'S RULES AND REGULATIONS

SUNNYBROOK HEALTH SCIENCES CENTRE HEALTH AND SAFETY RULES

(to be posted at job site)

1. Smoke tobacco in designated areas only. Never smoke in any location that contains a combustible or explosive condition or atmosphere.
2. No person who is impaired by alcohol or drugs shall enter and/or remain on the grounds.
3. Follow instructions; don't take chances. If you don't know, ask.
4. Immediately report to your supervisor any condition or practice you think might cause injury to employees or damage to equipment.
5. Put everything you use in its proper place. Disorder causes injury and wastes time, energy, and material. Keep your work area clean and orderly.
6. Any personnel operating equipment is to be duly authorized and instructed (licensed where practical) in the safe method of operation.
7. Whenever you, or the equipment you operate is involved in an accident, regardless of how minor, report it to your supervisor immediately. Get first aid promptly.
8. Repairs are to be made by authorized, licensed personnel only. Need for repairs must be reported to your immediate supervisor, and are not to be undertaken by non-qualified personnel.
9. Wear approved personal protective equipment as directed. Keep it in good condition.
10. All authorized visitors on the property are required to wear and use appropriate safety equipment.
11. Don't horseplay; avoid distracting others.
12. When lifting, bend your knees, grasp the load firmly, then raise the load, keeping your back as straight as possible. Get help for heavy loads.
13. Obey all rules, signs, and instructions.
14. In the event of an accident, the Occupational Health and Safety Clinic is located in H Wing, Ground Floor, room HG46.

SUNNYBROOK HEALTH SCIENCES CENTRE HEALTH AND SAFETY RULES
(to be posted on site)

15. A full report of any accident is to be submitted in writing to the Consultant's representative, within 24 hours of the occurrence.
16. The *Contractor* shall provide to the *Owner's* Safety Coordinator, the name and phone number of their health and safety delegate.
17. Before work begins, the *Contractor* shall deliver to the Sunnybrook Occupational Health and Safety Department - Safety Coordinator, a list of the chemical substances to be used in all work, and a Material Safety Data Sheet for each chemical substance (this is a WHMIS requirement).
18. The *Contractor* shall also provide a list of physical or biological agents produced by its work.
19. The *Contractor*, before the work commences, shall arrange a meeting where the *Contractor* and its workers are informed of the following:
 1. the requirement to comply with the general health and safety rules required by Sunnybrook;
 2. the requirement to comply with the *OHSA*;
 3. the name and telephone number (both home and office) of the *Contractor's* supervisor; and the health and safety representative, or members of the Subcontractors committee at the job site, whichever is applicable;
 4. the areas of the location to which the *Contractor* and the *Contractor's* workers are allowed access;
 5. any special hazards at the job site of which the *Contractor* and/or its workers normally would be expected to be aware (for example, what to do in case of a fire);
 6. the requirements imposed upon the *Contractor* in the event that one of the *Contractor* workers is injured at work.
20. As the work progresses, planned inspections are to be made of areas/places where the *Contractor* and his workers are working to ensure the following:
 1. the *Contractor* and his workers comply with health and safety laws;
 2. the and his workers comply with the *Owner's* general health and safety rules;
 3. the *Contractor's* work is not creating an unacceptable health and/or safety hazard for the *Owner's* employees.
21. Comply with the attached Contractor Safety Requirements document.

WHMIS

WORKPLACE HAZARDOUS MATERIALS INFORMATION SYSTEM REQUIREMENTS

1. Comply with Workplace Hazardous Materials Information System in accordance with the Occupational Health and Safety Act (*OHS*A) requirements.
2. Before commencement of Work and during full term of the Contract, provide a list with current Materials Safety Data Sheets (MSDS) of all hazardous materials proposed for use on Project. List and data sheets shall be delivered to Sunnybrook Occupational Health and Safety Department - Safety Co-ordinator.
3. Label hazardous materials used and/or supplied on the Project in accordance with WHMIS requirements.
4. Provide detailed procedures for safe handling storage and use of hazardous materials. List special precautions and safe cleanup and disposal procedures. Conform to Environmental Protection Act for disposal and cleanup requirements.
5. Obtain from the Owner, where applicable, a list and MSDS of hazardous materials that may be handled, stored or used by Owner's employees and/or Other Contractors retained by Owner at location where work of this Contract will be performed.
6. Ensure that those who handle, and/or are exposed to, or are likely to handle or to be exposed to hazardous materials, are fully instructed and trained in accordance with WHMIS requirements.

SUNNYBROOK HEALTH SCIENCES CENTRE

CONTRACTOR'S ACKNOWLEDGEMENT

Sunnybrook Health Sciences Centre ("Sunnybrook") has included in the Tendering information for this contract a copy of the list of any designated substances present at the Project or Work site. The Notice of Designated Substances included in the Tendering Information is attached to this Acknowledgement.

If awarded this contract, the Contractor, as Contractor within the meaning of the OHSA, undertakes:

- to inform other contractors and all subcontractors retained to perform services on the Project or the Work of the existence of the designated substances, if any, which are present at the Project, and to provide to other contractors and all subcontractors a copy of the list of designated substances which is attached to this Acknowledgement, prior to entering into any contracts with those other contractors or subcontractors for the supply of services;
- to notify Sunnybrook of the presence of any potentially hazardous materials or toxic substances which will be brought to the Project or the Work by the Contractor, or Contractor's employees and to provide all applicable MSDS sheets, if any, to Sunnybrook;
- to ensure that other contractors and all subcontractors retained to supply services for the Project or the work notify Sunnybrook of the presence of any potentially hazardous materials or toxic substances they bring to the Project or the Work and ensure that they provide all applicable MSDS sheets, if any, to the Contractor, other contractors and all subcontractors to so comply.

Contractor:

Contract to be performed:

The Contractor acknowledges that he has received the List of Designated Substances attached to the Tendering Information, and agrees to be bound by the undertakings set out above.

Date

Contractor's Signature

Note: This Acknowledgement is an integral element of the Tender Documents. This Acknowledgement must be signed and returned with the Tender Bid documents.

SUNNYBROOK HEALTH SCIENCES CENTRE

NOTICE OF DESIGNATED SUBSTANCES

The following Designated Substances are present at Sunnybrook Health Sciences Center:

<u>Designated Substance</u>	<u>Location</u>
Asbestos on Construction Projects and in Buildings and Repair Operations	Can be expected in varying states in all wings except L, M, S, and T
Ethylene Oxide	Regional Processing Centre; Receiving – M-Wing Basement; only present during a spill
Isocyanates	SCIL – possible in other areas in small quantities
Mercury	Used in older instruments – only present during a spill
Benzene	Principally found in laboratories but may be found elsewhere
Lead	Used in many locations as lead shielding, or in lead paint.
Arsenic	Possible in laboratories

SUNNYBROOK HEALTH SCIENCES CENTRE
NOTICE OF BIOLOGICAL, CHEMICAL AND PHYSICAL HAZARDS

Biological:

Sunnybrook Health Sciences Centre (Sunnybrook) is a fully functioning hospital and medical research facility. As such any biological hazard that could infect a person outside the facility can be expected within the facility. This includes any communicable or non-communicable disease.

Physical Hazards:

Sunnybrook also contains physical hazards common to all public buildings. Contractors, their employees, and subcontractors must be aware of the general hazards associated with any kind of work in a full service public facility with residential living.

In addition to "normal" physical hazards there are also specific departmental hazards. Contractors must make their employees and subcontractors aware of the hazards they may encounter and the safety precautions to take. Contractors are required to contact SHSC departmental managers, and/or the safety office, and/or the Corporate Planning and Development or maintenance project manager regarding any specific hazards.

Chemical Hazards:

In addition to the designated substances mentioned under The Notice of Designated Substances there are approximately 5000 WHMIS regulated chemicals at Sunnybrook and several thousand chemicals covered by The Food and Drug Act, The Pest Control Act, The Atomic Energy Control Act, and the Explosives Act. All contractors are required to have their workers WHMIS trained to work on the premises. Contractors are required to contact SHSC departmental managers, and/or the safety office, and/or the Corporate Planning and Development or maintenance project manager regarding any specific hazards.

SUNNYBROOK HEALTH SCIENCES CENTRE SAFETY RULES APPLICABLE TO OUTSIDE CONTRACTORS AND THEIR EMPLOYEES ENGAGED TO WORK AT SUNNYBROOK

(A) ALL CONTRACTOR'S PERSONNEL

1. Work in compliance with the provisions of the Occupational Health and Safety Act and the regulations, and in compliance with the employer's health and safety rules;
2. Use or wear any equipment, protective devices or clothing required by the Owner or by the employer;
3. Report missing or defective equipment or protective devices to the employer;
4. Report any known workplace hazard to the employer;
5. Report violations of safety legislation or safety rules to the employer;
6. Do not remove or make ineffective any protective device required by legislation, by SHSC or by the employer;
7. Do not use or operate any equipment or work in a way that might endanger oneself, or any other person;
8. Do not engage in any prank, contest, feat of strength, unnecessary running or rough or boisterous conduct.

(B) SUPERVISORY PERSONNEL (Person(s) having charge of the workplace or authority over the Contractor's employees)

1. Ensure that supervised employees work in compliance with the Occupational Health and Safety Act and regulations, these rules and the employer's health and safety rules;
2. Ensure that safety equipment, protective devices or clothing is used or worn by employees and visitors to the work site;
3. Advise employees and visitors to the work site of any potential or actual health or safety dangers known to exist;
4. Ensure appropriate training is given to employees about measures and procedures to be taken for their protection including, as required, (but not necessarily limited to): asbestos awareness training and WHMIS training);
5. Take every precaution reasonable in the circumstances for the protection of employees and any other persons at the work site.

* * *

END OF SECTION



Contractor Safety Requirements

Sunnybrook Health Sciences Centre		Policy No:	HR-0090
Title	Contractor Safety Requirements	Original: (mm/dd/yyyy)	11/01/2007
Category	Human Resources	Reviewed: (mm/dd/yyyy)	03/10/2022
Sub-Category	OccHealth & Safety	Revised: (mm/dd/yyyy)	03/27/2017
Issued By:	Occupational Health & Safety		
Approved By:	Senior Leadership		

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.

POLICY STATEMENT:

It is a Sunnybrook Health Sciences Centre (Sunnybrook) policy to ensure that the contractor shall also comply with all federal, provincial and municipal governmental laws and regulations which are applicable to its business, and in particular, those affecting health and safety, workers' compensation and environmental matters.

This policy applies to all contracted work including capital projects, renovation and service contracts. Sunnybrook or its agent or delegate is the owner of all projects and will select a constructor for all projects.

DEFINITION(S):

Constructor: a person who undertakes a project for an owner and includes an owner who undertakes all or part of a project by himself or by more than one employer. Occupational Health & Safety Act, s.1.

Contractor: refers collectively to constructors, employers, sub-contractors, service companies hired by the owner to perform project or service work.

Designated Substances: A biological, chemical or physical agent or a combination thereof prescribed as a designated substance (by the Act) to which the exposure of a worker is prohibited, regulated, restricted, limited or controlled e.g. asbestos, mercury, lead. Occupational Health & Safety Act, s.1.

Employer: a person who employs one or more workers or contracts for the services of one or more workers, and includes a contractor or subcontractor who performs work, supplies services, or undertakes with the owner, constructor or another contractor or subcontractor to perform work or supply services. Occupational Health & Safety Act, s.1.

Owner: includes a trustee, receiver, mortgagee in possession, tenant, lessee, or occupier of any lands or premises used or to be used as a workplace, and a person who acts for or on behalf of an owner as an agent or delegate. Occupational Health & Safety Act, s.1.

Project: means a construction, renovation or maintenance project.

Project Manager: and individual or firm designated by Sunnybrook to manage a project. It includes a manager who hires a contractor for service work.

RELATED POLICIES:

[Capital Project Management policy \(FIN-087\)](#)

[Infection Control during Construction, Renovation and Maintenance \(IPAC-0006\)](#)

[Mould Management \(IPAC-0015\)](#)

[Asbestos Management \(HR-0089\)](#)

[Restricted & Confined Space \(HR-109\)](#)

POLICY:**1.0 Responsibilities****Owner**

- Appoint a project manager.

Constructor**The constructor shall ensure the following for projects they undertake:**

- The measures and procedures prescribed by the Occupational Health & Safety Act (OHSA) and regulations are carried out.
- Every employer and worker performing work on the project complies with the OHSA and regulations.
- The health and safety of workers on the project is protected.
- Provide proof of WSIB coverage for all workers.
- Comply with Sunnybrook's sign in procedure.
- Ensure that all required communication is provided to all workers so they are also aware of Sunnybrook's policies and procedures.
- Ensure workers familiarise themselves with emergency equipment (i.e. fire extinguishers, pull stations, etc.) located in the immediate work area to facilitate a quick response in the event of an emergency. Monthly alarm tests are performed that require everyone to comply with evacuation procedures outlined for individual areas.
- The contractor shall abide by and shall ensure that each of the contractor's employees and sub-contractor's employees (if applicable) abide by Sunnybrook's health and safety policies and procedures. The contractor will also be able and willing at such times as recommended by Sunnybrook to provide additional precautions as deemed necessary by Sunnybrook for safeguarding employees and equipment. The contractor further acknowledges and agrees that any violation of safety policies and procedures is justification for the immediate termination of its Contract with Sunnybrook, without any further obligation on the part of the Sunnybrook.

Visitor (delivery personnel, inspectors, vendors etc. with an ongoing and/or established professional relationship with Sunnybrook)

- Must contact appropriate Sunnybrook personnel on arrival and be informed of and adhere to applicable Sunnybrook health and safety policies and procedures related to their visit.

Employer (constructor, contractor or sub-contractor)

- Employers are responsible for complying with all employer duties under the OHSA and regulations.
- Ensure workers are qualified for the work performed.

Project Manager (The person responsible for hiring the contractor and who the contractor will sign in with upon arrival at Sunnybrook)

- Is responsible for ensuring completion of the [Contractor Policy Sign-Off Form](#).

- Provide contractor with relevant hospital policies and information including designated substance surveys, confined or restricted spaces, as well as information on any other hazard inherent to the work area.
- Act as the contractor's contact person for the duration of the contract.
- Notify contractor that performance will be monitored and failure to follow legislative requirement or hospital policies may result in a "stop work" order or removal from the workplace.
- Notify occupant of project work.
- Involve Infection Prevention & Control (IP&C), Occupational Health and Safety (OHS), Fire Prevention and Security, Environmental Services, and Plant Operations and Maintenance as required to ensure hospital policies and procedures are followed.
- Ensure contractor(s) are properly identified by a Sunnybrook ID badge at all times
- Advise Sunnybrook Managers/Supervisors if work is being done in their area with the expected time frame and impact on the department.

2.0 **Planning & Contractor Selection Phase**

- a. All project work or work performed by an external contractor must have an assigned project manager.
- b. As part of the bidding process, contractors must provide health and safety documentation as well as previous accident/incident experience.
- c. The Project Manager must consider health, safety and environmental criteria as part of the pre-qualification or tendering process to select a contractor for a project. Certifications, training records, previous hospital experience, health and safety performance, WSIB CAD-7 Rating, and company policies should be reviewed and considered in the selection process.
- d. During the tendering process, the Project Manager must provide the contractors with a list of any designated substances in the work area, including the location and condition of any asbestos as well as the location of any other designated substances. For asbestos, the OHS department will provide information from the building survey.
- e. The Project Manager must notify the contractor if the project involves work in a restricted or confined space. The Project Manager and the contractor are responsible for following all requirements of the [Restricted and Confined Space Policy](#).

3.0 **Prior to Project Start Date**

- a. The contractor must provide copies of the SDS' for products that could impact the health and safety of building occupants.
- b. Contractors must carry comprehensive liability insurance and automobile liability insurance as per the contract agreement.
- c. The Project Manager must advise IP&C of the upcoming project and involve them during the planning stage. The requirements of the [Construction & Renovation Policy](#) must be followed and IP&C will review the containment strategies, waste removal, traffic patterns, impacts on ventilation and water systems as well as cleaning procedures. As required for Class III or IV work, IP&C will complete the checklist: *Risk Assessment & Prevention Measures for Healthcare Facilities Construction & Renovation*.
- d. As part of mould, dust & asbestos management, the Project Manager must notify OHS and IP&C of the project and obtain a *Construction, Renovation and Maintenance Permit* for any work that disturbs building materials or includes ceiling entry. The permit must be displayed in the work area for the duration of the work. This applies to capital or facility renewal projects.
- e. OHS will review procedures for asbestos work including containment, ventilation, air monitoring and final clean-up. OHS should also be consulted for MSDS/SDS review, restricted and confined space permits and a review of any other potential health or safety issue with the project (e.g. air quality).
- f. During the planning process, the Project Manager must consult departments that will be affected by the project to address health and safety concerns as well as logistics planning to minimize work disruptions.

- g. The Project Manager must provide contractors with the appropriate Sunnybrook policy requirements (e.g. Asbestos Management, Mould Response, Construction & Renovation, Restricted & Confined Space, etc.) as determined by the nature of the work.
- h. The Project Manager must provide the contractors with information on Code Brown and Code Red procedures at the hospital so that they are able to report and respond to any floods or fires in the construction area.
- i. The Project Manager is responsible for advising the contractor that construction areas must be secured at all times to prevent unauthorized entry and must ensure contractors follow procedures to comply with this requirement.
- j. IP&C, OHS or a designated third-party environmental consultant will inspect containment barriers prior to and during the work on a regular basis and advise the project manager of any concerns.

4.0 Policies & Training

- a. Contractors must follow the OHSA and regulations, all environmental protection legislation as well as the requirements of applicable Sunnybrook IP&C and OHS policies. Any violation of safety rules or regulations is justification for the immediate termination of a contract without further obligation on the part of Sunnybrook.
- b. All contracted workers must have WHMIS training as well as any other safety training relevant to the work (e.g. Asbestos Awareness, Confined Space training, Infection Prevention & Control procedures, etc).

5.0 Requirements for Onsite Work

- a. Contractors must ensure that onsite workers are supplied with and use appropriate safety equipment, personal protective equipment, and follow safe work procedures.
- b. Contractors are encouraged to get flu shots, particularly if they will be working in patient areas.
- c. All scaffolding must comply with applicable standards.
- d. A contractor shall ensure that any tools or equipment brought on hospital property are safe to use, meet applicable standards, and all equipment along with any safety devices are in good condition and functioning properly.
- e. The contractor is responsible for maintaining a clean work area free of debris. Once the work is finished, all equipment, tools, supplies and debris shall be removed by the contractor following IP&C, environmental, and asbestos procedures as required.
- f. Contractors requiring storage for flammables exceeding daily volumes must obtain permission from the Project Manager who will consult with the Fire Prevention Coordinator as required.
- g. IP&C will inspect renovated or newly-constructed patient care areas prior to occupancy.
- h. For projects with asbestos abatement, OHS and/or a third-party environmental consultant will evaluate clean-up and/or clearance sampling prior to moving forward after the abatement. Environmental Consultants for asbestos abatements must follow the requirements of Section 6.0 of the [Asbestos Management](#) policy pertaining to containment inspections and air monitoring.
- i. Project Managers and contractors must ensure pedestrian safety and access control in and around construction or renovation projects as per the [Falls Prevention](#) policy.
- j. Project Managers must notify contractors of required performance standards and enforce as necessary by warnings, "stop work" orders and removal from workplace.
- k. Contractors must adhere to the no smoking policy.

6.0 Incidents

- a. A contractor shall immediately notify the Project Manager of any employee incident, including potential critical injuries or fatalities to any person on hospital property that resulted, or may have resulted, in an injury, illness or property

damage. The Project Manager will follow-up with OHS as required. For critical injuries or fatalities, the Project Manager or Contractor Representative must page Sunnybrook Safety On-Call (7437 via locating). As there are dual responsibilities following a critical injury to a contractor, OHS will coordinate with the Project Manager and Contractor Representative regarding Ministry of Labour notification, investigations and reports.

- b. A contractor shall immediately notify the Project Manager of any breach in infection control or asbestos containment structure. The Project Manager will contact IP&C and/or OHS.
- c. If Contractors find an errant sharp e.g. needle during their work, they should notify their Sunnybrook contact to arrange for proper disposal. Contractors who have a needlestick injury should immediately seek medical care at the Occupational Health Clinic or the Emergency department if after hours.

6.0 Project Completion

- a. For any project work involving construction, installation or modification of new equipment or systems, the Project Manager must ensure that all appropriate start-up testing, commissioning or certifying is completed before final sign-off. This includes reviewing and documenting that project building materials and equipment meet pre-construction/renovation specifications and arranging required testing to verify materials and equipment are functioning properly.

APPENDICES AND REFERENCES:

REFERENCES:

1. Ontario Ministry of Labour. Occupational Health and Safety Act and Regulations for Industrial Establishments. 1990.

APPENDICES:

Forms listed below are available under [Contractor Sign offs](#)

- **Appendix B - Contractor Safety Checklist**

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Infection Control during Construction, Renovation and Maintenance

Sunnybrook Health Sciences Centre		Policy No:	IPAC-0006
Title	Infection Control during Construction, Renovation and Maintenance	Original: (mm/dd/yyyy)	01/01/2001
Category	Policies & Guidelines	Reviewed: (mm/dd/yyyy)	09/01/2007, 03/09/2010, 03/08/2012, 11/11/2013, 11/20/2017
Sub-Category	Infection Prevention & Control	Revised: (mm/dd/yyyy)	09/01/2007, 11/20/2017
Issued By:	Infection Prevention and Control		
Approved By:	Medical Advisory Committee		

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.

POLICY STATEMENT:

It is a Sunnybrook Health Sciences Centre (Sunnybrook) policy to ensure that infection prevention and control guidelines and standards are adhered to with all health care facility planning, design, construction, renovation, maintenance and repair. The goal is to eliminate any infectious risks where possible and minimize those risks that cannot be eliminated from agents released or augmented because of actions undertaken within the health care facility.

