

*Architects in Joint Venture for the
Metro Fire Hall and Day Care*

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To:	Commercial Real Estate Management, City of Toronto Metro Hall 2nd floor 55 John Street Toronto ON M5V 3C6	Addendum No:	01
		Project No:	21025 211018
Attention:	Bonita Lee	File No:	6-2-1
		Date:	October 11, 2024
		Pages (with cover):	419
Project:	Metro Hall Toronto Early Learning Child Care Centre	Delivery:	Electronic

The following information supplements and/or supersedes the bid documents issued on September 27, 2024.

This Addendum forms part of the contract documents and is to be read, interpreted and coordinated with all other parts. The cost of all contained herein is to be included in the contract sum. The following revisions supersede the information contained in the original drawings and specifications issued for the above-named project to the extent referenced and shall become part thereof. Acknowledge receipt of this Addendum by inserting its number and date on the Tender Form. Failure to do so may subject the bidder to disqualification.

Title

1.1 Addendum No. 01

2.0 References

2.1 Revised specification divisions below:

Division 20 – General Mechanical Specifications (dated October 1, 2024)

Division 21 - Fire Suppression (dated October 1, 2024)

Division 22 – Plumbing (dated October 1, 2024)

Division 23 – HVAC (dated October 1, 2024)

Division 25 - Integrated Automation (dated October 1, 2024)

2.2 Revised mechanical addendum package *ADD-M-1*, dated October 3, 2024, enclosed including:

.1 cover sheets (2 pages)

.2 drawings re-issued with revisions (7 sheets), AND

.3 aforementioned specifications (408 pages).

3.0 Description

3.1 Revisions and updates to mechanical drawings, schedules, and specification divisions as noted above and in individual addendum package(s) enclosed.

[End of Addendum]

Attachments:

Addendum ADD-M1 (417 pages)

Per: Harvey Wu
Diamond Schmitt Architects

Copied: Ryan Stitt
Brandon Bortolucci
David Dow

Salter Pilon
Salter Pilon
Diamond Schmitt

ADDENDUM



To:	Diamond Schmitt Architects 384 Adelaide Street West, Suite 100 Toronto, Ontario, Canada M5V 1R7	No.:	ADD-M1
		Date:	03/10/2024
		Project:	Metro Hall - Daycare
Fax/Email:	hwu@dsai.ca		
Attention:	Harvey Wu		
From:	Lucas Turrin	Project No.:	2021-0245

This Addendum shall be attached to the drawings and specifications and shall form an integral part of the Contract Documents. The contents of this Addendum shall be brought to the attention of all concerned.

1.1. REFERENCE: DC-M-101 – Level 1 – P&D New

- 1.1.1. Revised plumbing fixture tags.
- 1.1.2. Identified “owner supplied equipment”
- 1.1.3. Revised location of LAV-3 in Meeting Room C104
- 1.1.4. Refer to attached drawing for more information

1.2. REFERENCE: DC-M-102 – Level P1 – P&D New

- 1.2.1. Revised sanitary drain.
- 1.2.2. Revised domestic cold water supply line
- 1.2.3. Refer to attached drawing for more information

1.3. REFERENCE: DC-M-200 – Level P1 – Fire Protection Demo

- 1.3.1. Clarified existing and demolished sprinkler heads

1.4. REFERENCE: DC-M-201 – Level P1 – Fire Protection New

- 1.4.1. Revised sprinkler head locations.
- 1.4.2. Deleted one (1) fire hose cabinet
- 1.4.3. Refer to attached drawing for more information

1.5. REFERENCE: DC-M-302 – Level 1 – HVAC New

- 1.5.1. Added acoustically lined transfer air ducts
- 1.5.2. Add one (1) VAV system including ductwork, diffusers, controls
- 1.5.3. Deleted one (1) Exhaust fan EF-2 including ductwork, grilles
- 1.5.4. Added return grilles.
- 1.5.5. Refer to attached drawing for more information.

No.: ADD-M1
To: Diamond Schmitt Architects
Attention: Harvey Wu
Date: 03/10/2024
Project No.: 2021-0245