DEFINITIONS:

Construction:

Minor or major building activities that disturb or modify building structures and systems; Includes new construction, renovation, maintenance, and repair work within or adjacent to the facility.

Construction Cleaning:

The complete removal of all debris and vacuuming the entire area with a HEPA equipped unit. Wet mopping of area is permitted, dry sweeping is not.

Constructor:

A person who undertakes a construction or renovation project for an owner; May be a contractor, subcontractor, construction manager, consultant, or tradesperson.

Fungus:

A diverse group 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.

HEPA (High-Efficiency Particulate Air) filter:

An air filter with an efficiency of 99.97% in the removal of airborne particles 0.3 μ or larger.

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 environmentally significant filamentous fungi include *Aspergillus* and *Stachybotrys*.

Nosocomial Infection:

Infections that originate in a healthcare setting.

Project Manager (PM):

The lead representative from Corporate Planning and Development, Facilities Services and Others, responsible for the maintenance, construction or renovation project. The PM will advise I of any scheduled construction/renovation projects and ensure that IP&C requirements are addressed and adhered to from the start of the project.

Negative Pressure Differential:

Use of HEPA filtration units within the work zone to direct air flow from the corridors, or any adjacent area, into the work zone, ensuring that contaminated air cannot escape from the negative pressure room to other parts of the facility. Negative pressure differential with respect to all adjacent building areas is not less than 7.5 Pa (0.03 in wc).

PROCEDURE:**1. Planning and Design Phase:**

An interdisciplinary design team shall be assembled early on in the design process and must include an infection prevention and control representative. Designs shall incorporate the latest guidelines for design and construction of health care facilities (e.g. AIA, CSA). Subjects to be reviewed during the design phase include, but are not limited to, the following:

1. Number, location and type of airborne infection isolation rooms
2. Air-handling and ventilation needs in special areas such as operating theatres, critical care units, laboratories, etc.
3. Water systems to limit exposure to opportunistic water-borne organisms
4. Minimum spacing requirements
5. Sink selection and placement (see [Sink Standards](#))
6. Finishes and surfaces
7. Assessment of risks related to the project utilizing the Risk Assessment and Preventative Measures Checklist. The determination of risk will guide the need for barriers during the construction/renovation project, and will allow for the associated costs to be incorporated into the appropriate budgets/tender documents

2. Pre-Construction Phase:

At project start-up meeting, at meetings convened prior to the start of each Stage of the Work,

at pre-installation meetings, and at regular progress meetings, infection prevention and control procedures are to be reviewed. The designated infection prevention and control representative shall attend such meetings. Subjects to be reviewed include, but are not limited to, the following:

- o General outline of infection prevention and control requirements
- o Identification of patient populations that may be at risk
- o Prevention measures required during disruption of essential services (e.g. water, ventilation systems, electricity)
- o PM is responsible for completing the online [Construction, Renovation and Maintenance Permit](#) to determine preventive measures required for each project
- o The integrity of the facility's exterior structure, spatial separations, ventilation and water supplies for any infection control problems are reviewed and assessed
- o Methods for dust containment and removal of construction debris are outlined
- o Traffic patterns for construction workers and supply delivery routes will be established
- o Needs assessment for increased filter changes during construction
- o The need to close down dampers temporarily to reduce circulation of contaminated air or fumes is assessed
- o Impact of air systems (correct air exchange rates and pressure relationships) in critical areas near construction activity
- o Site inspection checklist
- o Provisions for ceiling/wall access

3. Construction Phase:

a. **Post Construction, Renovation and Maintenance Permit at the entrance to the area of construction**

b. **Dust Control**

Risk assessment of work zone shall be undertaken by IP&C, in conjunction with Project Manager at beginning of project. Preventative measures will be implemented to control the migration of dust particles from the work zone to adjacent areas. Methods will vary depending on the location, type of construction activity and population at risk.

c. **Heating, Ventilation, Air Conditioning (HVAC)**

All intake and exhaust vents/grills within work zone must be identified prior to construction. Where dust will be produced these vents/grills must be sealed off prior to construction to prevent contamination of HVAC system.

Occupied spaces adjacent to the work zone must have functioning HVAC systems throughout the project. All shutdowns affecting occupied areas must be communicated to IP&C in advance to determine if alternative means of air are required.

At the beginning and for the duration of construction/excavation outside/adjacent to the facility all intake grills will be identified and covered with a filter to prevent contamination. The internal pre-filter and primary filter for these air intakes will be monitored throughout the project and changed as required. IP&C and the Project Manager will monitor the HVAC system and determine if air monitoring is necessary.

d. **Plumbing**

IP&C is to be notified in advance of all water and steam shutdowns. Appropriate procedures must be followed throughout the project to ensure the potability of the water in the health care facility.

e. **Risk Reduction**

High risk populations must be moved to an area away from the construction zone if air

quality cannot be ensured during construction. Do not transport any patients through the construction zone. Staff, patients and visitors are not permitted to enter the construction work area. Provisions will be made throughout the project to ensure that fire/emergency exits are not compromised.

Breaches in pre-specified infection control preventative measures, as outlined in [Appendix I](#), that place staff and/or patients at risk will result in “stop” construction orders to the Project Manager and Site Foreman by Infection Prevention and Control. An Infection Prevention and Control Inspection Report shall be provided by IP&C outlining the deficiencies.

f. Surveillance

IP&C will conduct a pre-work inspection once all preventive measures are instituted and prior to the commencement of any work. An inspection report outlining deficiencies and permitting the project to proceed will be sent electronically to the PM involved ([Appendix II](#)). IP&C will perform regular site inspections to ensure continued compliance with assigned preventative measures and barrier integrity. The **Infection Control/Occupational Health and Safety Sign-off ([Appendix III](#))** will be used for these inspections and is provided as part of the *Construction, Renovation and Maintenance Permit* and is to be posted at the worksite.

g. Constructor Duties

It is the responsibility of the constructor to ensure that all personnel on-site are trained and compliant with the IP&C preventive measures. Constructors are not permitted to use elevators in use by visitors/staff/patients. Where separate elevators are not available for use by the constructor specific times will be designated. Prior to construction IP&C, Project Manager and the Project Team will establish paths, times and procedures for the transportation of clean/sterile supplies, equipment and construction materials, including removal of construction debris. Constructors are required to follow the designated routes for entry/exit to and from the work zone to the outside.

h. Mould

If mould is discovered during construction IP&C and Occupational Health and Safety must be notified and they will report to the Joint Occupational Health and Safety Committee. Please refer to [Mould Response Policy](#) for further information.

4. Post-Construction Phase:

a. Stages of Cleaning

Constructor is responsible for cleaning the work zone and adjacent zone on a regular basis throughout the project as per [Appendix I](#). The work zone must be cleaned prior to and at completion of work prior to user hand off and before the following:

- Prior to reopening a supply air duct (to be completed by Constructor)
- Prior to removal of containment barriers (to be completed by Constructor)
- After the removal of containment barriers (to be completed by Sunnybrook Environmental Services)

b. At completion of project the HVAC system must be inspected for evidence of dust/water contamination and cleaned if necessary prior to user hand off.

If the HVAC was turned off for the project then it must be re-commissioned prior to user hand off. Documentation shall be provided to Infection Prevention and Control regarding cleaning of HVAC system, viability of HEPA filters (if applicable), air balancing and direction of air flow.

c. Inspection/Sign-off

At the completion of construction, prior to containment barrier removal IP&C is to be notified to inspect.

Appendix I (Click here to read / print Appendix I) Risk Assessment and Preventative Measures Checklist

Appendix I consists of eight checklist pages, each titled "Appendix I: Infection Prevention and Control Risk Assessment and Preventative Measures Checklist" for "Health Care Facility Construction Phase 1a". The checklists are organized into four columns and two rows.

Top Row Checklists:

- Page 1 (Top Left):** Includes sections for "Construction Phase 1a", "Construction Type", "Risk Assessment", and "Scope of Construction Activities".
- Page 2 (Top Middle):** Titled "With Two Construction or Partition Risk Group", it contains a table for "ROUTION RISK GROUPS (CONDO)" with columns for "RISK GROUP", "CONSTRUCTION ACTIVITY", "RISK LEVEL", and "CONTROL MEASURES".
- Page 3 (Top Right):** Titled "With Four Construction or Partition Control Preventive Measure", it includes a table for "With Two Construction or Partition Control Preventive Measure" and a "Risk Group 1 (Prevention)" section.
- Page 4 (Top Far Right):** Titled "With Two Construction or Partition Control Preventive Measure", it includes a "Risk Group 2 (Prevention)" section and a "Risk Group 3 (Prevention)" section.

Bottom Row Checklists:

- Page 5 (Bottom Left):** Titled "With Two Construction or Partition Control Preventive Measure", it includes a "Risk Group 4 (Prevention)" section and a "Risk Group 5 (Prevention)" section.
- Page 6 (Bottom Middle):** Titled "With Two Construction or Partition Control Preventive Measure", it includes a "Risk Group 6 (Prevention)" section and a "Risk Group 7 (Prevention)" section.
- Page 7 (Bottom Right):** Titled "With Two Construction or Partition Control Preventive Measure", it includes a "Risk Group 8 (Prevention)" section and a "Risk Group 9 (Prevention)" section.
- Page 8 (Bottom Far Right):** Titled "With Two Construction or Partition Control Preventive Measure", it includes a "Risk Group 10 (Prevention)" section and a "Risk Group 11 (Prevention)" section.

Each checklist page contains a grid of boxes for recording observations, dates, and signatures, along with specific instructions for each risk group and control measure.

Appendix II (Click here to read / print Appendix II)



INFECTION PREVENTION AND CONTROL
APPENDIX II:
CONSTRUCTION/RENOVATION/REPAIR
MONITORING CHECKLIST

Date: _____ Time: _____

Location: _____ Inspector: _____

Construction/Renovation/Repair site has been checked for:

ITEM	COMPLIANCE?		
	Y	N	N/A
1. Construction Barriers			
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			
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			

3. 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

* 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.
 Appendix III (Click here to read / print Appendix III) will be maintained by Infection Prevention and Control



Appendix III

Infection Control/Occupational Health and Safety Sign-off

Project Name/Location: _____

Project Manager: _____

Contractor: _____

Initial sign-off (Infection Prevention and Control):

Date: _____ Signature: _____

Initial sign-off (Occupational Health and Safety):

Date: _____ Signature: _____

To be completed by IPC/OHS

Date	Walk-off (sticky) mats in place and in good condition	Negative pressure of 7.5 Pa (0.03 in wc) continuously monitored	Containment is well sealed	Comments/Correction actions	Initials
	<input type="radio"/> Yes <input type="radio"/> No	<input type="radio"/> Yes <input type="radio"/> No	<input type="radio"/> Yes <input type="radio"/> No		
	<input type="radio"/> Yes <input type="radio"/> No	<input type="radio"/> Yes <input type="radio"/> No	<input type="radio"/> Yes <input type="radio"/> No		
	<input type="radio"/> Yes <input type="radio"/> No	<input type="radio"/> Yes <input type="radio"/> No	<input type="radio"/> Yes <input type="radio"/> No		
	<input type="radio"/> Yes <input type="radio"/> No	<input type="radio"/> Yes <input type="radio"/> No	<input type="radio"/> Yes <input type="radio"/> No		
	<input type="radio"/> Yes <input type="radio"/> No	<input type="radio"/> Yes <input type="radio"/> No	<input type="radio"/> Yes <input type="radio"/> No		
	<input type="radio"/> Yes <input type="radio"/> No	<input type="radio"/> Yes <input type="radio"/> No	<input type="radio"/> Yes <input type="radio"/> No		
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	<input type="radio"/> Yes <input type="radio"/> No	<input type="radio"/> Yes <input type="radio"/> No	<input type="radio"/> Yes <input type="radio"/> No		
	<input type="radio"/> Yes <input type="radio"/> No	<input type="radio"/> Yes <input type="radio"/> No	<input type="radio"/> Yes <input type="radio"/> No		

(November 2017)

APPENDICES AND REFERENCES:

STAKEHOLDERS:

Plant Operations and Maintenance

REFERENCES:

1. Bartley JM and the 1997, 1998 and 1999 APIC Guidelines Committee. *APIC state-of-the-art report: the role of infection control during construction in health care facilities*. Am J Infect Control 2000;28(2):156-69
2. American Institute of Architects Academy of Architecture for Health. *Guidelines for design and construction of hospital and health care facilities*. Washington: American Institute of Architects Press, 2006.
3. Canadian Standards Association. *Canadian Health Care Facilities (Z8000-11)*. Etobicoke: Canadian Standards Association, 2016.
4. Canadian Standards Association. *Infection Control during Construction or Renovation of Health Care Facilities (Z317.13-12)*. Etobicoke: Canadian Standards Association, 2012.
5. Canadian Standards Association. *Special Requirements for Plumbing Installations in Health Care Facilities (Z317.1-09)*. Etobicoke: Canadian Standards Association, 2009.
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7. N.Y. City Dept. of Health. 2000. *Guidelines on assessment and remediation of fungi in indoor environments*. New York City Dept. of Health, New York, NY.

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Restricted & Confined Space Program

Sunnybrook Health Sciences Centre		Policy No:	HR-109
Title	Restricted & Confined Space Program	Original: (mm/dd/yyyy)	06/01/2005
Category	Human Resources	Reviewed: (mm/dd/yyyy)	02/10/2022
Sub-Category	OccHealth & Safety	Revised: (mm/dd/yyyy)	Feb. 2007, Nov. 2009, Dec. 2011, Dec. 2012, Nov. 2015, Jan 2020
Issued By:	Human Resources		
Approved By:	Senior Leadership Team		

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.

POLICY STATEMENT:

It is a Sunnybrook Health Sciences Centre policy to establish procedures to safely manage work in areas or in equipment meeting the criteria for confined or restricted spaces in accordance with requirements of the Occupational Health and Safety Act, Health Care Regulation, O.Reg. 67/93, and Confined Space Regulation, O. Reg 632/05.

This policy applies to all employees and contractors engaged in confined space and restricted space entry (at all Sunnybrook campus).

The procedures in **Sections 1.0-15.0** of this document outline the requirements for:

1. **Identification of Restricted or Confined Spaces**
2. **Hazard Assessment**
3. **Entry Plan**
4. **Coordination Document**
5. **Entry Permits & Entering Confined/Restricted Spaces**
6. **Training**
7. **Emergency Response & Equipment**
8. **Isolation & Control of Material Movement**
9. **Atmospheric Testing**
10. **Ventilation & Purging**
11. **Explosives, Flammables or Combustibles**
12. **Warning Signs & Barricades**
13. **Equipment in Confined Spaces**
14. **Contractors**
15. **Records**

DEFINITION(S):

Atmospheric Hazard

Atmospheric hazards include an accumulation of flammable, combustible, or explosive agents; an oxygen content below 19.5% or above 23%; an accumulation of contaminants such as gases, vapors, fumes, dusts or mists that could result in health effects that pose an immediate threat to life or could interfere with a person's ability to escape unaided.

Competent Person

A person who: i) is qualified because of knowledge, training, and experience organizing the work and its performance ii) is familiar with the Occupational Health and Safety Act and its regulations and iii) has knowledge of any potential or actual danger to health or safety in the workplace.

Cold Work

Work without a source of ignition or that does not generate a spark or flame.

Hot Work

Work with a source of ignition or work that generates a spark or flame.

Confined Space

A fully or partially enclosed space that is not designed or constructed for human occupancy and in which atmospheric hazards may occur because of its construction, location or contents or because of work that is done in it.

Lead Employer

An employer who contracts external services to do confined/restricted space work.

Lower Explosive Limit (LEL)

The lowest concentration of a flammable gas or vapor in air that could flash or cause a fire in the presence of a spark or flame (also referred to as Lower Flammable Limit, LFL).

Upper Explosive Limit (UEL)

The highest concentration of a flammable gas or vapor in air that could flash or cause a fire in the presence of a spark or flame (also referred to as Upper Flammable Limit, UFL).

Project Leader

The person responsible for a particular construction or maintenance project; includes but is not limited to: staff from Corporate Planning & Development, Facilities Planning; Facilities Services, Plant Operations & Maintenance; Building Managers etc.

Purging

The process of displacing contaminants from a confined space.

Qualified Person

A worker who, because of knowledge, training and experience, is capable of performing a duty safely and properly.

Related Work

Work that is performed near a confined/restricted space in direct support of the work inside the confined/restricted space.

Restricted Space

A tank, vat, vessel, duct, vault, boiler or other space from which the egress of a worker is restricted, limited, or impeded because of the construction, design, location or other physical characteristics of the space.

ROLES AND RESPONSIBILITIES

Employer:

- Control access to and authorizing work in confined and restricted spaces.
- Ensure employees are informed of the existence, location of, and the danger within confined and restricted spaces by posting danger signs or by any other

equally effective means

Manager/Supervisor/Project Leader

- Ensure staff and/or contractors working under their supervision understand the general and specific procedures, and know how to conduct their confined/restricted space tasks safely
- Ensure staff and/or contractors conducting work related to confined/restricted spaces are adequately trained.
- Provide staff with all specified equipment required for entry in a confined or restricted space as outlined in this program, maintain the equipment, and ensure that employees use that equipment properly
- Inform contractors entering the space must be informed of all aspects of the hazard assessment, control plan and testing results.
- Provide plan-specific training, as required
- When contractors are used for confined/restricted space entry, verify that the contractors are adequately trained in confined/restricted space work and have appropriate personal protective equipment
- Prepare a coordination document if workers of more than one employer perform work in the same confined space or related work with respect to the same confined space and share this document to employer of each worker who performs work in the same confined space and JOHSC.
- Ensure a written entry plan and on-site rescue plan have been prepared specially for the space where confined/restricted space entry will be done.
- Maintain training records of their employees including the training provider and the type/date of the training, and share this record with Occupational Health and Safety.
- Complete confined space/restricted space entry permit and provide a copy of the permit to Occupational Health and Safety

Employees

- Will not enter any confined or restricted space unless specifically authorized by Sunnybrook after participating in the required training program
- Attend and complete any scheduled training required by their supervisor and this program
- When selected as an entrant or attendant, perform those duties as outlined in this program
- No employee shall enter a confined or restricted space without having a properly completed entry permit

Attendant:

- Know the hazards that may be faced during the entry, including the mode, signs or symptoms, and consequences of the exposure
- Remain outside the confined/restricted space during entry operations until relieved by another qualified attendant
- Attendant must not enter the restricted/restricted/confined space
- Attendant must be trained in first aid and CPR as well as in the rescue procedures and the use of the equipment.
- Be in constant communication with the entrant(s)
- Monitor activities inside and outside restricted/confined/restricted space to determine if safe for entrant to remain in space and orders evacuation when necessary.
- Summon rescue and emergency services when assistance for emergency exit from restricted/confined space if necessary.
- Perform no duties that might interfere with their primary duty to monitor and protect the authorized entrant
- Control activities at the entrance and keep unauthorized people away

Entrant:

- Be aware of all known and potential hazards of the space as well as be capable of performing the work.
- Properly use equipment as required
- Remain in constant communication with the attendant is required

- Exit the space immediately if so ordered by the attendant

Occupational Health and Safety.

- Restricted or confined spaces will be identified by Plant Operations and Occupational Health and Safety and reviewed by the Joint Occupational Health and Safety Committee (JOHSC)
- Maintain inventory of all restricted/confined spaces on each campus

Joint Occupational Health and Safety Committee (JOHSC).

- A written confined/restricted space program must be maintained in consultation with the Joint Occupational Health and Safety Committee (JOHSC).

POLICY:

1. Identification of Restricted or Confined Spaces

- Restricted or confined spaces will be identified by Plant Operations and Occupational Health and Safety and reviewed by the Joint Occupational Health and Safety Committee (JOHSC).
- An inventory of confined and restricted spaces at each campus can be found on [Sunnynet](#). Where a space is not listed on the inventory and there are no signs posted, then a hazard assessment must be completed to determine if the space meets the requirements of a confined or restricted space.
- Even if a space does not meet the definition of a confined or restricted space, every precaution reasonable in the circumstances must be taken to protect workers entering the space

2. Hazard Assessment

- An assessment must be carried out **before any worker enters a confined space**. A competent person must complete and sign a written assessment of the hazards for a confined/restricted space with consideration for but not limited to potential atmospheric hazards, design, construction, location, use or contents of the space. This information will be documented on the entry permit.
- Copies of the assessment must be available upon request from the JOHSC / Safety Representatives of workers performing the confined/restricted space work and the workers themselves.
- Where two or more confined spaces are similar in construction and present the same hazards, the assessment for each specific confined space may be recorded in a single document. The specific confined space(s) to which each assessment applies must be clearly identified in the assessment.
- The assessment must be reviewed as often as necessary to ensure the plan remains adequate.

3. Entry plan

- Before any worker enters a restricted/confined space, the project leader shall ensure that a competent person completes a written entry plan and onsite rescue plan have been prepared specifically for that space and the work to be done in it. The entry plan is a set of measures and procedures to control all hazards identified by the assessment for that restricted/confined space to allow workers to enter and work safely. Individual departments are responsible for developing these specific procedures that relate to their work
- The plan shall include the following:
 - Duties of workers
 - On-site rescue procedures rescue equipment
 - Isolation of energy & control of materials movement
 - Atmospheric testing
 - Adequate procedures for working with explosive or flammable substances
 - Methods of communication
 - Inspection of equipment personal protective devices equipment, or clothing

- Adequate means of entering & exiting
- Ventilation & purging attendants
- Coordination document (where applicable)
- The information will be documented on the entry permit.
- The control plan must be reviewed as often as necessary to ensure it remains adequate.