1.6. REFERENCE: DC-M-303 – Mechanical Mezz – Mech. New

1.6.1. Added note to connect sub-meters to building automation system.

1.7. REFERENCE: DC-M-400 – Mechanical Schedules

1.7.1. Added Fan Coil schedule.

1.8. REFERENCE: Division 20 – General Mechanical Specifications

1.8.1. Revised date.

1.9. REFERENCE: Division 21 – Fire Suppression

1.9.1. Revised date.

1.10. REFERENCE: Division 22 - Plumbing

1.10.1. Revised date.

1.10.2. Revised Appendix A – Plumbing fixtures

1.11. REFERENCE: Division 23 - HVAC

1.11.1. Revised date.

1.11.2. Added Section 23 21 16 Hydronic Specialties

1.11.3. Added Section 23 83 33 Electric Heaters

1.12. REFERENCE: Division 25 – Integrated Automation

1.12.1. Revised date.

End of Addendum



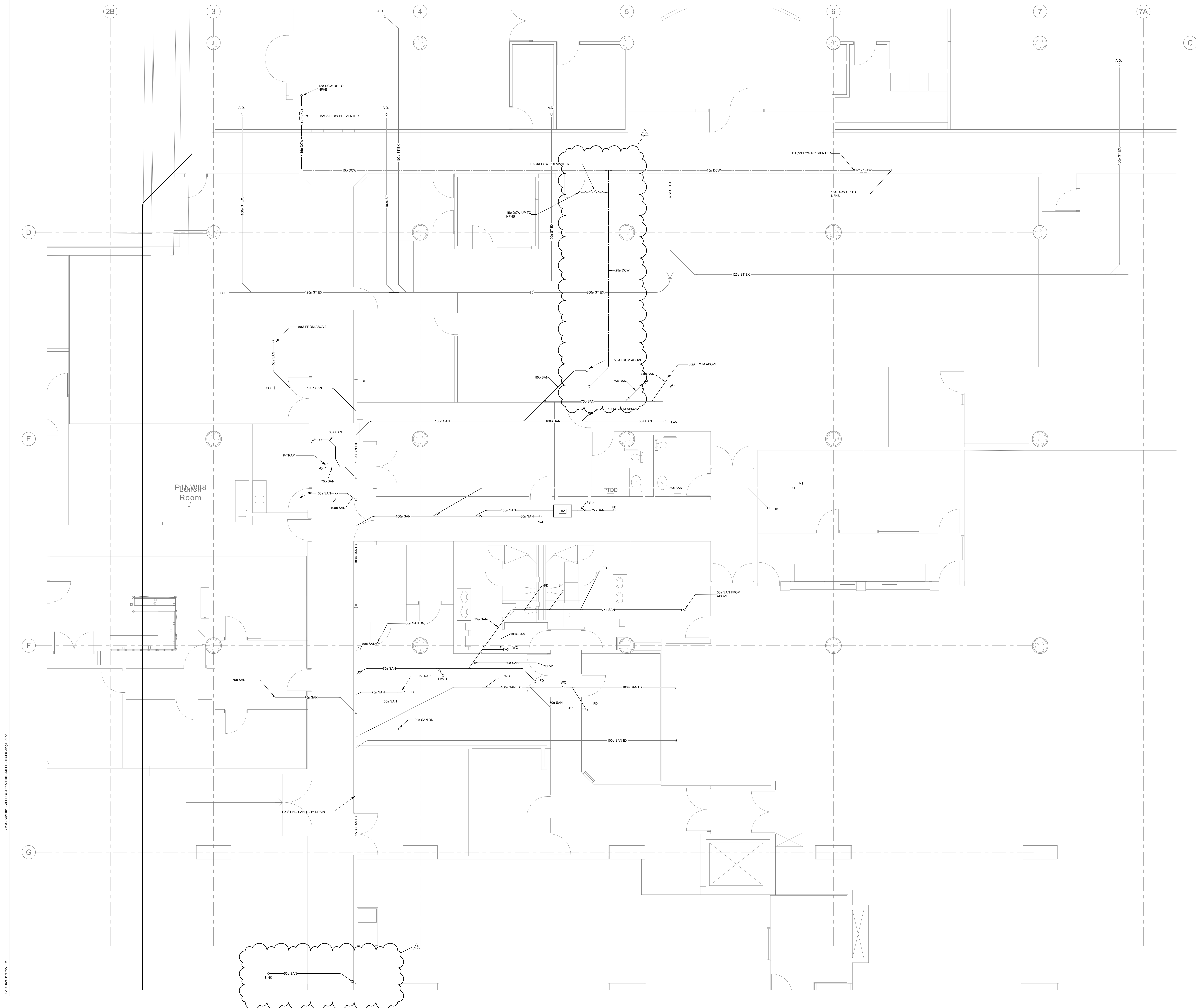
No.	Date	Description	ISSUED
1	23/06/2023	ISSUED FOR CLASS O COSTING	
2	17/03/2023	ISSUED FOR 75% DESIGN REVIEW	
3	02/05/2023	ISSUED FOR 90% DESIGN REVIEW	
6	14/07/2023	ISSUED FOR 95% DESIGN DEVELOPMENT	
7	25/08/2023	ISSUED FOR APPROVAL	
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This Drawing is Not to be used for Construction until Signed by the Architect.

TORONTO
Metro Hall Fire Station &
Early Years Child Care
Centre Renovation
25 Jane Street
Toronto, ON
M5V 3J2
2021-0245

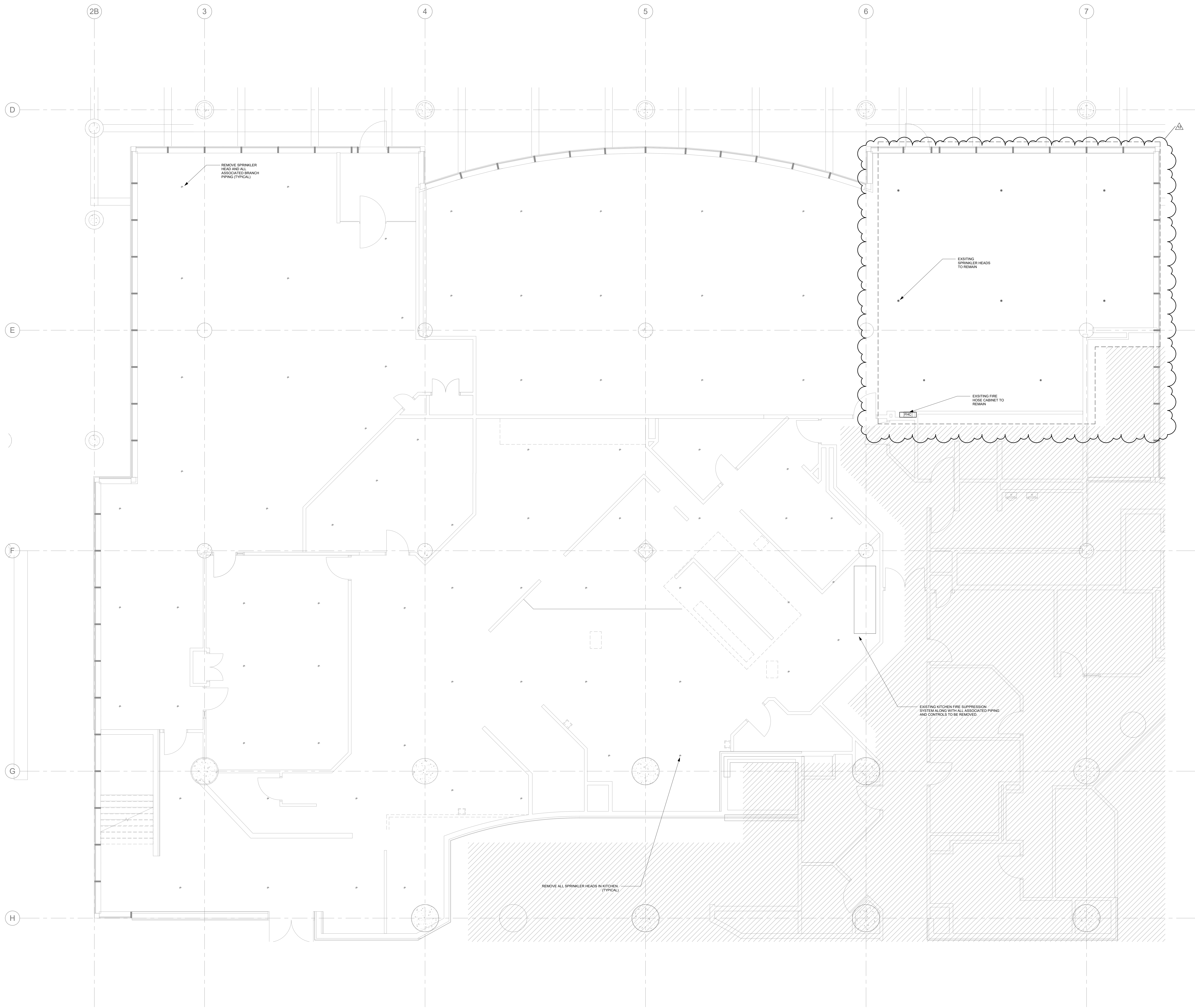
Level P1 - P&D NEW

DC-M-102



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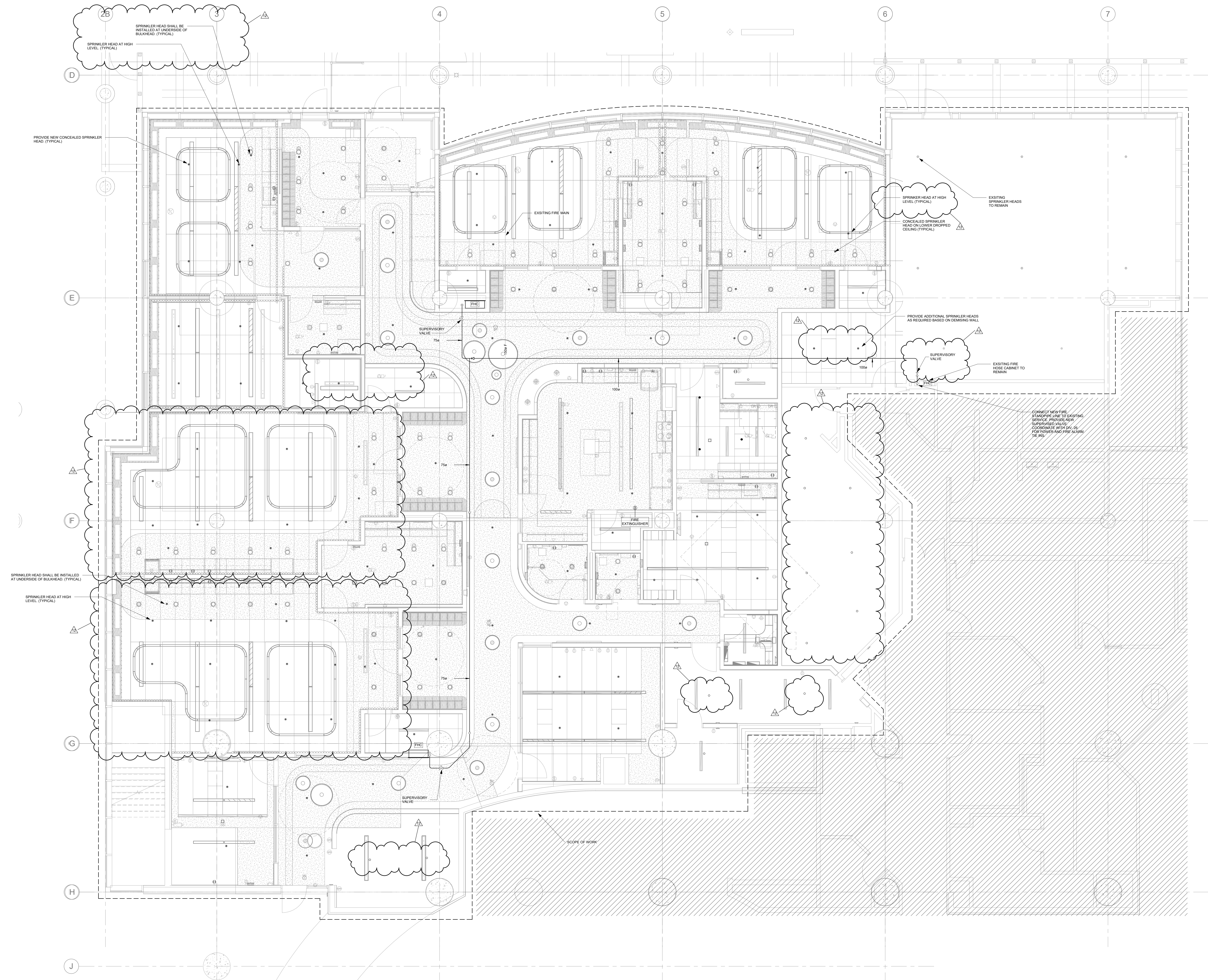
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Toronto
Metro Hall Fire Station &
Early Years Child Care
Centre Renovation
25 Jane Street
Toronto, ON
M5V 3L2
2021-0245