4. Coordination Document

- If workers from more than one employer (e.g. Sunnybrook staff and a contractor) are working in the same confined/restricted space or doing related work with respect to the same restricted/confined space, then the project leader must prepare a co-ordination document to ensure that all confined/restricted space duties are performed to protect the health & safety of all workers.
- A copy of the coordination document must be provided to each employer and the Safety Representative of each employer with workers performing confined/restricted space work.

5. Entry Permits & Entering Confined/Restricted Spaces

- The Project Leader must ensure the confined/restricted space entry permit is complete prior to anyone entering the space. The permit must be made available to all employees or contractors who will enter the space or perform related work.
- The permit must have the following:
 - Information the location of the ace
 - A description of the work being performed
 - The time period for which the entry permit applies
 - Name of each entrant and a record of their entries and exits
 - Name of the attendant
 - A description of the hazards and corresponding control measures
 - If there is hot work, a description of appropriate measures and procedures
 - A list of emergency equipment and verification that the equipment is in working order
 - Results from atmospheric testing
- Before each shift, a competent person shall verify that the entry permit complies with the relevant plan
- The entry permit must be updated with any new information during the time of entry such as changes in air testing results or problems encountered during the entry.
- Each confined/restricted space must have an adequate means for entering and exiting the space.
- Each restricted/confined space must have its own, separate entry permit

6. Training

- Every worker who enters a confined/restricted space or performs related work must have adequate training from a qualified person on safe work practices, following the control plan, and recognition of hazards.
- Managers/supervisors are responsible for identifying employees who require training
- Training will be assessed by Plant Operations and Maintenance and/or Occupational Health and Safety whenever there is a change in circumstances that may affect the safety of a worker in a confined/restricted space.
- The records may be incorporated into an entry permit

7. Emergency Response & Equipment

- The Project Leader must ensure a written emergency rescue procedure prior to a confined/restricted space entry based on the hazards identified in the hazard assessment and the control plan. The emergency rescue procedure shall be approved by the Supervisor in charge of the restricted/confined space work. Communication methods appropriate for the hazards must be established and made available to the workers and the attendant.
- If the control plan requires emergency equipment for serious health hazards such as potential engulfment, entrapment, the equipment must be readily available and appropriate for the parameters of the space.

- Emergency equipment must be inspected by a competent person as often as necessary to ensure proper working order. The project leader overseeing confined/restricted space work must maintain equipment inspection records.
- Each worker entering the confined/restricted space must be provided with Personal Protective Equipment (PPE) and safety equipment as indicated by the control plan and based on the air monitoring results.
- Emergency response personnel must have and be trained to use the emergency PPE as described in the control plan. A self-contained breathing apparatus or air-supplied respirator with an escape bottle must be used during rescue operations in an unknown or Immediately Dangerous to Life or Health (IDLH) atmosphere.

8. Isolation and Control of Material Movement

- Prior to each restricted/confined space entry, there must be adequate protection against:
- Contact with moving equipment parts inside the restricted/confined space by disconnecting the equipment from its power source, de-energizing, locking out and tagging out. If the above measures are not possible, immobilize the equipment by blocking or other means.
- Contact with electrical energy by disconnecting, de-energizing, locking & tagging the source of electrical energy or other means.
- Release of hazardous substances or energy by blanking, disconnecting piping or other adequate means. Drowning, engulfment, entrapment or other related hazards.
- LOTO & only those trained to perform LOTO shall install locks/tags

9. Atmospheric Testing

- Workers are not permitted to enter the work space if any atmospheric hazard is present including:
 - an oxygen content outside of the acceptable 19.5%-23% range
 - flammable, combustible, or explosive agents;
 - an accumulation of contaminants such as gases, vapors, fumes, dusts or mist that could result in health effects that pose an immediate threat to life or could interfere with a person's ability to escape unaided.
- Prior to each entry, a qualified person must perform atmospheric testing to determine oxygen content, and the presence of combustible or toxic gases/vapors.
- Testing must be repeated as often as necessary to ensure atmospheric conditions are within acceptable limits during the restricted/confined space work.
- The instrumentation for the testing must be calibrated, in proper working order and appropriate to test the atmospheric hazards identified in the hazard assessment.
- Results of all testing are to be documented on the restricted/confined space entry permit.

10. Ventilation & Purging

- If the oxygen level is outside of the acceptable range (19.5-23%), the confined space must be purged and/or ventilated before workers enter the confined space.
- To ensure adequate ventilation, the points of air supply and exhaust should be separated as far as possible. Openings must be provided for the entry of clean replacement air and/or to allow air to be exhausted. Pure oxygen must not be used to ventilate a confined space
- If mechanical ventilation is to be used, there must be adequate warning of a failure.
- If purging or ventilating is not practical or if an atmospheric hazard exists or is likely to exist, the workers entering the confined space must use appropriate respiratory protective equipment.
- Any respiratory equipment used by workers in a confined space must be inspected by a qualified person and be in good working order.

11. Explosives, Flammables or Combustibles

- No worker can enter or remain in a confined space that contains or is likely to contain an airborne combustible dust, or mist which an atmospheric concentration may create an explosion hazard
- If an explosive or flammable gas or vapor is present, the confined space can be entered only if the gas or vapor levels do not exceed:
 - 25% of LEL (For **Inspection Work**, no source of ignition)
 - 10% of LEL (For **Cold Work**, no source of ignition, flame or heat)
 - 5% of LEL (For **Hot Work**, generates heat, fire or spark) **and** the following must be implemented:
 - An assessment confirms safety
 - A qualified person implements adequate protective procedures a hot work permit is issued
 - An attendant is in place atmospheric testing is continuous
 - The oxygen content does not exceed 23% and an adequate alarm is in place to alert if the gas or vapor exceeds 5% of LEL or oxygen content exceeds 23%
 - The above measures do not apply if the atmosphere in the confined space has been made inert by inert gas, there is continuous monitoring and the worker has appropriate respiratory protective equipment.

12. Warning Signs & Barricades

- During restricted/confined space work, each entrance must be secured against unauthorized entry or have adequate warning signs and/or safety barricades.
- Additional signage and locks should be in place to identify and secure restricted/confined and restricted spaces.

13. Equipment In Confined Spaces

- Compressed Gas Cylinders
 - If compressed gas cylinders are required for the confined space work, the potential hazards and adequate controls must be considered in the hazard assessment and control plan.
- Torches and hoses
 - Torches and hoses used for welding, brazing or cutting should be removed from a confined space when not in use and when the confined space is vacated e.g. on breaks or lunches.
 - If removal is not possible, the equipment should be disconnected at the source or closed and tagged while workers are on breaks.
- Electrical equipment
 - Electrical tools and equipment used in a confined space must be grounded or double insulated.
 - If wet or damp conditions exist inside the space, tools must be protected by an approved Ground Fault Circuit Interrupter (GFCI).
 - Electrical tools and equipment used in a confined space where flammable vapours of explosive gases, or liquids are present must be Canadian Standards Association (CSA) approved for hazardous locations classified under CSA Standard C22.1, Canadian Electrical Code, Part I (24th Edition), Safety Standard for Electrical Installations, as Class 1, Division 2, Groups A, B and C.
 - Only non-sparking tools may be used in a confined space where flammable or explosive gases, vapours or liquids are present.
- Chemicals
 - Chemicals that will be used in the confined space should be evaluated in the hazard assessment and control plan
 - The Material Safety Data Sheet (MSDS) or Safety Data Sheet (SDS) of any product used in the confined space must be kept with the hazard assessment.

14. Contractors

- Project Leader shall ensure any contractors performing work in confined/restricted space shall be informed that the area is considered as such. The elements of the confined/restricted space program must be followed and the

contractor entering the space must be informed of all aspects of the hazard assessment, control plan and testing results.

- The Project Leader overseeing the contract work must verify that the contractors are adequately trained in confined/restricted space work and have appropriate personal protective equipment

15. Records

- All records including permits, hazard assessments, control plans, and training records, must be kept by the Project Leader for the longer of:
 - One year or;
 - The time period to have the 2 most recent records for each confined/restricted space

APPENDICES AND REFERENCES:

1. Ontario Ministry of Labour. Occupational Health and Safety Act, ONTARIO REGULATION 632/05, RESTRICTED AND CONFINED SPACES. Ottawa, 2011.
2. Ontario Ministry of Labour. Occupational Health and Safety Act, ONTARIO REGULATION 67/93, HEALTHCARE AND RESIDENTIAL FACILITIES
3. [List of confined/restricted spaces](#)
4. [Restricted/Confined Space Permit](#)

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Falls Prevention

Sunnybrook Health Sciences Centre		Policy No:	HR-0095
Title	Falls Prevention	Original: (mm/dd/yyyy)	12/01/2007
Category	Human Resources	Reviewed: (mm/dd/yyyy)	10/13/2022
Sub-Category	OccHealth & Safety	Revised: (mm/dd/yyyy)	10/10/2017
Issued By:	Human Resources		
Approved By:	Joint Health & Safety Comm.		

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.

POLICY STATEMENT:

It is a Sunnybrook Health Sciences Centre (Sunnybrook) policy to ensure precautions are in place to minimize the risk of slips, trips and falls (both same level and from heights) within the hospital and on the grounds. This policy includes requirements for ladders, step stools and guardrails. The hospital recognizes the importance of a safe environment for employees, physicians, volunteers, students, patients and visitors.

POLICY:

The following practices will reduce the risk of falls

1.0 Environmental Services will:

Within Hospital Buildings

- Check that rugs and carpeting are in good condition (e.g. free of bulges, rips), and securely attached to the floor.
- Place warning signs/barriers when cleaning floors. Care must be taken to remove water and/or floor products after cleaning.
- Wash half of the hallway at a time so that there is a dry area for walking.
- Provide regular removal of garbage, linen, discarded equipment etc. to keep rooms and corridors clear.
- Provide timely response to spills or leaks to remove any slip hazard.

Exterior Grounds

- Remove snow/ice promptly from pedestrian routes, parking lots/garages, and bus stop areas and/or provide salt/sand.
- Maintain landscaped areas on hospital property.

2.0 Maintenance will:

Within Hospital Buildings

- Fix damage to stairwell treads, risers and handrails.
- Replace/repair lighting in corridors, rooms and stairwells.
- Address plumbing leaks.
- Unclog floor drains to remove water from shower and washroom areas.

Exterior Grounds

- Complete semi-annual inspections of roads, sidewalks and parking areas.
- Make repairs on items identified during inspections or forward items to appropriate department for follow-up e.g. Environmental Services, Parking and Transportation, Corporate Planning, external contractors.
- Use anti-slip surface finishes in parking garages and on stairs.

3.0 Parking & Transportation will:

Exterior Grounds

- Address damaged walking surfaces in parking lots and structures.
- Ensure any vehicle fluid leaks that occur in parking areas are addressed appropriately.

4.0 Corporate Planning/Contractors:

Within Hospital Buildings

- Ensure corridors, stairwells in or around construction or renovation projects are safe for use by keeping areas free from debris or clutter.
- Provide appropriate signage to direct employees/visitors towards alternate routes if construction projects will impact passageways.
- Ensure secure construction areas are secured and that there is signage indicating that only authorized personnel can access construction areas.
- Employees authorized to go into construction areas must wear appropriate protective footwear as per the [Footwear Policy](#).

Exterior Grounds

- Ensure signage and barriers are in place to keep pedestrians away from construction areas.
- If construction projects will impact pedestrian areas, project managers must ensure a safe alternative e.g. temporary sidewalk, cordoned off area, or flag person as appropriate. Project Manager must ensure temporary or new sidewalks are accessible for wheelchairs and scooters.

5.0 Safe Work Practices for All Employees

- Wear appropriate footwear for the weather conditions, work tasks and work areas. Refer to the [Footwear Policy](#) for specific guidelines.
- Promptly report lighting problems or damage to carpet, floors, stairs, handrails etc. by submitting an online maintenance request.
- Report grounds maintenance concerns e.g. damage to sidewalks, damaged street lights to maintenance.
- Report snow/ice removal concerns to Environmental Services (ext. 4555).
- Immediately clean up small spills (e.g. coffee) or block area and contact Environmental Services (ext. 4555).
- Follow Environmental Service signage, barriers and instructions on safe areas to walk following a spill or during floor cleaning.
- Keep work areas and corridors free from clutter.
- Never carry a load that blocks vision or is difficult to balance. Carry smaller loads or use a cart.
- Minimize trip hazards due to cords by using ties to bundle computer/telephone cords, keeping cords away from walking surfaces or taping down/covering cords. Information Services will secure cords, contact by emailing sbiscallcentre@sunnybrook.ca. **The use of cordless devices is also encouraged.**
- Use established pedestrian routes rather than shortcuts.

- Exercise caution on stairs, use the handrails and slow down. If you are carrying an item with both hands, use the elevator rather than the stairs.
- Only use proper ladders or step stools; do not stand on chairs or other equipment, see Section 7.0.
- Avoid distracted walking by not using cellphones, tablets etc. while walking.

6.0 Joint Health Occupational & Safety Committee (JOHSC) & Department Safety Committees will:

- Complete regular inspections including checking for slip or trip hazards such as cords, damaged flooring, loose handrails, corridor or room clutter, damaged ladders or ladders that are not stored securely e.g. on hooks or chained to a surface.
- Inspect the exterior grounds as part of the annual JOHSC inspections.

7.0 Ladder/Step Stool Safety (also see Appendix 1)

- Follow any manufacturer's instructions or department procedures for the specific equipment.
- Step stools must have non-slip feet, be stable and in good condition.
- Inspect ladder prior to each use (see Appendix 1) and remove defective ladders from service until repaired.
- Ladder must have appropriate load capacity and be either an industrial or trade ladders (based on CSA rating). Household ladders are **not** to be used.
- Select proper ladder length and material type for the job and location.
- All ladders must have non-slip feet.
- Place ladder on solid and level base and for straight ladders ensure support surface is stable, and secure against slipping.
- If ladder will be used in a doorway or passageway, a second person must be stationed to direct traffic or a barrier/warning signs or tape must be in place.
- Ensure step ladder spreaders are locked into place.
- Ensure footwear is clean, dry and in good condition before climbing a ladder.
- Face ladder and do not overreach from the ladder, maintain 3 points of contact at all times (e.g. 2 feet and 1 hand) and keep centre of body/belt buckle within the ladder rails. If not aligned with work area, step down from ladder, move ladder to proper location, secure it and then step back onto ladder.
- For step ladders, don't stand on top 2 rungs, for straight ladders, don't stand on top 3 rungs.
- Instead of carrying objects in your hands, use a tool belt, hoist or have the items handed up.
- Only one person can use a ladder at a time.
- Ladders that are not in use, must be stored securely (e.g. on wall hooks or chained to surface).
- For outdoor use, take extra precautions if windy (secure ladder) and ensure rungs are dry and free from snow or ice.

8.0 Guardrails

• A guardrail is required:

- around the perimeter of uncovered openings in the floor, roof or other surface
- at the open side of a raised floor, mezzanine, balcony, gallery, landing, platform, walkway, stile, ramp or other surface
- at the open side of a vat, bin, or tank the top of which is less than 107 cm above the floor, platform, ground or surface
- around a machine, electrical installation, place or thing that is likely to endanger the safety of a worker

Guardrails are **not** required for loading docks, pit for vehicle maintenance, roof accessed for maintenance only, swimming pool/therapy pool or an auditorium/lecture theatre stage.

- A guardrail must meet requirements of Parts 3 & 4 of the Ontario Building code or must:
 - have horizontal top rail between 91 – 107cm above surface
 - have an intermediate rail midway between the top rail and surface

- have a toe board extending at least 125 mm, if tools or other objects may fall on a worker
- be free of splinters or other hazardous protrusions

APPENDICES AND REFERENCES:

APPENDIX 1: Ladders: Inspection and Securing

Prior to each use, inspect to ensure:

- Rungs, rails, steps and pail shelf are in good repair (no cracks or splinters, not bent or loose, not slippery, no missing parts)
- Spreaders are sturdy, tight, open fully and lock into place securely
- Nuts, bolts, rivets etc. are in place, in good condition and tight
- Ladder is clean and no signs of corrosion
- Anti-slip feet are in place and in good condition
- No sharp edges on rungs or rails
- For extension ladders, ropes and pulley are in good repair (not frayed or worn) and lubricated

Securing ladders and inclines:

- If the ladder is between 6-9 metres in length, it must be securely fastened or held in place by one or more co-workers
- For ladders beyond 9 metres in length, it must be securely fastened or stabilized to prevent tipping or falling.
- The top of a straight ladder must extend at least 0.9 metres above landing or support surface
- If ladder is not securely fastened, it must be inclined so that the horizontal distance from the top support to the foot of the ladder is between $\frac{1}{4}$ an $\frac{1}{3}$ the length of the ladder.

REFERENCES:

1. Ontario Ministry of Labour. Occupational Health and Safety Act and Regulations for Industrial Establishments. 1990.

RELATED POLICIES:

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Asbestos Management

Sunnybrook Health Sciences Centre		Policy No:	HR-0089
Title	Asbestos Management	Original: (mm/dd/yyyy)	06/01/2005
Category	Human Resources	Reviewed: (mm/dd/yyyy)	03/10/2022
Sub-Category	OccHealth & Safety	Revised: (mm/dd/yyyy)	Dec. 2006, Jun. 2009, Oct. 2010, Nov. 2011, Sept. 2013, Mar. 2017, Mar 2021
Issued By:	Human Resources		
Approved By:	Senior Leadership Team		

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.

POLICY STATEMENT:

It is Sunnybrook Health Sciences Centre's (Sunnybrook) policy to adhere to all necessary measures and procedures by means of engineering controls, work practices, hygiene practices and facilities to ensure the time-weighted average exposure of a worker to any of the forms of airborne asbestos, individually or collectively, is reduced to the lowest practical level and shall not exceed 0.1 fibers per cubic centimeter of air. Sunnybrook shall establish an Asbestos Management Program (AMP) as outlined under the Ontario Regulation 278/05: Designated Substance Regulation Respecting Asbestos on Construction Projects and in Buildings and Repair Operations, made under the Occupational Health and Safety Act.

This policy applies to every building owned or operated by Sunnybrook at all campuses and other locations (i.e. Pine Villa). This policy applies to every project owner, constructor, employer and worker who engages in the repair, alteration or maintenance of asbestos-containing material (ACM) where ACM is likely to be handled, dealt with, disturbed or removed.

The following sections outline the components of the Asbestos Management Program.

ROLES AND RESPONSIBILITIES

Managers and Supervisors shall:

- Ensure their staff adhere to the contents of this program
- Ensure their staff are familiar with the presence of asbestos-containing materials in their work area
- Ensure their staff do not disturb asbestos-containing materials
- Ensure occupants are notified of scheduled asbestos-related work in the work area
- Report damaged materials suspected to contain asbestos to OHS (Occupational Health & Safety).

Employees shall:

- Be aware of the present of ACMs in their work area ([Asbestos at Sunnybrook](#))

- Adhere to the contents of this program
- Report damaged materials suspected to contain asbestos to their supervisor
- Refrain from disturbing building materials containing or suspected to contain asbestos

Project Leader shall:

- Consult with the OHS, to jointly classify and plan all asbestos remediation activities.
- Ensure that a pre-job review of all maintenance, repair, and renovation or construction activity is conducted to verify that asbestos-containing materials will not be disturbed by such activities. In the case where asbestos-containing materials will be disturbed by maintenance, repair, renovation or construction activity, a [Construction, Renovation and Maintenance Permit](#) shall be completed.
- Communicate asbestos-related work to occupants of the affected area
- Ensure all contractors under their supervision are provided with a copy of the most recent Asbestos Inventory.
- Ensure all contractors under their supervision to conduct Type 3 asbestos work have appropriate training.
- Notify OHS and JOHSC in advance of any sampling or testing to be performed.
- Arrange for appropriate inspection and air monitoring of asbestos operations
- Forward asbestos-related documentation to OHS\

Occupational Health and Safety (OHS) shall:

- Ensure the asbestos inventory is available and kept up to date
- Provided the Project Leader, Plant Operations & Maintenance (POM) and/or Environmental Services (EVS) with a copy of the most recent asbestos survey as requested
- Notify the JOHSC of any sampling or testing
- Review and approve the CRMP, providing the recommended asbestos precautions as required.
- Administer medical surveillance requirements of the Asbestos Management Programs
- Respond to reports of asbestos disturbance or the discovery of previously undocumented locations of asbestos-containing material and ensure appropriate remediation and documentation procedures are followed
- Monitor compliance with the Asbestos Management Program

Joint Occupational Health and Safety Committee (JOHSC) shall:

- Be consulted prior to any asbestos sampling or inspections which may be required, and shall be given the opportunity to attend at the start of such activities
- Receive copies of all reports, sampling results and general information regarding any asbestos related activity

INVENTORY

A survey of the location of asbestos-containing materials (ACM) shall be completed and maintained. The survey shall contain the following information:

- Location of asbestos containing material
- For each material indicate whether the material is friable or non-friable
- An indication as to whether the material has been sampled to determine if it contains asbestos or whether it is assumed to contain asbestos
- If known to be asbestos, type of asbestos

The survey shall be updated every 12 months or as required to reflect any changes caused by construction, renovations or abatement.

OHS shall maintain copies of the survey. A copy of the survey is available upon request.

A summary of ACM is available on [Sunnynet](#).

INSPECTIONS AND HAZARD ASSESSMENT:

Period Inspections:

Inspection of the condition of ACM shall be conducted by a qualified consultant at reasonable intervals, at a minimum rate of once every year. The consultant shall determine identify locations and quantities of deteriorating ACM and generate a list of corrective actions.

Condition of ACM shall be classified as either good, fair, or poor. Fair and poor condition ACM shall be control either through repair, sealing, encapsulation or removal following appropriate asbestos precautions in accordance with O. Reg.278/05. OHS shall maintain documentation of these inspections in the form of a report issued by the consultant.