LEVEL 1 - FIRE
PROTECTION DEMO
DC-M-200

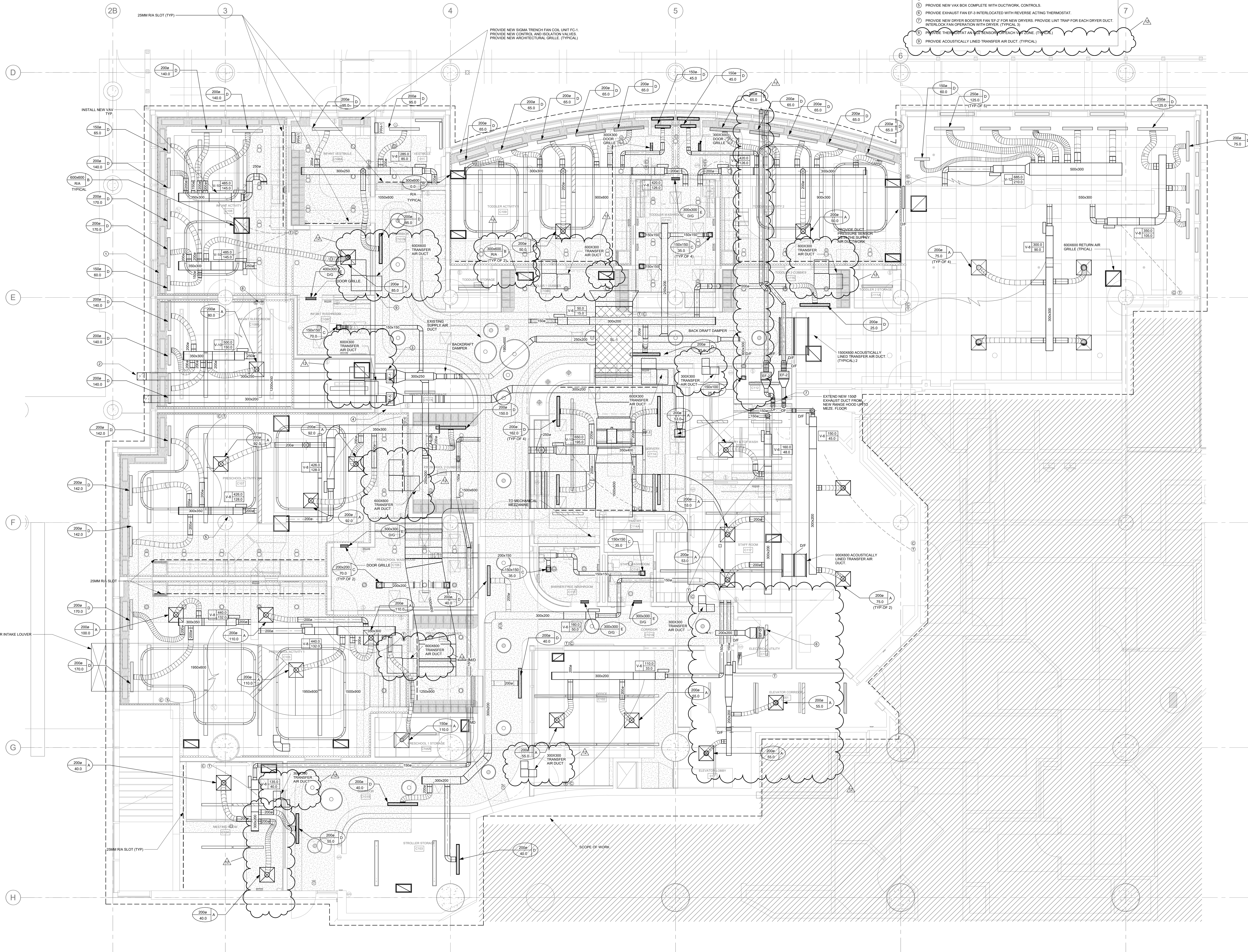
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Toronto
Metro Hall Fire Station &
Early Years Child Care
Centre Renovation
25 York Street
Toronto, ON
M5Y 1C2
2021-0245

LEVEL 1 - FIRE
PROTECTION NEW
DC-M-201



- GENERAL NOTES**
- REPLACE EXISTING PERIMETER SILL REGISTERS WITH NEW TYPE 'L' REGISTERS. NEW REGISTER LENGTHS AND WIDTH TO MATCH EXISTING UNITS (TYPICAL).
 - PROVIDE NEW 300x300 EXHAUST LOUVER. LOUVER TO COME WITH BIRD SCREEN AND BACKDRAFT DAMPER.
 - PROVIDE NEW EXHAUST FAN EF-1 ALONG WITH ALL ASSOCIATED HANGERS, SUPPORTS, SCALATORS, AND CONTROLS. EXTEND NEW DUCTWORK AS INDICATED. FAN TO BE CONNECTED TO BAS FOR OPERATING SCHEDULE (TYPICAL).
 - PROVIDE EXHAUST FAN EF-4 INTERLOCATED WITH KITCHEN HOOD.
 - PROVIDE NEW VAV BOX COMPLETE WITH DUCTWORK, CONTROLS.
 - PROVIDE EXHAUST FAN EF-3 INTERLOCATED WITH REVERSE ACTING THERMOSTAT.
 - PROVIDE NEW DRIVER BOOSTER FAN EF-2 FOR NEW DRIVERS. PROVIDE UNIT TRAP FOR EACH DRIVER DUCT. INTERLOCK FAN OPERATION WITH DRIVER (TYPICAL).
 - PROVIDE THERMOSTAT AT EACH VAV BOX REACH VAV BOX (TYPICAL).
 - PROVIDE ACOUSTICALLY LINED TRANSFER AIR DUCT (TYPICAL).

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FANS											
TAG	AREA SERVED	FUNCTION	MFG.	MODEL	AIRFLOW (L/S)	ESP (Pa)	WEIGHT (LBS)	ELEC.	MCA	STARTER	REMARKS
EF-1	WASHROOMS	SAN EXHAUST	COOK	GWVF-700	410	150	40	120/160	4.4	BAS	CW SPEED CONTROLLER, VIBRATION ISOLATORS, BACKDRAFT DAMPER, CONNECT TO BAS FOR CONTROLS AND MONITORING.
EF-2	LAUNDRY	DRYER BOOSTER	REVERSOMATIC	TL2000	75	100	-	120/160	0.70	DRYER	CW SPEED CONTROLLER, VIBRATION ISOLATORS, BACKDRAFT DAMPER, LINT TRAP, INTERLOCK WITH DRYER OPERATION.
EF-3	ELECTRICAL	TRANSFER AIR	GREENHECK	SP-A200	200	75		120/160			REVERSE ACTING THERMOSTAT
EF-4	SERVERY	RANGE HOOD EXHAUST	BROAD	ERLE13555	300	125		120/160			3 SPEED
EF-5	SERVERY	BOOSTER FAN	COOK	GWVF-700	300	100		120/160			INTERLOCK WITH KITCHEN HOOD FAN EF-4
RF-1	SF-1	RETURN AIR FAN	COOK	4025Q4-B	18000	150	697	0753680	9.0	BAS	CW VFD, MOTOR COVER, VIBRATION ISOLATORS, NEMA 1 DISCONNECT, INTERLOCK WITH EXISTING AIR HANDLER FOR VAV OPERATION.

SILENCER SCHEDULE																				
TAG	SYSTEM	LOCATION	MANUFACTURER	MODEL No.	AIR FLOW (L/S)	AIR VELOCITY (M/S)	PRESS. DROP (Pa)	MODULE SIZE (MM)			QTY OF PIECES	DYNAMIC INSERTION LOSS (dB) [AIRFLOW GENERATED NOISE (dB)]								REMARKS
								W	H	L		63 Hz	125 Hz	250 Hz	500 Hz	1K Hz	2K Hz	4K Hz	8K Hz	
SL-1	RETURN AIR	RETURN AIR DUCT	EH PRICE	FMX100VE	8455	5.7	62	2000	750	2700	X	16	25	32	44	34	22	16	12	25GA PERP LINER, FIBERGLASS, 2" SLIP INLET, 2" SLIP OUTLET
NOTES:																				

VARIABLE AIR VOLUME BOX SCHEDULE						
TAG	MANUFACTURER	MODEL No. (PNEUMATIC OR DIGITAL)	INLET SIZE (MM)	FLOW RANGE (L/S)		REMARKS
				MIN	MAX	
V-4	EH PRICE	SDV-8000	100	21	189	TERMINAL UNITS SILENCER
V-6	EH PRICE	SDV-8000	150	31	260	TERMINAL UNITS SILENCER
V-8	EH PRICE	SDV-8000	200	59	519	TERMINAL UNITS SILENCER
V-10	EH PRICE	SDV-8000	250	99	850	TERMINAL UNITS SILENCER
V-12	EH PRICE	SDV-8000	300	142	1227	TERMINAL UNITS SILENCER
V-14	EH PRICE	SDV-8000	350	203	1746	TERMINAL UNITS SILENCER
NOTES: THE CURRENT FLOW RANGE VALUES ARE DIGITAL, IF USING PNEUMATIC PLEASE CHANGE ACCORDINGLY.						