- POM will be responsible for all non-flooring corrective actions
- EVS will be responsible for all flooring corrective actions
- Corporate Planning and Development (CPD) will be responsible for any abatement or repair related to CPD project work
- POM, ES and CPD will be responsible for providing all asbestos-related records to OHS.

Hazard Reporting:

Damaged asbestos-containing material identified by employees during the course of their normal day-to-day activities shall be reported to the OHS who will ensure that appropriate remediation steps are taken.

Bulk Sampling

All materials that may contain asbestos must be sampled before requesting tenders or arranging for work (including non-friable materials).

Bulk sampling must be carried out on bulk material samples that are randomly collected by a competent worker and are representative of each area of homogeneous material.

The minimum number of bulk material samples to be collected from an area of homogeneous material is set out in Table 1 of O. Reg. 278/05. Three samples for most cases except for those listed in Table 1 of O. Reg. 278/05.

If analysis establishes that a bulk material sample contains 0.5 per cent or more asbestos by dry weight, the entire area of homogeneous material from which the bulk material sample was taken is deemed to be asbestos-containing material.

O. Reg. 278/05 references the prescribed test method and procedures for establishing whether material is asbestos-containing material and for establishing its asbestos content and the type of asbestos.

NOTIFICATIONS

Sunnybrook shall notify employees of the location of ACM through the Asbestos Management page on [Sunnynet](#). A copy of details reports can be provided as requested.

The project leader shall inform their employees and/or contractors when the work performed may bring them into contact or close proximity to ACM and they may disturb it.

TRAINING AND EDUCATION

Employees who work around and who may disturb asbestos containing material or who are responsible for managing, overseeing or coordinating such activities shall receive asbestos awareness training. Training will include

- Asbestos hazards
- Personal hygiene and appropriate work practices
- Use, care and disposal of respirators and protective equipment, including limitations, inspection and maintenance, proper fitting, respirator cleaning and disinfection.

Retraining is completed on a routine and as-needed basis

Employees involved in Asbestos Operations shall complete appropriate respirator fit testing as per Respiratory Protection Program. As such, the records of respirator fit tests will be maintained by the department.

Medical surveillance

To permit earlier detection of such diseases, O. Reg. 278/05 prescribes medical examinations for workers who work in Type 2 or Type 3 operations

BUILDING OPERATIONS

Classification of Asbestos:

Asbestos operations are as classified as Type 1, 2 or 3 as specified in O. Reg. 278/05. Refer to Appendix 1 for details outlining each type of operation.

Employees may engage in Type 1 or 2 asbestos operations provided they have completed the appropriate training. All 3 work must be contracted to fully qualified contractor

Routine Operations:

Prior to any planned maintenance or construction activity, the supervisor and/or project leader shall review the appropriate ACM Inventory, assess the probability that the work activity will, or will likely, disturb ACMs and determine the appropriate control measures (i.e. Type 1, 2, or 3).

If the activity will, or will, likely to disturb ACMs, the supervisor/project leader shall complete a [Construction, Renovation and Maintenance Permit](#). IPAC and OHS shall review and approve the permit.

If it is determined that ACM is present and will be disturbed by the work an inspection by OHS and/or IPAC is required.

- As part of tendering for a project, the project leader must provide a list of designated substances to all potential contractors who may work on the project. This list along with any inspections, reports or drawings must be included in any tendering information prior to the arrangement of the contract.
- If, in the course of work, material is discovered which was not identified in the asbestos assessment and report but which may be asbestos-containing material, work is stopped and the material is analyzed for asbestos content
- Project managers who oversee the work of asbestos abatement contractors are appropriately trained and competent

Infection Prevention and Control (IP&C)

In addition to asbestos precautions, IPAC controls as described in the Infection Control during [Construction, Renovation and Maintenance Policy \(IPAC-0006\)](#) shall be implemented to minimize the risk of nosocomial infection by containments and prevention of particulates from the construction area migrating into the high risk patient area(s).

Inspection and Air Monitoring of Asbestos Work

Visual clearance and clearance air testing shall be conducted for all Type 3 work areas.

Type 3 asbestos abatement shall be supervised by a qualified constant who shall:

- Inspect of the contaminant area prior to commencement of work to ensure it meets or exceeds the requirements under O. Reg. 278/05 prior to commencement
- Periodically monitor air inside and outside the containment area during work hours to verify the airborne fibre levels during removal procedures are under the recommended level.
- Complete final inspection of the containment area.

- Collect air samplings following forced air clearance testing. Air sample results <0.01fibers/cc are deemed acceptable.
- Conduct air monitoring to check all work is completed successfully and ensure that levels are lower than acceptable level prior to containment removal by the contractor
 - The number of air samples collected shall be in accordance with Table 3 of O. Reg. 278/05
- Provide a copy of the clearance air testing results to OHS.

Within 24 hours after the clearance air testing results are received:

- a copy of the results shall be placed in conspicuous place
- a copy shall be provide to the JOHSC

Emergency Procedures:

In the event that an employee or contractors determines that there has been unintentionally disturbance to ACM (ex. Accidental damage or uncovered during demolition/construction work), immediately notify the Project Manager, Maintenance and the OHS department and relay the location and the extent of the damage.

All activities in the area must immediately stop in order to minimise potential exposure of the individuals or other building occupants to airborne asbestos fibres.

Minor Release:

A minor release occurs when there is less than 9ft² of ACM (or 21 linear ft. of 1.6 in.) pipe or equivalent) is disturbed.

- *Immediately notify the Project Manager and/or POM and the on-call Safety Pager (ext. 4737)*
- Following the direction of the Project Manager, Maintenance and OHS, isolate the affected area by way of physical barriers such as doors or plastic sheeting and the shutdown of the HVAC system.
- At minimum, follow Type 2 procedures to remediate the release
- The Project Manager and/or POM shall complete a Fibre Release Episode Report form Appendix 2 and submit a copy to OHS.

Major Release:

A major release occurs when greater than 9ft² of ACM (or 21 linear ft. of 1.6 in. pipe) or equivalent is disturbed.

- *Immediately notify the Project Manager and/or POM and the on-call Safety Pager (ext. 4737)*
- Any major release episode shall require the immediate isolation of all affected areas and the involvement of a consultant and a removal contractor. At minimum, Type 2 procedures shall be followed to remediate the release.
- The consultant will design the appropriate response action and will work closely with the Project Manager, Maintenance, Infection Prevention and Control, Risk Management and OHS. Depending on the circumstances, remediate may be elevated to Type 3 status at the discretion of the Project Manager, Maintenance, OHS, Risk Management and Infection Prevention & Control.
- The Project Manager and/or POM shall complete a Fibre Release Episode Report form and submit a copy to OHS.

APPENDICES AND REFERENCES:

Related Policies

1. Infection Control during Construction, Renovation and Maintenance - IPAC-0006
2. Air Purifying Respirator Policy - HR-107

References:

- Ontario Ministry of Labour. Ontario Regulation 490/09 made under the Occupational Health and Safety Act 1990, as amended by O.Reg. 259/10; Designated Substances.
- Ontario Ministry of Labour. Ontario Regulation 278/05 made under the Occupational Health and Safety Act 1990, Designated Substance - Asbestos on Construction Projects and in Buildings and Repair Operations, 2005.
- Ontario Ministry of Labour. Ontario Regulation 67/93 made under the Occupational Health and Safety Act 1990, as amended to O.Reg. 631/05; Health Care and Residential Facilities
- Ontario Ministry of Labour. Occupational Health and Safety Act and Regulations for Industrial Establishments, 1990.
- Canadian Standards Association (CSA). Z94.4-02 Selection, Use, and Care of Respirators, 2018
- Canadian Standards Association (CSA). Z317.13-12. Infection Control during Construction or Renovation of Health Care Facilities, 2012

Appendices

[Appendix 1 – Classification of Asbestos Operations and Precautions](#)

[Appendix 2 – Fibre Release Episode Report](#)

[Appendix 3 – Definitions](#)

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Mould Response Policy (IP&C and OHS)

Sunnybrook Health Sciences Centre		Policy No:	IPAC-0015
Title	Mould Response Policy (IP&C and OHS)	Original: (mm/dd/yyyy)	04/01/2005
Category	Infection Prevention & Control	Reviewed: (mm/dd/yyyy)	05/01/2007, 10/29/2010, 11/11/2013, 07/10/2017
Sub-Category	Environmental Concerns & Reprocessing	Revised: (mm/dd/yyyy)	07/10/2017
Issued By:	Infection Prevention & Control		
Approved By:	Medical Advisory Committee		

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.

POLICY STATEMENT:

It is a Sunnybrook Health Sciences Centre 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, Plant Operations and Maintenance (POM) 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 two 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**, POM may remediate the mould following *CCA 82 - 2004 Mould Guidelines for the Canadian Construction Industry* in conjunction with *CSA Z317.13-17 Infection control during construction, renovation, and maintenance of health care facilities*.
4. If the presence of mould is confirmed and the **affected area is greater than 10 ft²**, POM (or Corporate Planning) must contact an external mould remediation contractor. An environmental consultant will be involved to oversee the work at the discretion of IP&C, OHS and POM (or Corporate Planning).
5. Project Manager or Project Lead must retain records of remedial work and forward copies to IP&C and OHS.
6. A Construction, Renovation and Maintenance Permit is to be requested for all work that disturbs building materials or includes ceiling entry.

APPENDICES AND REFERENCES:

RELATED POLICIES:

[IPAC-0006 Infection Control during Construction, Renovation and Maintenance](#)

STAKEHOLDERS:

Infection Prevention and Control
Plant Operations and Maintenance
Occupational Health and Safety
Corporate Planning

REFERENCES:

1. Mould guidelines for the Canadian construction industry. Canadian Construction Association, 2004.
2. Fungal contamination in public buildings: A guide to recognition and management. Federal-Provincial Committee on Environmental and Occupational Health, Health Canada, June 1995.
3. CSA Z317.13-17, Infection control during construction, renovation, and maintenance of health care facilities, Canadian Standards Association, 2016.

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Recommended Sink Standards for New Construction and Renovation

Sunnybrook Health Sciences Centre		Policy No:	IPAC-0007
Title	Recommended Sink Standards for New Construction and Renovation	Original: (mm/dd/yyyy)	05/01/2002
Category	Infection Prevention & Control	Reviewed: (mm/dd/yyyy)	10/15/2007, 03/09/2010, 03/08/2012, 11/11/2013, 11/10/2017
Sub-Category	Construction & Renovation	Revised: (mm/dd/yyyy)	11/11/2013
Issued By:	Infection Prevention and Control Committee		
Approved By:	Medical Advisory Committee		

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Please ensure that you have reviewed all linked documents and other referenced materials within this page.

POLICY STATEMENT:

It is a Sunnybrook Health Sciences Centre policy to provide guidelines for evidence-based sink design in new construction and renovation projects to decrease and prevent the transmission of pathogens to patients, staff and visitors.

In addition to consulting all applicable regulations, codes, and standards when selecting sinks and/or related plumbing fixtures, Infection Prevention & Control (IP&C) considerations must be reviewed in order to determine the type of sink, fixture and options that may be installed in a specific location as defined below.

These recommendations do not apply to utility sinks (e.g. clean/soiled rooms).

IP&C shall be consulted for review and approval of all sink specifications and placement within the facility, as required for new construction and renovation of existing spaces.

For manufacturer fixture specifications, refer to Corporate Planning & Development's Master Specifications.

DEFINITIONS:

Hand hygiene sink:

A sink dedicated for hand hygiene (HH).

Scrub Sink:

A sink equipped to enable medical personnel to scrub their hands prior to a surgical procedure. The water supply is activated by a knee-action mixing valve or by foot control.

Utility Sink:

A sink used to clean instruments/articles, or to be used for general purposes by staff in routine unit cleaning. This sink is not to be used for hand hygiene. Frequently located in soiled rooms and/or utility rooms.

Manual Washing Sinks:

Sinks used within food premises or food preparation facilities for the manual cleaning and sanitizing of multi-service articles and utensils differing from Hand Hygiene sinks and mechanical washing (dishwashers).

Backsplash:

Impermeable material mounted behind sink area to prevent rotting and deterioration of the wall from water/chemicals splashing behind the sink causing mould and bacterial contamination.

Hand Hygiene Sink Design Specifications:

Hand hygiene sinks design shall reflect the following criteria:

1. The sink material shall be non-porous (i.e. porcelain, enamel) or 18 gauge (or thicker) stainless steel.
2. The size shall minimize recontamination from splashing during use. Minimum inside dimension should be 350 x 250mm and a minimum depth of 225mm.
3. HH sinks shall be wall-mounted, free standing and not inserted into or immediately adjacent to a counter.
 - Sinks shall be at least 1m from any fixed surface, patient care equipment, storage unit. If not possible then consult with IP&C to determine if a splash guard barrier is appropriate.
 - There must be no space between the back of the sink and the wall.
 - The sink shall be installed at least 865mm above the floor.
 - There is to be no storage/cabinet/shelving beneath the HH sink.
4. Taps and controllers must be hands free, electronic eye or foot pedal may be used.
 - Electronic eye technology shall be hard wired to the emergency power system to allow for use in times of power outage and shall have a means for users to adjust water temperature adjacent to sink.
5. HH sinks shall be shaped to prevent splashing and with a collar directing runoff into the sink basin.
 - The faucet shall not direct water directly into drain but should hit basin surface in front of the drain.
 - Faucets shall be free of aerators/modulators/rose sprays and shall not swivel.
 - Traps shall be metal and 40mm diameter, gaskets shall at skin/drain connection shall be plastic or neoprene.
 - Sink overflows shall not be used.
6. Adjacent wall surfaces shall be protected from splashes by installing an impermeable back/side splash (i.e. Acrovyn).
 - Backsplashes shall be seam free and all edges shall be sealed with a waterproof barrier.
 - Backsplashes shall extend a minimum of 600mm above sink level and 250mm below sink level.
7. Single paper towels shall be provided, no knobs or levers.
8. Liquid dispensers (lotion or soap) to be in non-refillable bottles and placed so as to prevent splash-up contamination, minimize dripping and be easily accessible when at the sink.

Hand Hygiene Sink Placement Recommendations:

A hand hygiene sink shall be placed in the following locations for all renovations/new construction:

- In each soiled utility/dirty room (in addition to hopper/slop sink/deep sink used for cleaning purposes).
- Inside each inpatient bedroom, close to the exit.
- In any space where treatment is provided or procedures or physical exams are performed, as follows:
 - i. in a location designed for one patient to be present at a time: one sink; or
 - ii. in a location designed to accommodate three or more patients at a time: a minimum of one sink for every three patients, with no more than 6 m distance between any patient station and the nearest sink;
 - iii. inside or adjacent to each diagnostic MRI room.

- In any room in which food or patient care items (e.g., tray) are prepared.
- Inside each nursing station or within 6 m of the station.
- Inside each staff lounge or within 6 m of the lounge.
- Within 6 m of each laboratory workstation and within each work room.
- In each room in which medication is prepared (including in pharmacies).
- In each area where unbagged soiled linen is handled .
- In other areas where there is potential to contaminate hands including goods receiving areas, waste storage, and disposal.

Note: The above list highlights key areas for HH sink placement and is not inclusive of all areas within the facility. For all construction/renovation the location and design of hand hygiene facilities shall be developed in consultation with infection prevention and control personnel. This will ensure an Infection Control Risk Assessment is completed for each area where a handwash sink will be place and that the following items will be addressed:

- Addition of hand hygiene sinks in new construction/renovation projects.
- Placement and design specification of the sink(s).
- Use of the sink for hand hygiene only.
- Location of waterless hand hygiene stations.

APPENDICES AND REFERENCES:

REFERENCES:

1. FGI. *Guidelines for Design and Construction of Hospital and Health Care Facilities, 2014 Edition*. The Facility Guidelines Institute, 2014 (7).
2. CSA Z8000-11, *Canadian Health Care Facilities*, Canadian Standards Association, 2016.

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Footwear

Sunnybrook Health Sciences Centre		Policy No:	HR-0096
Title	Footwear	Original: (mm/dd/yyyy)	06/01/2001
Category	Human Resources	Reviewed: (mm/dd/yyyy)	06/09/2022
Sub-Category	OccHealth & Safety	Revised: (mm/dd/yyyy)	12/01/2015
Issued By:	Human Resources		
Approved By:	Senior Leadership Team		

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.

POLICY STATEMENT:

It is a Sunnybrook Health Sciences Centre policy to prevent foot injuries, exposures as well as injuries related to slips or trips by taking all reasonable precautions and ensuring employees wear footwear appropriate for the type of work and environment, as per the Occupational Health and Safety Act, S. 25.

This includes requirements for protective footwear as well as for recommended safe footwear, see definitions below.

DEFINITION(S):

Protective Footwear:

A boot or shoe that provides a degree of protection against injury to the wearer as defined in Canadian Standards Association, CSA, Z195-09. e.g. shoes or boots with steel toe, puncture resistant or electrical resistant soles.

Safe Footwear:

A boot or shoe that minimizes the risk of slips, trips or fall as well as foot injury. Safe footwear would have the following features:

- Closed toe and secured heel,
- non-slip sole,
- low or flat heel e.g. walking shoe

POLICY:

1. **Selecting & Obtaining Footwear**

- Supervisors must assess the foot and slip/trip hazards in their areas and then in consultation with the department safety committee or employees determine and communicate the department footwear based on the guidelines in Section 2.0. Occupational Health can assist with the hazard assessment if required.
- Employees are to follow the footwear standards for their department/role.
- Employees who are required by the Hospital to wear safety footwear during the course of their duties, will be directed by their manager to purchase safety footwear. The manager will administer payment for the

safety footwear in accordance with the collective agreements and administrative policies

- o Signage must be posted in areas that require protective footwear. For areas that don't require protective footwear, but have established department general footwear requirements, staff must be educated on the policy requirements and signs should be posted.

Supervisors and employees must be aware that not following recommended footwear can result in injury or fines from enforcement bodies.

2. Guidelines for Appropriate Footwear

The following guidelines from CSA Z195.1-09 are to be used in determining appropriate footwear:

Hazard	Examples of Departments	Footwear
Wet Floors e.g. water, cleaning solutions, body fluids	Environmental Services, Food Services, Patient Care Units, Operating Rooms, Labs, Patient Transport Department	Safe Footwear <ul style="list-style-type: none"> • Closed toe and secured heel, • non-slip sole, • low or flat heel recommended e.g. walking shoe • fluid resistant, • covers top of the foot
<ul style="list-style-type: none"> • Heavy Lifting >5kg • Mechanical Work • Transport Vehicles e.g. Tow Motors or Hand Trucks 	Shipping/Receiving, Stores, Tow-Motor Operators, Maintenance, Groundskeeping *	Protective Footwear (Required) <ul style="list-style-type: none"> • Steel toe • Green Patch
Possible Electrical Shock e.g. work on Electrical equipment	Facilities Services	Protective Footwear (Required) <ul style="list-style-type: none"> • Steel toe/Electrical Insulation • Green Patch/Omega W
Dropped small items e.g. glass items, minor spills	Labs, Patient Care Units	Safe Footwear <ul style="list-style-type: none"> • Closed toe and secured heel, • non-slip sole, • low or flat heel recommended e.g. walking shoe
Patient Transport	Porters, Medical Imaging, Patient Care Units	Safe Footwear <ul style="list-style-type: none"> • Closed toe and secured heel, • non-slip sole, • low or flat heel recommended e.g.

walking shoe

All Staff

****Walking** (includes walking on grounds

e.g. from car/TTC stop to building entrance

Safe Footwear

- Closed toe and secured heel,
- non-slip sole,
- low or flat heel recommended e.g. walking shoe

* If Groundskeepers are doing chainsaw work, their protective footwear must have chainsaw protection.

** All staff are reminded that Sunnybrook campus and buildings cover a large area and may require walking significant distances including stairs, ramps, hills, crosswalks, high traffic and wet areas. In addition, many staff are required to respond to emergency situations. It is recommended that all staff wear safe footwear while walking significant distances or when they will encounter any of the aforementioned conditions.

APPENDICES AND REFERENCES:**REFERENCES:**

1. Ontario Ministry of Labour. Occupational Health and Safety Act and Regulations for Industrial Establishments. 1990.
2. Canadian Standards Association. Z195.1-09, Guidelines on Selection, Care and Use of Protection Footwear. 2009.

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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.

-

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.

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

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Sunnybrook Contractor Safety Form

By signing below, the Contractor representative certifies that the Contract Company has received copies of all Policies and Procedures required for safe practice while providing a service to Sunnybrook Health Sciences Centre (SHSC). The Contractor further agrees to communicate the required information embedded in these policies and procedures to all of its workers.

It is expected that the Contractor;

- Will maintain a safe workplace and work in accordance with safe work practices and house keeping
- The Contractor shall comply and cause all of its subcontractors to comply with all applicable provisions, requirements and safety standards of the Ontario Occupational Health and Safety Act and its regulations and all SHSC Safety Policies and Procedures. The Contractor will also be able and willing at such times as recommended by SCHC to provide additional precautions as deemed necessary by SHSC for safe-guarding employees and equipment. The Contractor further acknowledges and agrees that any violation of safety rules or regulations is justification for the immediate termination of its Contract with SCHC, without any further obligation on the part of SHSC.
- Comply with the sign in procedure and applicable SHSC policies and procedures.