DIFFUSER & GRILLE SCHEDULE								
TAG	UNIT			DAMPER		MATERIAL	FINISH	REMARKS
	MANUFACTURER	MODEL No.	APPLICATION	PART OF UNIT	REMOTE IN DUCT			
A	E.H. PRICE	SPD	SUPPLY	N	Y	ALUMINIUM	WHITE	
B	E.H. PRICE	80-EGG CRATE GRILLE	RETURN	N	N	ALUMINIUM	WHITE	
C	E.H. PRICE	80-EGG CRATE GRILLE	EXHAUST	Y	N	ALUMINIUM	WHITE	25mm 1-SLOT LINEAR SLOT DIFFUSER, SDB PLENUM FACE OPERATED BALANCING DAMPER
D	E.H. PRICE	SDS	SUPPLY	Y	N	ALUMINIUM	WHITE	
E	E.H. PRICE	ATG	DOOR GRILLE	N	N	ALUMINIUM	WHITE	SIGHT-PROOF DOOR TRANSFER GRILLE
NOTES:								

ELECTRIC HEATER SCHEDULE							
TAG	TYPE	MANUFACTURER	MODEL	ELECTRICAL		LOCAL OR BAS CONTROL	REMARKS
				CAPACITY (kW)	VOLTAGE		
FPH-1	FORCE FLOW HEATER	OUELLET	OAC-200B-T	2	208/160	BAS	C/W ROOM THERMOSTAT
NOTES:							

FAN COIL SCHEDULE							
TAG	MANUFACTURER	MODEL	LENGTH	AIR FLOW (L/S)	HEATING CAPACITY (kW)	CONTROL	REMARKS
FPH-1	SIGMA	STFC-CL-H0-L42 10V	1070	44	1.5	BAS	CONTRACTOR TO VERIFY CAPACITY AND PHYSICAL DIMENSIONS PRIOR TO ORDERING
NOTES:							

GREASE INTERCEPTOR

GREASE INTERCEPTOR, ALL CALCULATION:
2-COMPARTMENT SANI VOLUME = 398mmx408mmx24mm x 3 = 28.1 GALLONS
1 MINUTE DRAIN DOWN TIME
FLOW = 0.75/29 L/S
FLOW = 21.83 GPM
DISHWASHER FLOW: 15 GPM
TOTAL FLOW: 15 + 21.80 = 36.83 GPM
GREASE INTERCEPTOR SHALL BE SIZED @ 50 GPM
GREASE INTERCEPTOR, ALL SHALL BE WATTS WD-150, PROVIDE EXTENSION AS REQUIRED

CONTROLS CONTRACTOR

BUILDING AUTOMATION SYSTEM SHALL BE BY BASE BUILDING CONTROLS CONTRACTOR (ANNEX FORTH)

ISSUED		
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12	03/10/2024	ISSUED FOR ADDENDUM M1



DIVISION 20 – GENERAL MECHANICAL
SPECIFICATIONS
FOR THE
CITY OF TORONTO - DAYCARE CENTRE (METRO HALL)
55 JOHN STREET
TORONTO, ONTARIO

Prepared by:

**The HIDI Group
155 Gordon Baker Road
Suite 200
Toronto, ON M2H 3N5**

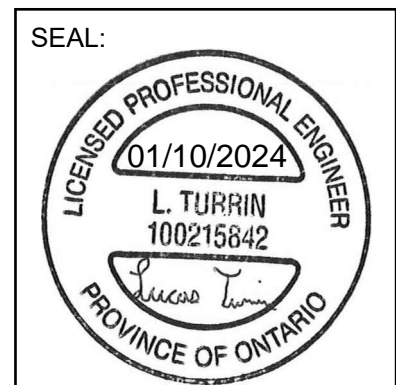
Telephone: 416-364-2100

Our Project No. 2021-0245

Issued for Tender

October 1, 2024

DISCIPLINES MECHANICAL
ELECTRICAL
PLUMBING
LIGHTING DESIGN
COMMUNICATIONS & AV
SECURITY & RISK
COMMISSIONING
ENERGY SERVICES



Project Name: CITY OF TORONTO - DAYCARE CENTRE (METRO HALL)
Project No.: 2021-0245
Section Name: **Table of Contents**
Section No.: **Division 20 - General Mechanical**
Date: October 1, 2024

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Section 20 00 50	Basic Materials and Methods
Section 20 00 55	Work in Existing Buildings
Section 20 05 13	Electric Motors
Section 20 05 14	Electrical Wiring
Section 20 05 19	Meters and Gauges
Section 20 05 29	Bases, Hangers and Supports
Section 20 05 48	Vibration Isolation
Section 20 05 53	Identification
Section 20 05 93	Testing, Balancing and Adjusting
Section 20 07 00	Mechanical Insulation

Project Name: CITY OF TORONTO - DAYCARE CENTRE (METRO HALL)
Project No.: 2021-0245
Section Name: **General Requirements**
Section No.: **20 00 00**
Date: October 1, 2024

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Project Name: CITY OF TORONTO - DAYCARE CENTRE (METRO HALL)
Project No.: 2021-0245
Section Name: **General Requirements**
Section No.: **20 00 00**
Date: October 1, 2024

1 **GENERAL**

1.1 GENERAL

1.1.1 Conform to the conditions stated in the Contract Form Document CCDC 2 – 2008, Supplementary Conditions and Division 01 - General Requirements of these Specifications.

1.1.2 The General Mechanical Requirements apply to all Sections of this Division and of Divisions 21, 22, 23 and 25.

1.1.3 The Specifications are arranged generally in accordance with the MasterFormat 2004 Edition. Sections of this Division are not intended to delegate functions or to delegate work to any specific Subcontractor(s).

1.2 DEFINITIONS

1.2.1 “Provide” means to supply and install the Products and services specified in the Contract Documents.

1.2.2 “The Work” means the total construction and related services required by the Contract, and it includes all labour, products, and services.

1.2.3 “Products” means all material, machinery, equipment, and fixtures forming part of the Work but does not include machinery and equipment used for preparation, fabrication, conveying and erection of the Work which is normally referred to as construction machinery and equipment.