We have read and understand the above information

Contractor (Signature)

Name (Please Print)

Date

SHSC Project Manager (Name)

Contact Number

Date

WSIB Clearance Certificate Provided

Certificate of Liability Insurance Provided

Contractor Safety Checklist

Description of Work:					
Area(s) to be Affected:					
Approximate Duration (include dates):					
Contractors Name and Contact Number:					
Project Managers Signature:				Date:	
		YES	NO	NA	Comments
1.0	ID Badges	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
2.0	Sign-in procedure and location	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
3.0	All applicable policies and procedures have been provided to contractor staff working at SHSC	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
3.1	<i>Emergency Codes (Quick Guide)</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
3.2	<i>Copy Respect Program (Corporate Code of Conduct) provided</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
3.3	<i>Asbestos Management</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
3.4	<i>Mould Response/Management</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
3.5	<i>Restricted and Confined Space</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
3.6	<i>Infection Control during Construction, Renovation and Maintenance</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

		YES	NO	NA	Comments
4.0	<i>Smoke-Free Environment</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
5.0	Fire alarm bypass required	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
6.0	Aware of incident/accident reporting procedures	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
7.0	Contractor aware of required permits	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
7.1	<i>Construction Renovation and Maintenance Permit</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
7.2	<i>Hot Work Permit</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
7.3	<i>Restricted and Confined Space Permit</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
8.0	Record of training required? (i.e. Type 3 work as per O.Reg. 278/05)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
9.0	MRI/Radiation Safety required (working in AG, SG, TB, M3)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
10	Contractor has been made aware of all Designated Substances and other hazards within work area	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

Contractor (Signature)

Name (Please Print)

Date

SHSC Project Manager (Name)

Contact Number

Date

Fire Watch Procedure

Fire Alarm Outages Sunnybrook Health Sciences Centre

A fire watch is required should the sprinkler system or fire alarm system or components of either system be on bypass, disconnected, or fail to work as designed and not provide continuous facility-wide protection. Components of fire alarm system could include but is not limited to: the fire alarm panel, smoke or heat detection system, and the fire alarm notification system. A designated person, trained in containment and extinguishment shall implement a fire watch of the total impacted area of the facility.

DOCUMENTATION: Every fire watch tour needs to be documented with the findings which will include the date, time and staff initials of person(s) performing the watch. A fire watch tour is a continuous activity performed by having one or more assigned/trained staff walking the entire affected area of the system outage. The tour monitors the facility through direct observation for possible signs of fire.

OCCURENCES: Sprinkler and fire alarm system outages can occur during construction, renovations or other planned or unplanned events which eliminate part or the entire sprinkler or fire alarm system's functioning ability.

WHAT TO DO:

1. Contact security when any bypasses are required or a problem is encountered with the sprinkler or fire alarm system.
2. Security will contact Toronto Fire and the fire alarm company to be made aware of the impairment to the impacted system
3. The fire watch procedure shall designate the wing, floor or building identifier during the facility tour.
4. Location of the facility's fire extinguishers shall be known in the impacted building and additional extinguisher(s) shall be supplied and kept in a known location by the contractor during construction and renovation.
5. Fire watch tours shall occur continuously. Typically at 1 hour intervals 24 hours a day for as long as the system is impacted.
6. A fire watch should check and document the following in all rooms including:
 - Patient/Resident rooms
 - Offices
 - Mechanical and Electrical rooms
 - Construction or renovation work areas shall be monitored continuously

7. Observation of fire or smoke during this fire watch should immediately initiate the facility's fire safety plan. Remove anyone requiring assistance, Alert other's by shouting, calling 5555 from a house phone or 416 480 5555 from a cell phone and pulling a fire alarm pull station(pull station may be disabled depending the nature of the impairment). Contain the fire by closing doors and prepare to evacuate.
8. Maintenance staff shall be available on site or on call for equipment emergency shut down situations.

**LIMITED DESIGNATED SUBSTANCE SURVEY
REPORT
(RENOVATION AREAS)**

**Sunnybrook Health Sciences Center K Wing 3rd
Floor Center and East Pod
2075 Bayview Avenue
Toronto, Ontario**

Presented to:
Sunnybrook Health Sciences Center
2075 Bayview Avenue
Toronto, Ontario
M4N 3M5

Attention: Manish Mistry

August 4, 2020

Maple Project No. 18903

EXECUTIVE SUMMARY

Maple Environmental Inc. ('Maple') was retained by Sunnybrook Health Sciences Center to perform a survey for Designated Substances as well as polychlorinated biphenyls (PCBs) and mould within the Center and East Pod of the K Wing of Sunnybrook Hospital located at 2075 Bayview Avenue, Toronto, Ontario (the 'Site'). It is our understanding that the building requires a survey to identify possible hazardous building materials that may be disturbed during the renovations of the selected areas.

The survey was limited to the Center and East POD of the K Wing. The findings of the current survey are summarized below. Please refer to the main body of this report for details on all materials.

Asbestos

Asbestos-containing materials (ACM) identified within the surveyed area at the time of the assessment are as follows:

- Vinyl Sheet Flooring

Suspect asbestos-containing materials identified within the surveyed area at the time of the assessment are as follows:

- Vinyl Floor Tiles

It should be noted that due to the presence of solid walls and ceilings (i.e. masonry walls and above solid ceilings) throughout the survey area, access for viewing within the wall and ceiling cavities was not always possible. Suspect asbestos-containing materials may be present within wall and ceiling cavities that were not identified but are suspected to be present in this report. Caution should be taken when demolishing solid walls and ceilings within the areas being surveyed.

Lead

Samples of the predominant paint colours indicated that general oil based green, brown/tan, beige and peach paint are considered to be Low-Level Lead (virtually safe) and red paints are considered to be Lead-based.

It should be noted that lead may also be present in wiring connectors, electric cable sheathing, solder joints on copper piping, ceramic glazes, lead sheeting, masonry mortar, and as sub-surface layers to the most recent paint layers currently applied, where present at the Site.

Mercury

Mercury vapour is present in all fluorescent light tubes.

Silica

Free crystalline silica, present as common construction sand, is present in all concrete and masonry products where present within the surveyed areas.

Mould

Minor mould growth (~5 square feet) was observed on the underside of sink millwork within K3E14, K3E16 and K3E23.

It is possible that mould growth is present in concealed areas such as wall or ceiling cavities, pipe chases, etc. or in areas not currently assessed by Maple.

PCBs

The fluorescent lamp fixtures observed contained T8 fluorescent light tubes. T8 fixtures have electronic ballasts and are considered as not containing PCB.

Recommendations

Based on the Laboratory Analytical Results and observations made on Site, Maple provides the following recommendations.

- Remove all asbestos-containing materials that may be disturbed during the planned renovation using the appropriate asbestos abatement procedures as outlined in Section 5.0 of the Report.
- Low Level Lead paints (0.1% or less) are considered virtually safe provided that;
 - airborne lead concentrations are kept below 0.05 mg/m³
 - general dust suppression and worker hygiene procedures are utilized
 - torching or other activities that create fumes are not completed
- Disturbance of paints that are considered Lead-Based should be completed using Lead abatement procedures as appropriate in accordance with EACO and Ministry of Labour Guidelines as outlined in Section 5.0 of the Report.
- Further, prior to disposal it is recommended that materials containing lead should be sampled and analyzed for Metals/Inorganics using the Toxicity Characteristic Leaching Procedure (TCLP) as described under O. Reg. 347. The testing is required to determine waste classification in accordance with Ontario Regulation 347 of R.R.O. 1990 made under the Environmental Protection Act amending Reg. 558/00.
- Remove all mercury containing components (including fluorescent light tubes) prior to renovations if the materials are being removed. These components should be removed intact and disposed of appropriately.
- Proper dust suppression techniques and other safety precautions to control possible generation of silica dust from the demolition of concrete and masonry products present in the surveyed area should follow those outlined in the Ministry of Labour Guideline- Silica on Construction Projects, 2004.
- Using Level 1 mould remediation procedures consider removal and replacement of the impacted millwork within the surveyed area.

Appropriate procedures for asbestos, lead, mercury, silica, and mould must be observed if these materials are likely to be disturbed by scheduled renovations. Please refer to Section 5.0 of the report to review the required procedures.

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1.0 INTRODUCTION

Maple Environmental Inc. ('Maple') was retained by Sunnybrook Health Sciences Center to perform a survey for Designated Substances as well as polychlorinated biphenyls (PCBs) and mould within the third floor of the Center and East Pod of the K Wing of Sunnybrook Hospital located at 2075 Bayview Avenue, Toronto, Ontario (the 'Site'). It is Maple's understanding that the building requires a survey to identify possible hazardous building materials that may be disturbed during the renovations of the areas surveyed.

The survey was limited to the third floor of the Center and East Pod of K Wing.

Section 30 of the Ontario Occupational Health and Safety Act requires that the following Designated Substances be included in a Designated Substance Survey:

Asbestos

Lead

Mercury

Silica

Isocyanates

Vinyl Chloride Monomer

Benzene

Acrylonitrile

Coke Oven Emissions

Arsenic

Ethylene Oxide

Additional detailed information with respect to asbestos was collected at the time of the survey to ensure compliance with Ontario Regulation 278/05.

The assessment was performed by Daniel Prosia of Maple on July 31, 2020.

2.0 APPLICABLE ONTARIO REGULATIONS

Applicable Ontario Regulations for each of the materials included in the investigation are briefly described below.

2.1 Designated Substances and Other Hazardous Materials

Section 30 of the Occupational Health and Safety Act requires building owners or their agents (architects, general contractors, etc.) to prepare or have prepared a Designated Substance report for specified potentially hazardous materials possibly present in a facility. The owner must ensure that a prospective constructor has received a Designated Substance report before entering into a binding contract with the contractor. The owner is liable to the contractor for damages and costs arising from unreported materials (of which the owner should reasonably have been aware) and could also be subject to orders and fines from the Ministry of Labour.

The disturbance of asbestos materials on construction projects is controlled by Ministry of Labour Regulation R.R.O. 2005/278. The disposal of asbestos waste is controlled by Ministry of Environment Regulation, R.R.O. 1990/347.

There are no specific Ministry of Labour regulations for control of the other Designated Substances on construction projects. However, the Ministry of Labour actively enforces the general duty clause of the Health and Safety Act which protects workers and provides guidance on exposure monitoring, permissible exposure levels, medical monitoring, etc. for all Designated Substances.

Although Regulations exist for many of the Designated Substances, they apply to industry settings using Designated Substances in manufacturing processes, and do not apply to general property management, renovation or maintenance of buildings.

Polychlorinated Biphenyls ("PCBs") and mould were also included in the investigation, which are not specifically named as Designated Substances. No specific regulations are attached to these materials but are generally governed by the due diligence section of the Health and Safety Act for employers to protect their workers.

2.2 Ontario Regulation 278/05 (Asbestos)

Ontario Regulation 278/05 applies to buildings with regards to maintenance, renovations or demolition work where asbestos-containing materials (ACM) is present and may be disturbed. The Regulation requires that a detailed asbestos inventory be performed in all buildings where friable and non-friable asbestos materials are present. The inventory must be available at the work place and must identify the type of asbestos, and location of asbestos on a room-by-room basis. The following report does not necessarily meet the requirements for an asbestos survey under Ontario Regulation 278/05.

2.3 Ontario Regulation 347

Ontario Regulation 347 applies to the transport of waste from the location of generation to a landfill site authorized to receive specific wastes. The regulation also prescribes procedures on how the specific wastes are to be handled at the landfill site.

The major requirements of the building owner and the person(s) removing the waste are to ensure that:

- The waste is appropriately packaged and labelled;
- The transport vehicle is appropriately placard; and
- The waste is to be transported as directly as possible to the landfill site once it leaves the site.

Some wastes require the owner to register a Generator (of waste) number and many wastes require classification that can restrict or even prohibit their disposal in landfill.

It is important to note that the building owner can be held responsible for the waste until the waste disposal site accepts it.

2.4 Ontario Regulation 362

Ontario Regulation 362, made under the Ontario Environmental Protection Act applies to the waste management and transport of PCB waste from the location of generation to a landfill site authorized to receive specific wastes. The regulation also prescribes procedures on how the specific wastes are to be handled at the landfill site.

3.0 SURVEY SCOPE AND METHODOLOGY

The survey was limited to the third floor of the Center and East Pod of K Wing. The methodology included the assessment for hazardous materials and how the assessment was performed is outlined below.

In order to determine the location of materials included in the assessment, the project technologist entered the room where practical (i.e. where access was possible without the demolition of walls, roof or ceilings or destruction of flooring). Representative views were made above accessible suspended ceiling systems. Cavities within solid ceiling and wall systems were accessed via existing access panels only. The inventory did not include demolition of building systems or finishes to check on possible hidden conditions.

3.1 Asbestos-Containing Building Materials (ACM)

The scope of the survey included all friable asbestos products and all major non-friable asbestos materials. The term friable is applied to a material that can be readily reduced to dust or powder by hand or moderate pressure. Asbestos materials that are friable have a much greater potential to release airborne asbestos fibres when disturbed.

Typical friable asbestos materials include: sprayed fireproofing or thermal insulation, textured (stippled) plaster, and thermal mechanical insulation. Typical non-friable materials include: asbestos cement (transite) products, vinyl floor tiles, asbestos textiles and gaskets. Additional materials such as ceiling tiles, drywall joint compounds and vinyl sheet flooring are classified as non-friable, but because of their ability to release dust when disturbed are considered as "potentially friable" for the purpose of this report.

Bulk samples of materials suspected to contain asbestos were collected for analysis during the survey. Specifically, a small volume of material was removed either from a damaged section of suspect material or taken from intact material. In these latter cases, the material from which the sample was collected was sealed with tape to temporarily prevent fibre release. Samples were placed in plastic bags and sealed until receipt by an independent laboratory. To ensure quality results, the independent laboratory chosen successfully participates in an "Asbestos Proficiency Analytical Testing Program". As such, these independent laboratories are responsible for their findings.

Bulk samples were collected in accordance with regulatory sampling requirements and with sufficient frequency to obtain a general pattern of asbestos use within the building. Due to building renovations or modifications that may have occurred in the past, the consistency of the application of asbestos materials may not be uniform throughout the entire Site. It is important to note that without sampling each individual wall, pipe section, ceiling tile etc. it is not possible to identify the asbestos content of every material present in the selected areas. For this reason, visually similar materials are considered to be homogenous with those already sampled elsewhere in the building without additional analysis.

O. Reg. 278/05 prescribes that a minimum number of samples be collected of materials suspected to contain asbestos. These minimum sampling requirements are summarized in Table 1, below.

Table 1 - Suspect ACM Bulk Sampling Requirements

Type of Material	Quantity of Material Present	Minimum # of Bulk Samples Required
Surfacing Materials (i.e. sprayed fireproofing, drywall joint compound, texture coat, and plaster)	Up to 90 sq. m. (1000 sq. ft.)	3
	From 90 sq. m. (1000 sq. ft.) to 450 sq. m. (5000 sq. ft.)	5
	Greater than 450 sq. m. (5000 sq. ft.)	7
All other potential ACM	Any	3

Excluding surfacing materials, the laboratory was instructed to cease analysis within Sample Groups of homogenous materials when one of the samples in the group is found to contain asbestos. For example, if three samples of a type of vinyl floor tile are collected (as required by O. Reg. 278/05) and submitted for analysis and the first sample is positively identified as containing asbestos, the balance of the sample group is not analysed.

EMC Scientific Inc. ('EMC'), an independent laboratory, was selected to analyse the collected bulk suspect asbestos samples. EMC successfully participates in an "Asbestos Proficiency Analytical Testing Program" and as such, is responsible for its findings. EMC followed the Code of Practice for the identification of asbestos in bulk material, as detailed in O. Reg. 278/05. Bulk samples were analysed using the Polarized Light Microscopy ("PLM") Technique with Dispersion Staining. The identification of asbestos fibre in bulk material is based on a collective set of parameters dependent on the unique shape and crystallographic properties of each fibre as viewed through the microscope. This method is useful for the qualitative identification of asbestos and the semi-quantitative determination of asbestos content in bulk materials expressed as a percent of projected area. The method identifies types of asbestos and also measures percent of asbestos as perceived by the analyst in comparison to standard area projections or trained experience.

The recommendations made as part of this report with respect to asbestos have taken into consideration: the condition and accessibility of the material, vibration, air movement, and general activities likely to occur within the vicinity of the ACM.

In each area or room inventoried, the technician recorded the quantity, condition (GOOD, FAIR, or POOR) of each suspect asbestos-containing material.

The definitions for condition and accessibility of the asbestos-containing items are as follows:

- GOOD** Material is intact with no visible signs of damage.
- FAIR** Material is visibly damaged but can be repaired.
- POOR** Material is damaged beyond repair and likely needs to be removed.

Where ACM is found to be in GOOD condition and not likely to deteriorate or fall, the general recommendation would be to re-evaluate the condition of the material on an annual basis (required by O. Reg. 278/05). This recommendation can be subject to change if the material is located in a manner that persons untrained in asbestos awareness could physically damage it.

Where ACM is found to be damaged (i.e. FAIR or POOR condition), a recommendation to have the material cleaned-up, repaired, removed, enclosed, or encapsulated is offered. The recommendation will also indicate which asbestos procedure should be used to perform the remedial work (i.e. Type 1, Type 2, Type 3, or Glove Bag Removal Methods).

3.2 Lead

The investigation included the collection and analysis of all major paint colour applications for the presence of lead in the paint. Other materials that possibly contain lead were identified by known historic use, where relevant. The lead in paint samples were analysed by EMSL Canada ('EMSL'), using atomic absorption spectrophotometry. EMSL is AIHA (American Industrial Hygiene Association) and NIOSH (National Institute of Occupational Safety and Health) accredited for this type of analysis. The Laboratory Analysis Report for lead in paint samples is included with this Report as Appendix II.

3.3 Mercury

The assessment included a visual identification of fluorescent light tubes, switches, electrical controls, heating system thermostats, thermometers, and other components historically known to contain mercury.

3.4 Other Designated Substances

Other materials listed in Section 1.0 of this Report were identified on a visual basis where present, as part of the current assessment. It should be noted that no manufacturing or heavy industrial activities are known by Maple to occur at the Site. Therefore, Designated Substances associated with these activities (i.e. those other than Asbestos, Lead, Mercury, and Silica) would not be expected to be present in the selected areas.

3.5 Mould

The assessment for mould was conducted in accordance with standard industry practice as set out in the Canadian Construction Association (CCA) "Mould Guidelines for the Canadian Construction Industry" for a visual assessment. Although there are no regulatory requirements in Ontario for such an assessment, the CCA Guidelines, and similar guidelines from other agencies have been accepted as the industry standard by most experts, consultants, the Ontario Ministry of Labour, and the Canadian Construction Association.

All guidelines and protocols for mould investigations indicate that investigations should be performed largely on a visual basis with limited collection of bulk and/or air samples. The Ontario Ministry of Labour has consistently enforced the removal of all mould from buildings regardless of mould genus or species, and therefore bulk samples or air samples for confirmation of mould are not typically collected for investigative purposes where mould is visible.

3.6 Polychlorinated Biphenyls

Manufacturers labels/codes collected from fluorescent lamp ballasts suspected of containing Polychlorinated Biphenyls ("PCBs") are compared with Environment Canada's document titled "Identification of Lamp Ballasts Containing PCBs", which identifies PCB-containing ballasts.

3.7 Limitations and Omissions from Scope

Due to the nature of building construction some limitations exist as to the possible thoroughness of any building materials inventory. The field observations, measurements, and analysis are considered sufficient in detail and scope to form a reasonable basis for the findings presented in this report. Maple warrants that the findings and conclusions contained herein have been made in accordance with generally accepted evaluation methods in the industry and applicable regulations at the time of the performance of the inventory.

It is possible that conditions may exist which could not be reasonably identified within the scope of the inventory or which were not apparent during the Site investigation. Maple believes that the information collected during the investigation concerning the property is reliable. No other warranties are implied or expressed.

During a standard ACM inventory performed for the purposes of regulatory compliance, it is industry practice to exclude certain suspect asbestos-containing materials from sampling. These materials are often excluded from sampling due to the risk of compromising the health and safety of the technician, other building occupants, or the integrity of the systems with which these materials are associated. Examples of such materials include; elevator brakes, roofing felts and mastics, high voltage wiring, mechanical packing and gaskets, underground services or piping, fire-doors, window caulking and levelling compound. Where observed, these materials were presumed to be ACM.

3.8 Drawings

Drawings included in Appendix III will indicate the locations of any major applications of an asbestos-containing material with the exception of mechanical insulations, drywall, plaster finishes and transite (which cannot be accurately depicted on drawings). The information depicted on the drawings is not to scale and is only meant to provide a general representation of the locations of asbestos-containing materials.

3.9 Previous Reports

Where possible, Maple utilized the observations and representative bulk sampling results from previous Survey Reports that were made available at the time of the survey. Maple utilized sampling data from the following sources:

- December, 2013 – Maple Environmental Inc. Project 13907 – DSUB Report;

4.0 INVENTORY FINDINGS

The findings of the survey are presented separately below for each of the eleven Designated Substances as well as microbial growth (mould), and polychlorinated biphenyls. Asbestos is further detailed by typical applications of asbestos.

4.1 Asbestos

The following is a brief discussion of the extent to which ACM was identified in the surveyed area. The discussion is organized under the headings of materials that are generally suspected of containing asbestos. The sample numbers refer to the laboratory analysis report presented as Appendix I and summarised in Table 2 below.

Thirteen (13) bulk samples were collected for the determination of asbestos content and submitted to the lab to be analysed. Due to the presence of more than one phase of material in some of the original samples the laboratory may have performed multiple analyses for some samples. In addition, some of the samples may not have been analysed due to the positive confirmation of asbestos in a previous sample of the same material during analysis. As a result, a total of eighteen (18) samples were analyzed.