1.2.4 “This Division” means all Subcontractors performing work under the Mechanical Contract, including Divisions 21, 22, 23 and 25.

1.2.5 “Other Divisions” means other Subcontractors not included in this Division.

1.2.6 “Balancing Subcontractor” means the Subcontractor responsible for the balancing work.

1.3 INTENT

1.3.1 Provide all work, including items, articles, materials, operations, and methods listed, mentioned, and scheduled in the Contract Documents. Include all labour, equipment, tools, scaffolds, and other incidentals necessary and required for the complete installation.

Project Name: CITY OF TORONTO - DAYCARE CENTRE (METRO HALL)
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- 1.3.2 Consider the Specifications and city of Toronto standards as an integral part of the Drawings, which accompany them. Do not use the Drawings or the Specifications or city standards alone. Consider any item or subject omitted from one, but mentioned or reasonably implied in the other, as properly and sufficiently specified and provided under the work of this Division.
- 1.3.3 This installation shall be made in strict accordance with the Drawings, Specifications, and all applicable codes, regulations, standards, bylaws, including the Ontario Building Code, requirements of local authorities having jurisdiction, Owner's Insurers', and NFPA regulations. Codes, standards, and regulations referenced by these Specifications shall be the latest edition as applicable at the time of building permit application unless noted otherwise or specifically defined under the OBC.
- 1.3.4 All equipment and devices used shall be UL/cUL listed and/or CSA certified where applicable.
- 1.3.5 Each Subcontractor is considered an expert in their field.
- 1.4 **EXAMINATION OF SITE AND CONTRACT DOCUMENTS**
- 1.4.1 Before tendering, visit the Site of the proposed Work and obtain all information as to existing conditions and limitations.
- 1.4.2 Examine the Specifications and all Drawings including the Specifications and Drawings of all other Divisions before commencing any portion of the work to this Division.
- 1.4.3 No allowance will be made for any consideration that may have been overlooked.
- 1.4.4 Unless exceptions are specifically noted in the Contract Documents at the time of Tender, the submission of a bid confirms that the Contract Documents and the Site conditions are accepted without qualification.
- 1.5 **SCOPE**
- 1.5.1 Major aspects of the work of this Division shall include, but not necessarily be limited to, the following items. Refer to Contract Drawings for the full scope of the Work included in the Contract.
- 1.5.1.1 Heating, Ventilation, and Air Conditioning (HVAC) systems, consisting of modifications to the existing air handling unit system,

Project Name: CITY OF TORONTO - DAYCARE CENTRE (METRO HALL)
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Section No.: **20 00 00**
Date: October 1, 2024

conversion to VAV system, perimeter fan coil units, general exhaust and sanitary exhaust systems, associated ductwork, grilles, diffusers, and controls.

- 1.5.1.2 Plumbing systems, including tenant connections with water meters, domestic cold water, sanitary drain and vent risers.
- 1.5.1.3 Plumbing fixtures for public washrooms, kitchens,
- 1.5.1.4 Fire protection systems including modifications to existing wet sprinkler system throughout the building and fire standpipe system
- 1.5.1.5 Noise control and vibration isolation systems.
- 1.5.1.6 Pool water treatment system.
- 1.5.1.7 DDC building automation system.
- 1.5.1.8 Testing, adjusting and balancing.
- 1.5.1.9 Commissioning of mechanical systems and equipment.

1.6 PERMITS, FEES AND INSPECTIONS

- 1.6.1 Apply for, obtain, and pay for all permits, licenses, inspections, examinations, and fees required.
- 1.6.2 Arrange for inspection of all work by the authorities having jurisdiction over the Work. On completion of the Work, present to the Owner the final unconditional certificate of approval of the Inspection Authorities.
- 1.6.3 Comply with requirements of the edition as applicable at the time of building permit application, of the relevant CSA standards, the requirements of the authorities, Federal, Provincial and Municipal codes, the applicable standards of the Underwriters' Association and all other authorities having jurisdiction. These codes and regulations constitute an integral part of these Specifications. In case of conflict between the Codes and the Contract Documents, the more stringent requirement shall apply.
- 1.6.4 In no instance reduce the standard established by the Drawings and Specifications by applying any of the codes referred to herein.
- 1.6.5 Before starting any work, submit the required number of copies of the Drawings and Specifications to the authorities for their approval and comments. Comply with any changes requested as part of the

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Contract, but notify the Owner immediately in writing of such changes for proper processing of these requirements. Prepare and furnish any additional drawings, details or information as may be required.

1.7 CONTRACT DRAWINGS

1.7.1 The Drawings for the mechanical work are diagrammatic performance drawings, intended to convey the scope of the Work, and indicate general arrangement and approximate location of apparatus, fixtures, and pipe runs. The Drawings do not intend to show architectural and structural details.

1.7.2 Do not scale drawings, but obtain information involving accurate dimensions to structure from dimensions shown on architectural and structural drawings, or by site measurements. Consult general construction Drawings as well as detail Drawings to become familiar with all conditions affecting the Work and verify spaces in which the Work will be installed.

1.7.3 Make, at no additional cost to the Owner, any changes or additions to materials and/or equipment necessary to accommodate structural conditions (runs around beams, columns, etc.).

1.7.4 Alter at no additional cost to the Owner, the location of materials and/or equipment as directed, provided that the changes are made before installation and do not necessitate additional material.

1.7.5 Install all ceiling mounted components (diffusers, grilles, sprinklers) in accordance with reflected ceiling drawings reviewed by the Consultant.