Table 2 - Summary of Analysis of Asbestos Bulk Samples

Sample No.	Room Name	Sample Description	Result
S01A	K3C16	Drywall Joint Compound	None Detected
S01B	K3C08	Drywall Joint Compound	None Detected
S01C	K3C02	Drywall Joint Compound	None Detected
S01D	K3C21	Drywall Joint Compound	None Detected
S01E	K3E31	Drywall Joint Compound	None Detected
S01F	K3E18A	White Drywall Joint Compound	None Detected
		Grey Joint Compound	None Detected
S01G	K3E COR 02	Drywall Joint Compound	None Detected
S02A	K3C35	Vinyl Sheet Flooring - 01	Chrysotile 60%
S02B	K3C23	Vinyl Sheet Flooring - 01	Not Analyzed
S02C	K3C COR 01	Vinyl Sheet Flooring - 01	Not Analyzed
S03A	K3C COR 01	Vinyl Sheet Flooring - 02	None Detected
		Vinyl Backing	None Detected
		Yellow Mastic	None Detected
S03B	K3C COR 01	Vinyl Sheet Flooring - 02	None Detected
		Vinyl Backing	None Detected
		Yellow Mastic	None Detected
S03C	K3C COR 01	Vinyl Sheet Flooring - 02	None Detected
		Vinyl Backing	None Detected
		Yellow Mastic	None Detected

Asbestos-containing materials (ACM) are present in the form of vinyl sheet flooring. Details for all confirmed and suspect asbestos-containing materials are presented below under the headings of the most typical asbestos applications in buildings.

It should be noted that due to the presence of solid walls and ceilings (i.e. masonry block walls and above solid ceilings) throughout the survey area, access for viewing within the wall and ceiling cavities was not always possible. Suspect asbestos-containing materials may be present within wall and ceiling cavities that were not identified but are suspected to be present in this report. Caution should be taken when demolishing solid walls and ceilings within the areas being surveyed.

4.1.1 Sprayed Fireproofing

No sprayed fireproofing was identified within the surveyed area at the time of the assessment.

4.1.2 Thermal Mechanical Insulation (Friable)

Non-asbestos mechanical insulations are present throughout the surveyed area.

Piping Systems:

No asbestos-containing pipe systems were identified within the surveyed area at the time of the assessment.

Pipe systems observed within the surveyed area were either not insulated or were insulated with fibreglass, which is not suspected to contain asbestos.

Duct Systems

Duct systems observed throughout the surveyed area were observed to be either un-insulated or were insulated with foil-face fibreglass insulation which is not suspected to contain asbestos.

Mechanical Equipment

Wall mounted radiant heaters and air handling units were observed to be externally un-insulated.

4.1.3 Texture Finish (Friable)

No textured finishes were identified within the surveyed area at the time of the assessment.

4.1.4 Acoustic Ceiling Tiles (Potentially Friable)

A non-asbestos acoustic ceiling tile system was identified within the surveyed area at the time of the assessment.

- AT-01 (2x4 Pinholes):

No bulk samples of AT-01 were collected as a date stamp manufacture code (11/06/99) was present on the backside of the tile indicating that the tiles were recently manufactured and therefore not suspected to contain asbestos.

4.1.5 Vinyl Sheet Flooring (Potentially Friable)

Three (3) visually distinct types of vinyl sheet flooring finishes were observed in the surveyed area. A brief description of each type of flooring is outlined below.

- VSF-01 (Light Brown with Dark Brown Squares)

VSF-01 was observed through the surveyed area. Three (3) representative samples of vinyl sheet flooring were collected (Sample Set S02) and analyzed for asbestos. Analysis of Sample Set S02 found that the samples contain **60% Chrysotile asbestos**.

- VSF-02 (Light Brown with Yellow Squares)

VSF-02 was observed under utility sinks within the Corridor of the Central Pod. Three (3) representative samples of vinyl sheet flooring were collected (Sample Set S03) and analyzed for asbestos. Analysis of Sample Set S03 found that the samples do not contain asbestos.

- VSF-03 (Dark Blue with Grey Flecks)

No bulk samples of VSF-03 were collected as building personnel notified Maple that the materials were recently manufactured and are therefore not suspected to contain asbestos.

4.1.6 Vinyl Floor Tile (Non-Friable)

Three (3) visually distinct types of vinyl floor tiles systems were observed in the surveyed area. A brief description of each type of vinyl floor tile is outlined below.

- VFT-01 (12x12 Light Green)
No bulk samples were collected of VFT-01 as building personnel notified Maple that the material was not to be disturbed during the proposed renovation and as such should not be sampled.
- VFT-02 (12x12 Dark Green)
No bulk samples were collected of VFT-02 as building personnel notified Maple that the material was not to be disturbed during the proposed renovation and as such should not be sampled.
- VFT-03 (12x12 Beige)
No bulk samples were collected of VFT-03 as building personnel notified Maple that the material was not to be disturbed during the proposed renovation and as such should not be sampled.

Asbestos-containing vinyl floor tiles are present elsewhere within the building. Sampling of vinyl floor tiles is recommended for the determination of asbestos prior to any disturbance.

4.1.7 Asbestos Cement Products "Transite" (Non-Friable)

No transite cement products were identified within the surveyed area at the time of the assessment.

4.1.8 Drywall Joint Compound (DJC) (Potentially Friable)

Non-asbestos drywall joint compound was identified within the surveyed area at the time of the assessment.

Seven (7) representative samples (Sample Set S01) of drywall joint compound were collected and analyzed for determination of asbestos content. Analysis of Sample Set S01 found that the samples do not contain asbestos.

While sample results indicated all drywall joint compound sampled within the surveyed area do not contain asbestos, it should be noted that the concentration of asbestos within drywall joint compound is historically known to be potentially inconsistently distributed. Further, it is possible that various phases of construction and renovations have occurred at the Site. Therefore, the number of samples collected may not be representative of all drywall joint compound finishes on Site. Prior to the disturbance of any drywall finishes, it is recommended that additional area specific bulk samples be collected.

4.1.9 Plaster (Potentially Friable)

No plaster finishes were identified within the surveyed area at the time of the assessment.

4.1.10 Vermiculite (Friable)

No vermiculite insulation was observed to be present within the surveyed area at the time of the assessment. It should be noted that loose fill vermiculite insulation can often be present within voids of masonry and possibly some pre-manufactured surveyed area components that would not be identified during the course of this assessment.

4.2 Lead

Five (5) bulk paint samples were collected for determination of lead content and submitted to EMSL for analysis during the assessment. The sample number refers to the Certificate of Analysis Report presented as Appendix II and summarised in Table 3 below.

Table 3 - Summary of Analysis of Lead-in-Paint Samples

Sample No.	Locations	Sample Description	Result (%)
Pb-01	Centre Pod Corridor	Green Paint	<0.0082
Pb-02	Centre Pod Corridor	Brown/Tan Paint	0.023
Pb-03	Centre Pod K3C14	Red Paint	1.2
Pb-04	East Pod Corridor 2	Beige Paint	<0.0081
Pb-05	East Pod Corridor 2	Peach Paint	<0.008

No regulations currently exist in Ontario defining the lower limit of lead-containing material. The Ontario Ministry of Labour (MOL) has issued a guideline for lead abatement, entitled Guideline – Lead on Construction Projects (2004) which is considered enforceable. The Guideline does not specify what constitutes a material as “lead-containing”. Instead, it outlines procedures based on the concentration of airborne lead encountered during removal, as well as provides procedures and/or specific operations for lead-containing material removal. However, the Environmental Abatement Council of Ontario (EACO) Lead Guideline for Construction, Renovation, Maintenance or Repair document classifies paint as either Low-Level, Lead-Containing, or Lead-Based as follows:

TABLE 4 EACO Classification of Lead Paint	
Concentration of Lead (%)	Definition
0.1 or less	Low Level Lead (Virtually Safe)
Greater than 0.1 but less than 0.5	Lead-Containing
0.5 or greater	Lead-Based

Based on these criteria and the results of the sample analysis, general oil based green, brown/tan, beige and peach paint are considered to be Low-Level Lead (virtually safe). Red paints are considered to be Lead-based.

4.3 Mercury

Mercury vapour is present in all fluorescent light tubes.

4.4 Silica

Free crystalline silica, present as common construction sand, is present in all concrete and masonry products where present in the Select areas surveyed.

4.5 Isocyanates

Free isocyanate compounds would not be expected to be found in a non-manufacturing facility.

4.6 Vinyl Chloride Monomer

Vinyl chloride monomer would not be expected to be found in a non-manufacturing facility.

4.7 Benzene

Benzene would not be expected to be found in a non-manufacturing facility.

4.8 Acrylonitrile

Acrylonitrile would not be expected to be found in a non-manufacturing facility.

4.9 Coke Oven Emissions

Coke oven emissions would not be expected to be found in a non-manufacturing facility.

4.10 Arsenic

Arsenic would not be expected to be found in a non-manufacturing facility.

4.11 Ethylene Oxide

Ethylene oxide would not be expected to be found in a non-manufacturing facility.

4.12 Mould

Minor mould growth (~5 square feet) was observed on the underside of sink millwork within K3E14, K3E16 and K3E23.

It is possible that mould growth is present in concealed areas such as wall or ceiling cavities, pipe chases, etc. or in areas not currently assessed by Maple. The client should notify Maple should any water damage or suspect mould growth be discovered.

4.13 Polychlorinated Biphenyls (PCBs)

The fluorescent lamp fixtures observed contained T8 fluorescent light tubes. T8 fixtures have electronic ballast and are considered as not containing PCB.

5.0 RECOMMENDATIONS

5.1 Asbestos

Asbestos materials within the site include vinyl sheet flooring finishes as well as suspect vinyl floor tiles.

General recommendations for each of the confirmed asbestos-containing and suspect asbestos-containing materials are as follows.

Removal or disturbance of ACM vinyl floor tiles requires the use of Type 1 Asbestos procedures (provided no power tools are used and the material is wetted). If power tools are required Type 3 Asbestos procedures must be applied.

Removal or disturbance of ACM vinyl sheet flooring requires the use of Type 2 or Type 3 Asbestos procedures as appropriate.

It is important to note that due to the presence of solid wall and ceiling systems, the assessment was not able to confirm or deny the presence of ACM within wall and ceiling cavities. The presence of concealed ACM should be assumed as well as within rooms that were not accessible during the assessment. It is possible that ACM is present that was not identified in this report.

5.2 Lead

Green, brown/tan, beige and peach paint finishes sampled were found to contain Low Levels of Lead (Virtually Safe).

Low Level Lead paints (0.1% or less) are considered virtually safe provided that;

- airborne lead concentrations are kept below 0.05 mg/m³
- general dust suppression and worker hygiene procedures are utilized
- torching or other activities that create fumes are not completed

Red paints are lead-based. Follow appropriate procedures if disturbed or removed.

Disturbance of paints that are considered Lead-Based should be completed using Lead abatement procedures as appropriate in accordance with EACO and Ministry of Labour Guidelines and are generally as follows;

- Class 1 Lead abatement procedures (removing paint by means of chemical stripper or heat gun, removal of lead sheeting),
- Class 2A Lead abatement procedures (removal of lead paint using power tools equipped with HEPA vacuum attachment, removal by scraping or sanding using non-powered hand tools, or manual demolition of plaster finishes)
- Class 3A Lead abatement procedures (removal using power tools, welding or torching,
- Class 3B Lead abatement procedures (for abrasive blasting).

Further, prior to disposal it is recommended that materials containing lead should be sampled and analyzed for Metals/Inorganics using the Toxicity Characteristic Leaching Procedure (TCLP) as described under O. Reg. 347. The testing is required to determine waste classification in accordance with Ontario Regulation 347 of R.R.O. 1990 made under the Environmental Protection Act amending Reg. 558/00.

5.3 Mercury

Mercury vapour is present in all fluorescent light tubes. All fluorescent light tubes should be handled and disposed of appropriately.

5.4 Silica

Proper dust suppression techniques and other safety precautions to control possible generation of silica dust from the demolition of concrete and masonry products present in the building should follow those outlined in the Ministry of Labour Guideline- Silica on Construction Projects, 2004.

5.5 Mould

Using Level 1 mould remediation procedures consider cleaning or removal of the affected millwork throughout the surveyed area.

6.0 LIMITATIONS

Due to the nature of building construction some limitations exist as to the possible thoroughness of the subject investigation. The field observations are considered sufficient in detail and scope to form a reasonable basis for the findings presented in this report. Maple warrants that the findings and conclusions contained herein have been made in accordance with generally accepted evaluation methods in the industry and applicable regulations at the time of the performance of the assessment.

It is possible that conditions may exist which could not be reasonably identified within the scope of the investigation or which were not apparent during the site investigation. Maple believes that the information collected during the investigation period concerning the property is reliable. No other warranties are implied or expressed.

Information provided by Maple is intended for Client use ONLY. Any use by a third party, of reports or documents authored by Maple, or any reliance by a third party on or decisions made by a third party based on the findings described in said documents, is the sole responsibility of such third parties. Maple accepts no responsibility for damages suffered by any third party as a result of decisions made or actions conducted.

The liability of Maple or its staff will be limited to the lesser of the fees paid or actual damages incurred by the Client. Maple will not be responsible for any consequential or indirect damages. Maple will only be liable for damages resulting from negligence of Maple; all claims by the Client shall be deemed relinquished if not made within two years after last date of services provided.

Please contact Maple Environmental Inc. at (905) 257-4408 for inquiries regarding this project.

MAPLE ENVIRONMENTAL INC.

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APPENDIX I

LABORATORY ANALYSIS REPORT - ASBESTOS

Laboratory Analysis Report

To:

Daniel Prosia
 Maple Environmental Inc.
 482 South Service Road East, Suite 116
 Oakville, Ontario
 L6J 2X6

EMC LAB REPORT NUMBER: A60677
Job/Project Name: SHSC K Wing
Analysis Method: Polarized Light Microscopy – EPA 600
Date Received: Jul 31/20 **Date Analyzed:** Aug 4/20
Analyst: Dina Yousif, *Analyst*
Reviewed By: Malgorzata Sybydlo, *Laboratory Manager*

Job No: 18903
Number of Samples: 13
Date Reported: Aug 4/20

Client's Sample ID	Lab Sample No.	Description/Location	Sample Appearance	SAMPLE COMPONENTS (%)		
				Asbestos Fibres	Non-asbestos Fibres	Non-fibrous Material
S01A	A60677-1	Drywall joint compound	White, joint compound	ND		100
S01B	A60677-2	Drywall joint compound	White, joint compound	ND		100
S01C	A60677-3	Drywall joint compound	White and off white, joint compound	ND		100
S01D	A60677-4	Drywall joint compound	White, joint compound	ND		100
S01E	A60677-5	Drywall joint compound	White, joint compound	ND		100
S01F	A60677-6	Drywall joint compound	2 Phases:			
			a) Grey, joint compound	ND		100
			b) White, joint compound	ND		100
S01G	A60677-7	Drywall joint compound	White, joint compound	ND		100
S02A	A60677-8	Vinyl sheet flooring-01	Off white, vinyl backing	Chrysotile	60	40
S02B	A60677-9	Vinyl sheet flooring-01	NA	NA		
S02C	A60677-10	Vinyl sheet flooring-01	NA	NA		
S03A	A60677-11	Vinyl sheet flooring-02	3 Phases:			
			a) Off white, vinyl flooring	ND		100
			b) Grey, vinyl backing	ND	55	45
			c) Yellow, mastic	ND	1	99

EMC LAB REPORT NUMBER: A60677

Client's Job/Project Name/No.: 18903

Analyst: Dina Yousif, *Analyst*

Client's Sample ID	Lab Sample No.	Description/Location	Sample Appearance	SAMPLE COMPONENTS (%)		
				Asbestos Fibres	Non-asbestos Fibres	Non-fibrous Material
S03B	A60677-12	Vinyl sheet flooring-02	3 Phases: a) Off white, vinyl flooring b) Grey, vinyl backing c) Yellow, mastic	ND ND ND	55 1	100 45 99
S03C	A60677-13	Vinyl sheet flooring-02	3 Phases: a) Off white, vinyl flooring b) Grey, vinyl backing c) Yellow, mastic	ND ND ND	55 1	100 45 99

Note:

1. Bulk samples are analyzed using Polarized Light Microscopy (PLM) and dispersion staining techniques. The analytical procedures are in accordance with EPA 600/R-93/116 method.
2. The results are only related to the samples analyzed. **ND** = None Detected (no asbestos fibres were observed), **NA** = Not Analyzed (analysis stopped due to a previous positive result).
3. This report may not be reproduced, except in full without the written approval of EMC Scientific Inc. This report may not be used by the client to claim product endorsement by NVLAP or any other agency of the U.S. Government.
4. The Ontario Regulatory Threshold for asbestos is 0.5%. The limit of quantification (LOQ) is 0.5%.

APPENDIX II

LABORATORY ANALYSIS REPORT – LEAD

**EMSL Canada Inc.**

2756 Slough Street, Mississauga, ON L4T 1G3

Phone/Fax: (289) 997-4602 / (289) 997-4607

<http://www.EMSL.com>torontolab@emsl.com

EMSL Canada Or 552009089

CustomerID: 55MAPL78

CustomerPO: 18903

ProjectID:

Attn: **Daniel Prosia**
Maple Environmental, Inc.
482 South Service Road East
Suite 116
Oakville, ON L6J 2X6

Phone: (905) 257-4408
 Fax: (905) 257-8865
 Received: 7/31/2020 04:26 PM
 Collected: 7/31/2020

Project: 18903 SHSC K Wing 3

Test Report: Lead in Paint Chips by Flame AAS (SW 846 3050B/7000B)*

<i>Client Sample Description</i>	<i>Collected</i>	<i>Analyzed</i>	<i>Weight</i>	<i>RDL</i>	<i>Lead Concentration</i>
Pb-01 552009089-0001	7/31/2020 Site: Green Paint	8/4/2020	0.2442 g	0.0082 % wt	<0.0082 % wt
Pb-02 552009089-0002	7/31/2020 Site: Brown/Tan Paint	8/4/2020	0.1966 g	0.010 % wt	0.023 % wt
Pb-03 552009089-0003	7/31/2020 Site: Red Paint	8/4/2020	0.2463 g	0.041 % wt	1.2 % wt
Pb-04 552009089-0004	7/31/2020 Site: Beige Paint	8/4/2020	0.2472 g	0.0081 % wt	<0.0081 % wt
Pb-05 552009089-0005	7/31/2020 Site: Peach Paint	8/4/2020	0.2489 g	0.0080 % wt	<0.0080 % wt

Rowena Fanto, Lead Supervisor
 or other approved signatory

EMSL maintains liability limited to cost of analysis. Interpretation and use of test results are the responsibility of the client. This report relates only to the samples reported above, and may not be reproduced, except in full, without written approval by EMSL. EMSL bears no responsibility for sample collection activities or analytical method limitations. The report reflects the samples as received. Results are generated from the field sampling data (sampling volumes and areas, locations, etc.) provided by the client on the Chain of Custody. Samples are within quality control criteria and met method specifications unless otherwise noted.
 Analysis following Lead in Paint by EMSL SOP/Determination of Environmental Lead by FLAA. Reporting limit is 0.008% wt based on the minimum sample weight per our SOP. "<" (less than) result signifies the analyte was not detected at or above the reporting limit. Measurement of uncertainty is available upon request. Definitions of modifications are available upon request.
 Samples analyzed by EMSL Canada Inc. Mississauga, ON AIHA-LAP, LLC - ELLAP #196142

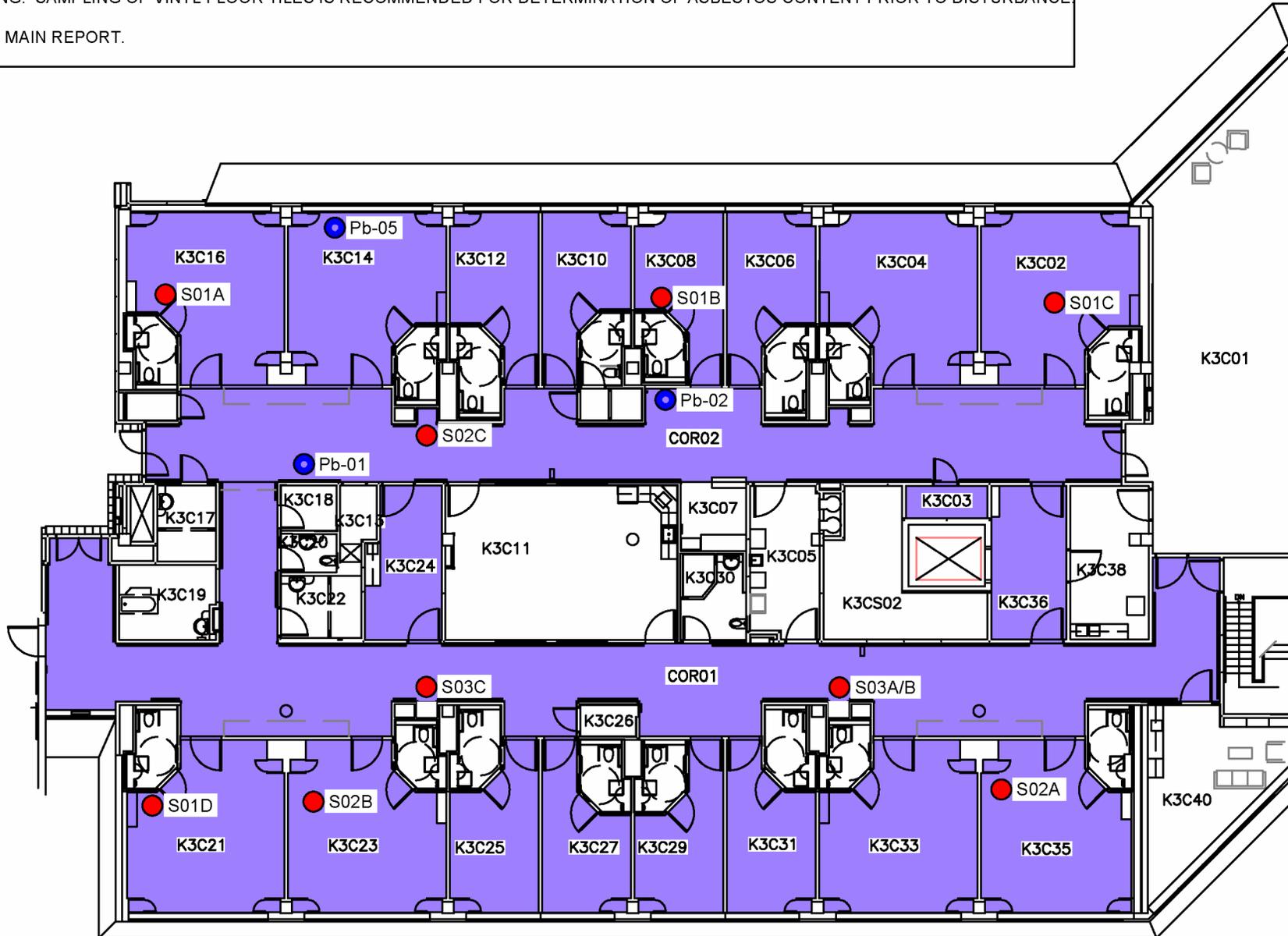
Initial report from 08/04/2020 12:16:19

APPENDIX III
DRAWINGS

NOTE:

1) ASBESTOS CONTAINING VINYL FLOOR TILES ARE PRESENT WITHIN THE BUILDING. ALL VINYL FLOOR TILES ARE CONSIDERED ASBESTOS CONTAINING. SAMPLING OF VINYL FLOOR TILES IS RECOMMENDED FOR DETERMINATION OF ASBESTOS CONTENT PRIOR TO DISTURBANCE

REFER TO MAIN REPORT.



MAPLE ENVIRONMENTAL INC.
 ENVIRONMENT, HEALTH & SAFETY CONSULTANTS
 482 South Service Rd. E. - Suite 116
 Oakville - Ontario - L6J-2X6
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 www.MapleEnvironmental.com

PROJECT NO.:
18903

Drawn By:
 D. Prosia

Checked By:
 K. Prosser

SAMPLE LOCATIONS	
SYMBOL	DESCRIPTION
●	ASBESTOS BULK SAMPLE: S-##
●	LEAD BULK SAMPLE: Pb-##

CONFIRMED & SUSPECTED ACM	
SYMBOL	DESCRIPTION
■	VINYL SHEET FLOORING
NOTE	VINYL FLOOR TILE

Designated Substance Survey

Sunnybrook Health Sciences Centre
 K-Wing
 2075 Bayview Avenue
 Toronto, Ontario

Centre POD Layout
 3rd Floor

SCALE	NTS
SHEET	DS-01

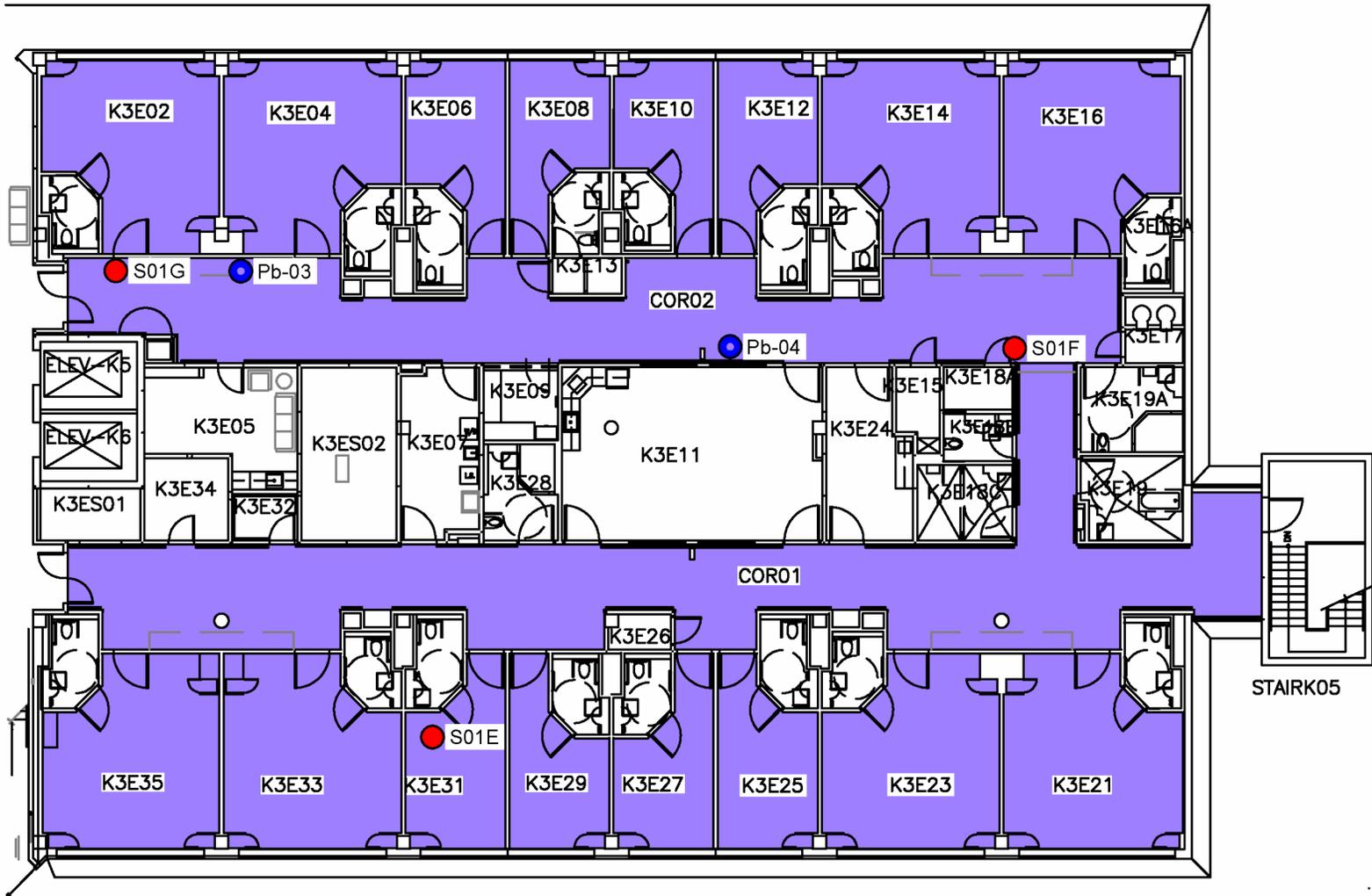


DATE:
 August 4, 2020

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REFER TO MAIN REPORT.



SAMPLE LOCATIONS	
SYMBOL	DESCRIPTION
●	ASBESTOS BULK SAMPLE: S-##
●	LEAD BULK SAMPLE: Pb-##

CONFIRMED & SUSPECTED ACM	
SYMBOL	DESCRIPTION
■	VINYL SHEET FLOORING
NOTE	VINYL FLOOR TILE

**LIMITED DESIGNATED SUBSTANCE SURVEY
REPORT
K2C CEILING SPACE**

**Sunnybrook Health Sciences Center
K-Wing Hematology Project
2075 Bayview Avenue
Toronto, Ontario**

Presented to:
Sunnybrook Health Sciences Center
2075 Bayview Avenue
Toronto, Ontario
M4N 3M5

Attention: Valentiu Cadar

November, 2023

Maple Project No. 21292

EXECUTIVE SUMMARY

Maple Environmental Inc. ('Maple') was retained by Sunnybrook Health Sciences Center (SHSC) to perform a survey for Designated Substances as well as polychlorinated biphenyls (PCBs) and mould within the 2nd Floor Center Pod of the K Wing of Sunnybrook Hospital located at 2075 Bayview Avenue, Toronto, Ontario (the 'Site'). It is our understanding that the area requires a survey to identify possible hazardous building materials that may be disturbed during renovations of K3C that will impact ductwork in the ceiling space of K2C. It should be noted that a Designated Substance Survey prepared by Maple of K3C dated August 4, 2020 is presented under separate cover. The current survey was limited to specific areas of ductwork present in the ceiling space of K2C as identified by others. The findings of the current survey are summarized below. Please refer to the main body of this report and the August 2020 report for details on all materials.

Asbestos

The following ACM was identified within the K-Wing Second Floor Centre Pod during the current survey:

- Duct Mastic

It should be noted that asbestos-containing vinyl sheet flooring is present in the K3C Work Area that could be impacted by disturbance of ductwork in K2C where ductwork penetrates the floor system.

It should be noted that due to the presence of solid walls and ceilings (i.e. masonry walls and above solid ceilings) throughout the survey area, access for viewing within the wall and ceiling cavities was not always possible. Suspect asbestos-containing materials may be present within wall and ceiling cavities that were not identified but are suspected to be present in this report. Caution should be taken when demolishing solid walls and ceilings within the areas being surveyed.

Lead

No major paint applications were identified in association with the ceiling and ceiling space of K2C and therefore no Lead samples were collected as part of the current assessment.

It should be noted that lead may also be present in wiring connectors, electric cable sheathing, solder joints on copper piping, ceramic glazes, lead sheeting, masonry mortar, and as sub-surface layers to the most recent paint layers currently applied, where present at the Site.

Mercury

Mercury vapour is present in all fluorescent light tubes.

Silica

Free crystalline silica, present as common construction sand, is present in all concrete and masonry products where present within the surveyed areas.

Mould

No visible mould growth was observed within the K2C ceiling space during the subsequent survey.

It is possible that mould growth is present in concealed areas such as wall or ceiling cavities, pipe chases, etc. or in areas not currently assessed by Maple.

PCBs

The fluorescent lamp fixtures observed contained T8 fluorescent light tubes. T8 fixtures have electronic ballasts and are considered as not containing PCB.

Recommendations

Based on the Laboratory Analytical Results and observations made on Site, Maple provides the following recommendations:

- Remove all asbestos-containing materials that may be disturbed during the planned renovation using the appropriate asbestos abatement procedures as outlined in Section 5.0 of the Report.
- Remove all mercury containing components (including fluorescent light tubes) prior to renovations if the materials are being removed. These components should be removed intact and disposed of appropriately.
- Proper dust suppression techniques and other safety precautions to control possible generation of silica dust from the demolition of concrete and masonry products present in the surveyed area should follow those outlined in the Ministry of Labour Guideline- Silica on Construction Projects, 2004.

Appropriate procedures for asbestos, lead, mercury, silica, and mould must be observed if these materials are likely to be disturbed by scheduled renovations. Please refer to Section 5.0 of the report to review the required procedures.

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APPENDICES

APPENDIX I

LABORATORY ANALYSIS REPORT - ASBESTOS

APPENDIX II

DRAWINGS

1.0 INTRODUCTION

Maple Environmental Inc. ('Maple') was retained by Sunnybrook Health Sciences Center (SHSC) to perform a survey for Designated Substances as well as polychlorinated biphenyls (PCBs) and mould within the 2nd Floor Center Pod of the K Wing of Sunnybrook Hospital located at 2075 Bayview Avenue, Toronto, Ontario (the 'Site'). It is our understanding that the area requires a survey to identify possible hazardous building materials that may be disturbed during renovations of K3C that will impact ductwork in the ceiling space of K2C.

It should be noted that a Designated Substance Survey prepared by Maple of K3C dated August 4, 2020 is presented under separate cover (Maple Project 18903). The current survey was limited to specific areas of ductwork present in the ceiling space of K2C as identified by others.

Section 30 of the Ontario Occupational Health and Safety Act requires that the following Designated Substances be included in a Designated Substance Survey:

Asbestos

Lead

Mercury

Silica

Isocyanates

Vinyl Chloride Monomer

Benzene

Acrylonitrile

Coke Oven Emissions

Arsenic

Ethylene Oxide

Additional detailed information with respect to asbestos was collected at the time of the survey to ensure compliance with Ontario Regulation 278/05.

Richards Reboks from Maple conducted the assessment of the ductwork on the Second Floor of K-Wing Centre Pod in September 2023 which will be removed as part of the project.

2.0 APPLICABLE ONTARIO REGULATIONS

Applicable Ontario Regulations for each of the materials included in the investigation are briefly described below.

2.1 Designated Substances and Other Hazardous Materials

Section 30 of the Occupational Health and Safety Act requires building owners or their agents (architects, general contractors, etc.) to prepare or have prepared a Designated Substance report for specified potentially hazardous materials possibly present in a facility. The owner must ensure that a prospective constructor has received a Designated Substance report before entering into a binding contract with the contractor. The owner is liable to the contractor for damages and costs arising from unreported materials (of which the owner should reasonably have been aware) and could also be subject to orders and fines from the Ministry of Labour.

The disturbance of asbestos materials on construction projects is controlled by Ministry of Labour Regulation R.R.O. 2005/278. The disposal of asbestos waste is controlled by Ministry of Environment Regulation, R.R.O. 1990/347.

There are no specific Ministry of Labour regulations for control of the other Designated Substances on construction projects. However, the Ministry of Labour actively enforces the general duty clause of the Health and Safety Act which protects workers and provides guidance on exposure monitoring, permissible exposure levels, medical monitoring, etc. for all Designated Substances.

Although Regulations exist for many of the Designated Substances, they apply to industry settings using Designated Substances in manufacturing processes, and do not apply to general property management, renovation or maintenance of buildings.

Polychlorinated Biphenyls ("PCBs") and mould were also included in the investigation, which are not specifically named as Designated Substances. No specific regulations are attached to these materials but are generally governed by the due diligence section of the Health and Safety Act for employers to protect their workers.

2.2 Ontario Regulation 278/05 (Asbestos)

Ontario Regulation 278/05 applies to buildings with regards to maintenance, renovations or demolition work where asbestos-containing materials (ACM) is present and may be disturbed. The Regulation requires that a detailed asbestos inventory be performed in all buildings where friable and non-friable asbestos materials are present. The inventory must be available at the work place and must identify the type of asbestos, and location of asbestos on a room-by-room basis. The following report does not necessarily meet the requirements for an asbestos survey under Ontario Regulation 278/05.

2.3 Ontario Regulation 347

Ontario Regulation 347 applies to the transport of waste from the location of generation to a landfill site authorized to receive specific wastes. The regulation also prescribes procedures on how the specific wastes are to be handled at the landfill site.

The major requirements of the building owner and the person(s) removing the waste are to ensure that:

- The waste is appropriately packaged and labelled;
- The transport vehicle is appropriately placard; and
- The waste is to be transported as directly as possible to the landfill site once it leaves the site.

Some wastes require the owner to register a Generator (of waste) number and many wastes require classification that can restrict or even prohibit their disposal in landfill.

It is important to note that the building owner can be held responsible for the waste until the waste disposal site accepts it.

2.4 Ontario Regulation 362

Ontario Regulation 362, made under the Ontario Environmental Protection Act applies to the waste management and transport of PCB waste from the location of generation to a landfill site authorized to receive specific wastes. The regulation also prescribes procedures on how the specific wastes are to be handled at the landfill site.

3.0 SURVEY SCOPE AND METHODOLOGY

The original survey was limited to the third floor of K Wing Center and East Pods. This subsequent survey includes sections of K2C limited to K2C00, K2C21, K2C23, K2C51, K2C53, K2C53A, K2C53B, K2C53C, K2C53D, and Corridor 22C1. The methodology included the assessment for hazardous materials and how the assessment was performed is outlined below.

In order to determine the location of materials included in the assessment, the project technologist entered the room where practical (i.e. where access was possible without the demolition of walls, roof or ceilings or destruction of flooring). Representative views were made above accessible suspended ceiling systems. Cavities within solid ceiling and wall systems were accessed via existing access panels only. The inventory did not include demolition of building systems or finishes to check on possible hidden conditions.

3.1 Asbestos-Containing Building Materials (ACM)

The scope of the survey included all friable asbestos products and all major non-friable asbestos materials. The term friable is applied to a material that can be readily reduced to dust or powder by hand or moderate pressure. Asbestos materials that are friable have a much greater potential to release airborne asbestos fibres when disturbed.

Typical friable asbestos materials include: sprayed fireproofing or thermal insulation, textured (stippled) plaster, and thermal mechanical insulation. Typical non-friable materials include: asbestos cement (transite) products, vinyl floor tiles, asbestos textiles and gaskets. Additional materials such as ceiling tiles, drywall joint compounds and vinyl sheet flooring are classified as non-friable, but because of their ability to release dust when disturbed are considered as "potentially friable" for the purpose of this report.

Bulk samples of materials suspected to contain asbestos were collected for analysis during the survey. Specifically, a small volume of material was removed either from a damaged section of suspect material or taken from intact material. In these latter cases, the material from which the sample was collected was sealed with tape to temporarily prevent fibre release. Samples were placed in plastic bags and sealed until receipt by an independent laboratory. To ensure quality results, the independent laboratory chosen successfully participates in an "Asbestos Proficiency Analytical Testing Program". As such, these independent laboratories are responsible for their findings.

Bulk samples were collected in accordance with regulatory sampling requirements and with sufficient frequency to obtain a general pattern of asbestos use within the building. Due to building renovations or modifications that may have occurred in the past, the consistency of the application of asbestos materials may not be uniform

throughout the entire Site. It is important to note that without sampling each individual wall, pipe section, ceiling tile etc. it is not possible to identify the asbestos content of every material present in the selected areas. For this reason, visually similar materials are considered to be homogenous with those already sampled elsewhere in the building without additional analysis.

O. Reg. 278/05 prescribes that a minimum number of samples be collected of materials suspected to contain asbestos. These minimum sampling requirements are summarized in Table 1, below.

Table 1 - Suspect ACM Bulk Sampling Requirements

Type of Material	Quantity of Material Present	Minimum # of Bulk Samples Required
Surfacing Materials (i.e. sprayed fireproofing, drywall joint compound, texture coat, and plaster)	Up to 90 sq. m. (1000 sq. ft.)	3
	From 90 sq. m. (1000 sq. ft.) to 450 sq. m. (5000 sq. ft.)	5
	Greater than 450 sq. m. (5000 sq. ft.)	7
All other potential ACM	Any	3

Excluding surfacing materials, the laboratory was instructed to cease analysis within Sample Groups of homogenous materials when one of the samples in the group is found to contain asbestos. For example, if three samples of a type of vinyl floor tile are collected (as required by O. Reg. 278/05) and submitted for analysis and the first sample is positively identified as containing asbestos, the balance of the sample group is not analysed.

EMC Scientific Inc. ('EMC'), an independent laboratory, was selected to analyse the collected bulk suspect asbestos samples. EMC successfully participates in an "Asbestos Proficiency Analytical Testing Program" and as such, is responsible for its findings. EMC followed the Code of Practice for the identification of asbestos in bulk material, as detailed in O. Reg. 278/05. Bulk samples were analysed using the Polarized Light Microscopy ("PLM") Technique with Dispersion Staining. The identification of asbestos fibre in bulk material is based on a collective set of parameters dependent on the unique shape and crystallographic properties of each fibre as viewed through the microscope. This method is useful for the qualitative identification of asbestos and the semi-quantitative determination of asbestos content in bulk materials expressed as a percent of projected area. The method identifies types of asbestos and also measures percent of asbestos as perceived by the analyst in comparison to standard area projections or trained experience.

The recommendations made as part of this report with respect to asbestos have taken into consideration: the condition and accessibility of the material, vibration, air movement, and general activities likely to occur within the vicinity of the ACM.

In each area or room inventoried, the technician recorded the quantity, condition (GOOD, FAIR, or POOR) of each suspect asbestos-containing material.

The definitions for condition and accessibility of the asbestos-containing items are as follows:

GOOD	Material is intact with no visible signs of damage.
FAIR	Material is visibly damaged but can be repaired.
POOR	Material is damaged beyond repair and likely needs to be removed.

Where ACM is found to be in GOOD condition and not likely to deteriorate or fall, the general recommendation would be to re-evaluate the condition of the material on an annual basis (required by O. Reg. 278/05). This recommendation can be subject to change if the material is located in a manner that persons untrained in asbestos awareness could physically damage it.

Where ACM is found to be damaged (i.e. FAIR or POOR condition), a recommendation to have the material cleaned-up, repaired, removed, enclosed, or encapsulated is offered. The recommendation will also indicate which asbestos procedure should be used to perform the remedial work (i.e. Type 1, Type 2, Type 3, or Glove Bag Removal Methods).

3.2 Lead

The investigation included the collection and analysis of all major paint colour applications for the presence of lead in the paint. Other materials that possibly contain lead were identified by known historic use, where relevant. The lead in paint samples were analysed by EMSL Canada ('EMSL'), using atomic absorption spectrophotometry. EMSL is AIHA (American Industrial Hygiene Association) and NIOSH (National Institute of Occupational Safety and Health) accredited for this type of analysis. The Laboratory Analysis Report for lead in paint samples is included with this Report as Appendix II.

3.3 Mercury

The assessment included a visual identification of fluorescent light tubes, switches, electrical controls, heating system thermostats, thermometers, and other components historically known to contain mercury.

3.4 Other Designated Substances

Other materials listed in Section 1.0 of this Report were identified on a visual basis where present, as part of the current assessment. It should be noted that no manufacturing or heavy industrial activities are known by Maple to occur at the Site. Therefore, Designated Substances associated with these activities (i.e. those other than Asbestos, Lead, Mercury, and Silica) would not be expected to be present in the selected areas.

3.5 Mould

The assessment for mould was conducted in accordance with standard industry practice as set out in the Canadian Construction Association (CCA) "Mould Guidelines for the Canadian Construction Industry" for a visual assessment. Although there are no regulatory requirements in Ontario for such an assessment, the CCA Guidelines, and similar guidelines from other agencies have been accepted as the industry standard by most experts, consultants, the Ontario Ministry of Labour, and the Canadian Construction Association.

All guidelines and protocols for mould investigations indicate that investigations should be performed largely on a visual basis with limited collection of bulk and/or air samples. The Ontario Ministry of Labour has consistently enforced the removal of all mould from buildings regardless of mould genus or species, and therefore bulk samples or air samples for confirmation of mould are not typically collected for investigative purposes where mould is visible.

3.6 Polychlorinated Biphenyls

Manufacturers labels/codes collected from fluorescent lamp ballasts suspected of containing Polychlorinated Biphenyls ("PCBs") are compared with Environment Canada's document titled "Identification of Lamp Ballasts Containing PCBs", which identifies PCB-containing ballasts.

3.7 Limitations and Omissions from Scope

Due to the nature of building construction some limitations exist as to the possible thoroughness of any building materials inventory. The field observations, measurements, and analysis are considered sufficient in detail and scope to form a reasonable basis for the findings presented in this report. Maple warrants that the findings and conclusions contained herein have been made in accordance with generally accepted evaluation methods in the industry and applicable regulations at the time of the performance of the inventory.

It is possible that conditions may exist which could not be reasonably identified within the scope of the inventory or which were not apparent during the Site investigation. Maple believes that the information collected during the investigation concerning the property is reliable. No other warranties are implied or expressed.

During a standard ACM inventory performed for the purposes of regulatory compliance, it is industry practice to exclude certain suspect asbestos-containing materials from sampling. These materials are often excluded from sampling due to the risk of compromising the health and safety of the technician, other building occupants, or the integrity of the systems with which these materials are associated. Examples of such materials include; elevator brakes, roofing felts and mastics, high voltage wiring, mechanical packing and gaskets, underground services or piping, fire-doors, window caulking and levelling compound. Where observed, these materials were presumed to be ACM.

3.8 Drawings

Drawings included in Appendix II will indicate the locations of any major applications of an asbestos-containing material with the exception of mechanical insulations, drywall, plaster finishes and transite (which cannot be accurately depicted on drawings). The information depicted on the drawings is not to scale and is only meant to provide a general representation of the locations of asbestos-containing materials.

3.9 Previous Reports

Where possible, Maple utilized the observations and representative bulk sampling results from previous Survey Reports that were made available at the time of the survey.

Maple utilized sampling data from the following sources:

- August, 2020 – Maple Environmental Inc. Project 18903 – K3C Hematology DSUB Report; and
- December, 2013 – Maple Environmental Inc. Project 13907 – Annual Asbestos Reassessment Report.

4.0 INVENTORY FINDINGS

The findings of the survey are presented separately below for each of the eleven Designated Substances as well as microbial growth (mould), and polychlorinated biphenyls. Asbestos is further detailed by typical applications of asbestos.

4.1 Asbestos

The following is a brief discussion of the extent to which ACM was identified in the surveyed area during the original survey and the subsequent survey. The discussion is organized under the headings of materials that are generally suspected of containing asbestos. The sample numbers refer to the laboratory analysis report presented as Appendix I and summarised in Table 2 below.

As part of the current survey for the areas of K2C, six (6) bulk samples were collected for the determination of asbestos content and submitted to the lab to be analysed. In addition, some of the samples may not have been analysed due to the positive confirmation of asbestos in a previous sample of the same material during analysis. As a result, a total of four (4) samples were analyzed.

Table 2 - Summary of Analysis of Asbestos Bulk Samples

Sample No.	Room Name	Sample Description	Result
21292-S01A	Corridor 22C1	Grey Duct Mastic	Chrysotile 2%
21292-S01A	Corridor 22C1	Grey Duct Mastic	Not Analyzed
21292-S01A	Corridor 22C1	Grey Duct Mastic	Not Analyzed
21292-S02A	Room K2C53A	AT02 – 2' x 4' Uniform Pinhole	None Detected
21292-S02B	Room K2C53B	AT02 – 2' x 4' Uniform Pinhole	None Detected
21292-S02C	Room K2C53	AT02 – 2' x 4' Uniform Pinhole	None Detected

Asbestos-containing materials (ACM) identified during the subsequent survey of K2C Ductwork are present in the form of duct mastic. Details for all confirmed and suspect asbestos-containing materials are presented below under the headings of the most typical asbestos applications in buildings.

It should be noted that asbestos-containing materials (ACM) identified during the original survey of K3C are present in the form of vinyl sheet flooring.

It should be noted that due to the presence of solid walls and ceilings (i.e. masonry block walls and above solid ceilings) throughout the survey area, access for viewing within the wall and ceiling cavities was not always possible. Suspect asbestos-containing materials may be present within wall and ceiling cavities that were not

identified but are suspected to be present in this report. Caution should be taken when demolishing solid walls and ceilings within the areas being surveyed.

4.1.1 Sprayed Fireproofing

No sprayed fireproofing was identified within the surveyed area at the time of the assessment.

4.1.2 Thermal Mechanical Insulation (Friable)

Non-asbestos mechanical insulations are present throughout the surveyed area.

Piping Systems:

No asbestos-containing pipe systems were identified within the surveyed area at the time of the assessment.

Pipe systems observed within the surveyed area were either not insulated or were insulated with fibreglass, which is not suspected to contain asbestos.

Duct System Insulation

Duct systems observed throughout the surveyed areas were observed to be either uninsulated or were insulated with foil-face fibreglass insulation which is not suspected to contain asbestos.

Refer to Section 4.1.11 Other materials for more details on the grey asbestos-containing duct mastic observed.

Mechanical Equipment

Wall mounted radiant heaters and air handling units were observed to be externally uninsulated.

4.1.3 Texture Finish (Friable)

No textured finishes were identified within the surveyed area at the time of the assessment.

4.1.4 Acoustic Ceiling Tiles (Potentially Friable)

No asbestos-containing acoustic ceiling tile system was identified within the surveyed area at the time of the assessment. A brief description of each type of acoustic ceiling tile is outlined below:

- AT-01 (2' x 4' Pinhole and Fissures):
No bulk samples of AT-01 were collected as a date stamp manufacture code (11/06/99) was present on the backside of the tile indicating that the tiles were recently manufactured and therefore not suspected to contain asbestos.
- AT-02 (2' x 4' Uniform Pinholes and Mechanically Fastened):
Three (3) representative samples of AT02 were collected (Sample Set 21292 S02A-C) and analyzed for asbestos. Analysis of Sample Set 21292 S02 found that the samples do not contain asbestos.

4.1.5 Vinyl Sheet Flooring (Potentially Friable)

Asbestos-containing vinyl sheet floor was previously identified on K3C (refer to Maple report 18903). Vinyl sheet floor on K2C is also suspected of containing asbestos although not formally assessed as part of the current assessment as it is not likely to be disturbed by work in the ceiling space of K2C.

4.1.6 Vinyl Floor Tile (Non-Friable)

Vinyl floor tile on K2C was not formally assessed as part of the current assessment as it is not likely to be disturbed by work in the ceiling space of K2C.

4.1.7 Asbestos Cement Products "Transite" (Non-Friable)

No transite cement products were identified within the surveyed area at the time of the assessment.

4.1.8 Drywall Joint Compound (DJC) (Potentially Friable)

Drywall joint compound was not formally assessed as part of the current assessment as it is not likely to be disturbed by work in the ceiling space of K2C.

4.1.9 Plaster (Potentially Friable)

No plaster finishes were identified within the surveyed area at the time of the assessment.

4.1.10 Vermiculite (Friable)

No vermiculite insulation was observed to be present within the surveyed area at the time of the assessment. It should be noted that loose fill vermiculite insulation can often be present within voids of masonry and possibly some pre-manufactured surveyed area components that would not be identified during the course of this assessment.

4.1.11 Other (Non-Friable)

Duct Mastic:

On K2C survey area, there was a grey mastic material observed at the flange of the Ductwork where the sections are joined together on the main line.

Three (3) representative samples of duct mastic were collected (Sample Set 21292 S01) and was analyzed for asbestos content. Analysis of Sample Set S01A found that the mastic contained **2% Chrysotile asbestos**. The mastic was concealed by the flange as shown in Figures 1 and 2.

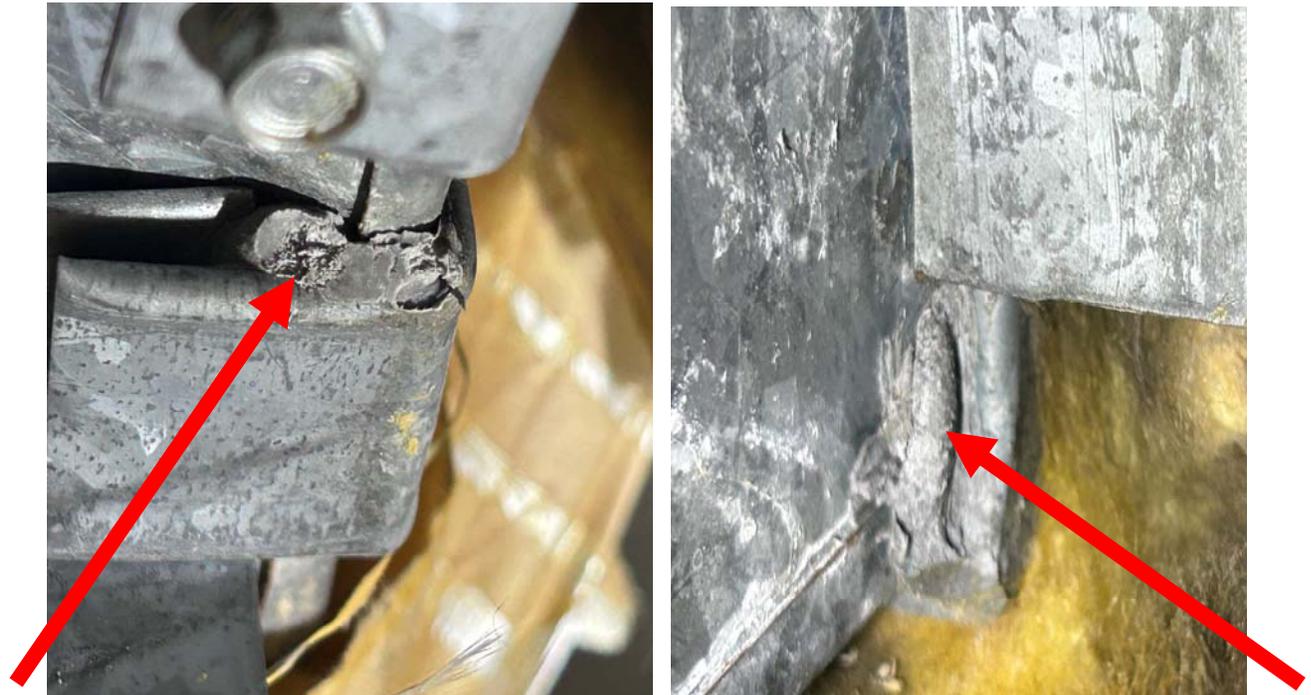


Figure 1

Figure 2

The grey duct mastic material was observed to be in GOOD condition at the time of the assessment.

4.2 Lead

No major paint applications were identified in association with the ceiling and ceiling space of K2C and therefore no Lead samples were collected as part of the current assessment.

4.3 Mercury

Mercury vapour is present in all fluorescent light tubes.

4.4 Silica

Free crystalline silica, present as common construction sand, is present in all concrete and masonry products where present in the Select areas surveyed.

4.5 Isocyanates

Free isocyanate compounds would not be expected to be found in a non-manufacturing facility.

4.6 Vinyl Chloride Monomer

Vinyl chloride monomer would not be expected to be found in a non-manufacturing facility.

4.7 Benzene

Benzene would not be expected to be found in a non-manufacturing facility.

4.8 Acrylonitrile

Acrylonitrile would not be expected to be found in a non-manufacturing facility.

4.9 Coke Oven Emissions

Coke oven emissions would not be expected to be found in a non-manufacturing facility.

4.10 Arsenic

Arsenic would not be expected to be found in a non-manufacturing facility.

4.11 Ethylene Oxide

Ethylene oxide would not be expected to be found in a non-manufacturing facility.

4.12 Mould

No visible mould was observed in the areas surveyed for the K2C Work Area.

It is possible that mould growth is present in concealed areas such as wall or ceiling cavities, pipe chases, etc. or in areas not currently assessed by Maple. The client should notify Maple should any water damage or suspect mould growth be discovered.

4.13 Polychlorinated Biphenyls (PCBs)

The fluorescent lamp fixtures observed contained T8 fluorescent light tubes. T8 fixtures have electronic ballast and are considered as not containing PCB.

5.0 RECOMMENDATIONS

5.1 Asbestos

Asbestos materials within the areas investigated in the ceiling space of K2C include duct mastic. It should be noted that vinyl sheet flooring is present on K3C that may be impacted by work on ducting where it penetrates the floor system.

General recommendations for each of the confirmed asbestos-containing and suspect asbestos-containing materials are as follows:

- Removal or disturbance of ACM duct mastic requires the use of Type 1 Asbestos Abatement Procedures (provided no power tools are used and the material is wetted). If power tools are required Type 3 Asbestos Abatement Procedures must be applied.
- Removal or disturbance of ACM vinyl sheet flooring requires the use of Type 2 or Type 3 Asbestos Abatement Procedures as appropriate.

It is important to note that due to the presence of solid wall and ceiling systems, the assessment was not able to confirm or deny the presence of ACM within wall and ceiling cavities. The presence of concealed ACM should be assumed as well as within

rooms that were not accessible during the assessment. It is possible that ACM is present that was not identified in this report.

5.2 Mercury

Mercury vapour is present in all fluorescent light tubes. All fluorescent light tubes should be handled and disposed of appropriately.

5.3 Silica

Proper dust suppression techniques and other safety precautions to control possible generation of silica dust from the demolition of concrete and masonry products present in the building should follow those outlined in the Ministry of Labour Guideline- Silica on Construction Projects, 2004.

6.0 LIMITATIONS

Due to the nature of building construction some limitations exist as to the possible thoroughness of the subject investigation. The field observations are considered sufficient in detail and scope to form a reasonable basis for the findings presented in this report. Maple warrants that the findings and conclusions contained herein have been made in accordance with generally accepted evaluation methods in the industry and applicable regulations at the time of the performance of the assessment.

It is possible that conditions may exist which could not be reasonably identified within the scope of the investigation or which were not apparent during the site investigation. Maple believes that the information collected during the investigation period concerning the property is reliable. No other warranties are implied or expressed.

Information provided by Maple is intended for Client use ONLY. Any use by a third party, of reports or documents authored by Maple, or any reliance by a third party on or decisions made by a third party based on the findings described in said documents, is the sole responsibility of such third parties. Maple accepts no responsibility for damages suffered by any third party as a result of decisions made or actions conducted.

The liability of Maple or its staff will be limited to the lesser of the fees paid or actual damages incurred by the Client. Maple will not be responsible for any consequential or indirect damages. Maple will only be liable for damages resulting from negligence of Maple; all claims by the Client shall be deemed relinquished if not made within two years after last date of services provided.

Please contact Maple Environmental Inc. at (905) 257-4408 for inquiries regarding this project.

MAPLE ENVIRONMENTAL INC.

Environment, Health and Safety Consultants

Prepared By:



**Richards Reboks,
Senior Project Technologist**

Reviewed By:



**Kyle Prosser
Senior Project Manager**

APPENDIX I

LABORATORY ANALYSIS REPORT - ASBESTOS

Laboratory Analysis Report

To:

Richards Reboks
 Maple Environmental Inc.
 482 South Service Road East, Suite 116
 Oakville, Ontario
 L6J 2X6

EMC LAB REPORT NUMBER: A96241
Job/Project Name: SHSC, K2C, Hematology
Analysis Method: Polarized Light Microscopy – EPA 600
Date Received: Sep 26/23 **Date Analyzed:** Sep 29/23
Analyst: Fabio Anunciacao
Reviewed By: Malgorzata Sybydlo

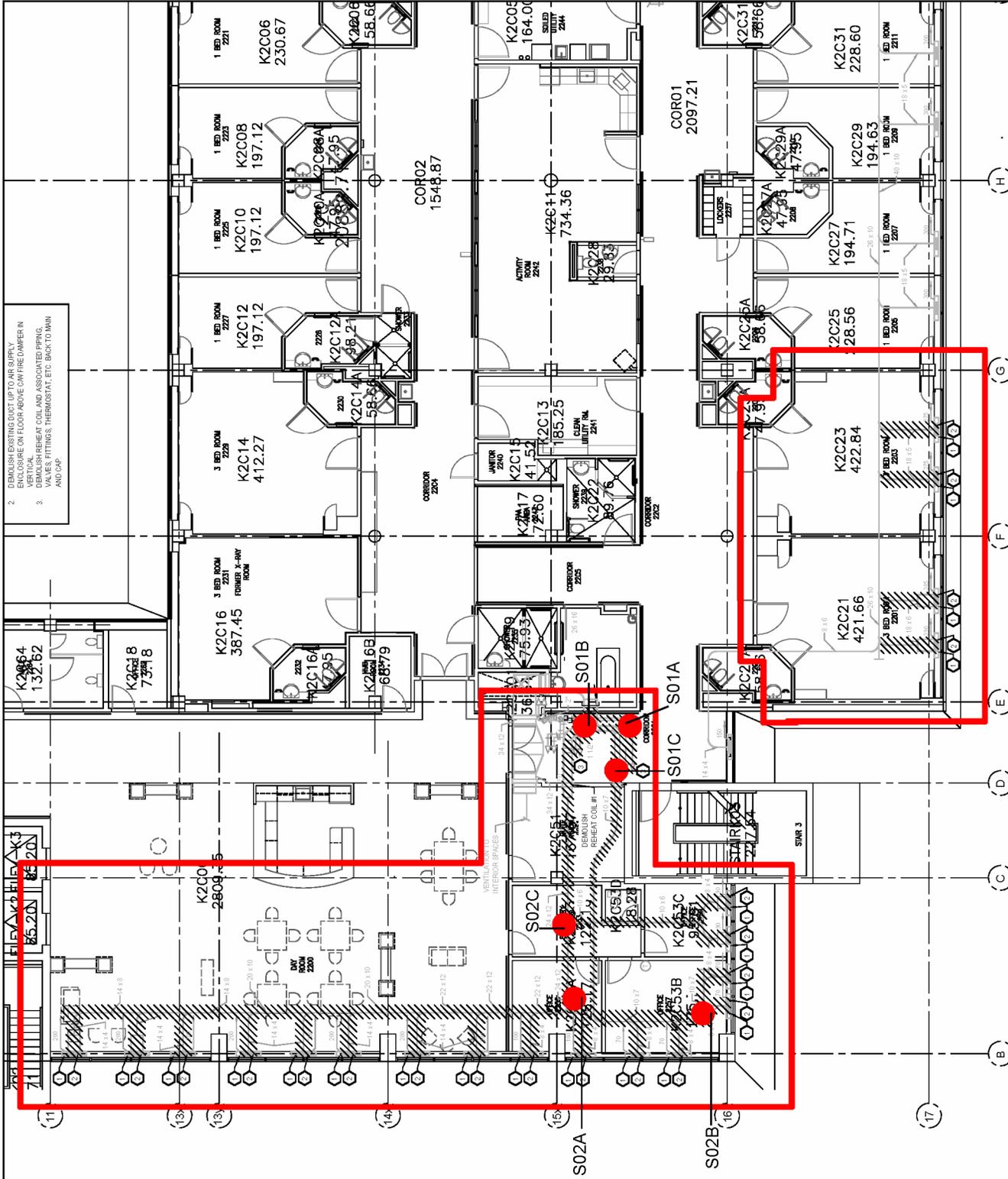
Job No: 21292
Number of Samples: 6
Date Reported: Sep 29/23

Client's Sample ID	Lab Sample No.	Description/Location	Sample Appearance	SAMPLE COMPONENTS (%)		
				Asbestos Fibres	Non-asbestos Fibres	Non-fibrous Material
S01A	A96241-1	Grey duct mastic	Grey, caulking	Chrysotile	2	98
S01B	A96241-2	Grey duct mastic	NA	NA		
S01C	A96241-3	Grey duct mastic	NA	NA		
S02A	A96241-4	AT02- 2' x 4' uniform pinhole, mech fastened	Beige, ceiling tile	ND	75	25
S02B	A96241-5	AT02- 2' x 4' uniform pinhole, mech fastened	Beige, ceiling tile	ND	75	25
S02C	A96241-6	AT02- 2' x 4' uniform pinhole, mech fastened	Beige, ceiling tile	ND	75	25

Note:

1. Bulk samples are analyzed using Polarized Light Microscopy (PLM) and dispersion staining techniques. The analytical procedures are in accordance with EPA 600/R-93/116 method.
2. The results are only related to the samples analyzed. **ND** = None Detected (no asbestos fibres were observed), **NA** = Not Analyzed (analysis stopped due to a previous positive result).
3. This report may not be reproduced, except in full without the written approval of EMC Scientific Inc. This report may not be used by the client to claim product endorsement by NVLAP or any other agency of the U.S. Government.
4. The Ontario Regulatory Threshold for asbestos is 0.5%. The limit of quantification (LOQ) is 0.5%.

APPENDIX II
DRAWINGS



- DEMOLISH EXISTING DUCT UP TO AIR SURVEY
- REMOVE ON FLOOR ABOVE CAPTIVE DAMPERS IN VERTICAL
- DEMOLISH REHEAT COIL AND ASSOCIATED PIPING, VALVES, FITTINGS, THERMOSTAT, ETC. BACK TO MAIN AND CAP

SCALE	NTS
SHEET	DS-01
DATE:	October 4, 2023

Designated Substance Survey
 Sunnybrook Health Sciences Centre
 Hematology - K-Wing
 2075 Bayview Avenue
 Toronto, Ontario
 Third Floor Plan

CONFIRMED & SUSPECTED ACM	DESCRIPTION
●	DUCT/MASTIC

CONFIRMED & SUSPECTED ACM	DESCRIPTION
●	ASBESTOS BULK SAMPLE: S-#
□	SURVEY AREA

PROJECT NO.: 21292
 Drawn By: S. Knight
 Checked By: R. Reboks

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