1.7.6 Leave space clear and install all work to accommodate future materials and/or equipment as indicated and to accommodate equipment and/or material supplied by another Division of Work or Contract. Verify spaces in which Work is to be installed. Install all pipe runs, etc., to maintain headroom and clearances and to conserve space in shafts and ceiling spaces.

1.7.7 Confirm on the Site the exact location of outlets and fixtures. Confirm location of outlets for equipment supplied under other Divisions of Work or Contracts.

1.8 CONSTRUCTION DRAWINGS

1.8.1 Prepare dimensioned co-ordination drawings in conjunction with all

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Subcontractors concerned, showing sleeves, access door locations, and openings through structure and all insert sizes and locations. Show all weights on load points. Show all electrical systems, mechanical systems, conduit, and ductwork.

1.8.2 Prepare drawings of pump pits, equipment bases, anchors, inertia slabs, floor and roof curbs pertaining to the Mechanical Work. Base drawings upon reviewed Shop Drawings. Indicate all loads transferred to the structure.

1.8.3 Submit drawings approved by all trades, to the Consultant and include one complete set in each operating and maintenance instruction manual.

1.9 SHOP DRAWINGS

1.9.1 Submit Shop Drawings and samples for material and equipment as listed in the Specifications. Provide one (1) electronic pdf file. Each Shop Drawing shall have a clear margin equal to the half of a 216 mm x 280 mm (8-1/2" x 11") size sheet for the application of all necessary approval stamps.

1.9.2 Contractor shall provide a shop drawing submission schedule at the start of the project. Schedule shall indicate the description of each shop drawing and the date of submission to the Consultant.

1.9.3 The Consultant will only consider Shop Drawings bearing the stamp of approval of the Contractor and all Sub-Contractors involved when applicable. Check for all pertinent information such as physical dimensions, make, performance, electrical characteristics, and indicate the intended use and location before stamping these drawings approved.

1.9.4 Assume responsibility for accuracy of equipment dimensions related to available space and accessibility for maintenance and service, and compliance with Codes and Inspection Authorities.

1.9.5 Submit Shop Drawings showing the following:

1.9.5.1 Project name.

1.9.5.2 Project tag number.

1.9.5.3 Manufacturer's name and model number.

1.9.5.4 Supplier's name.

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- 1.9.5.5 Approval agencies.
- 1.9.5.6 Shipping and working weight.
- 1.9.5.7 Performance characteristics.
- 1.9.5.8 Dimensions including required clearances.
- 1.9.5.9 Electrical characteristics.
- 1.9.5.10 Materials used in manufacture and type of finish.
- 1.9.5.11 Time required to fabricate and to deliver.
- 1.9.5.12 All variations from Tender Documents.
- 1.9.5.13 Construction and field connection details.
- 1.9.5.14 Motor locations.
- 1.9.6 Shop Drawings for packaged equipment shall be submitted as complete packages, including all equipment components and details (wiring diagrams, control diagrams, etc.).
- 1.9.7 The Consultant's review shall not relieve the Contractor from responsibility for deviations from the Consultant's Drawings and Specifications, unless they have in writing, called the Consultant's attention to such deviations at the time of submission of drawings. The Consultant's review shall be construed to apply to and only to general arrangement and shall not relieve the Contractor from the entire responsibility for correctness of details and dimensions. Any fabrication, erection, setting out or other work done in advance of the receipt of stamped drawings shall be done entirely at the Contractor's risk.
- 1.9.8 Shop Drawings will be marked by the Consultant for action by the Contractor as follows:

Consultant's <u>Markings</u> Not reviewed	Action by <u>Contractor</u> Product does not fall under this Division's scope and it does not affect this Division's Work in any way
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Reviewed	Proceed with work
Reviewed as Noted	Proceed in accordance with mark-up. Resubmit revised drawings for record
Revise and Resubmit	Submit revised drawings for review before proceeding

1.10 SCHEDULING

1.10.1 Comply with the Contractor's construction schedule.

1.10.2 Provide in the tender price any costs for premium time outside of normal working hours to complete the work on schedule.

1.11 RECORD DRAWINGS

1.11.1 Obtain electronic copy of the Drawings, Specifications & Contract Documents in PDF format and AutoCAD/Revit drawing files from a central project management website. If such a website is not set-up for the project, obtain electronic copy of the Drawings, Specifications & Contract Documents in PDF format and AutoCAD/Revit drawing files from the Consultant via email or other electronic file transfer tool used by the Consultant, after returning Consultant's waiver signed. As the job progresses, produce white prints of the relevant drawings and mark the prints to accurately indicate installed work. Have the white prints available for inspection at the site at all times, and present for scrutiny at job meeting. Transfer all information onto the AutoCAD drawing files/Revit model. Drawing files shall retain all original layering standards. Submit one (1) set of AutoCAD drawing files/Revit model files and one (1) set of pdf files, via email or other mutually agreed electronic file transfer tool, of final "Record" documents (drawings and specifications) to the Consultant for review. Note that the consultant's AutoCAD drawing files/Revit model files are copyrighted and may not be used for any other purpose other than that described above.

1.11.2 The drawing files shall be provided solely to assist the Subcontractor in the preparation of "Record" drawings. The Consultant assumes no liability for any errors, omissions, incomplete information, incorporation of latest changes, or other instructions.

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- 1.11.3 While the Consultant takes precautions to ensure that no computer virus is transmitted, scanning for viruses upon receipt is recommended.
- 1.11.4 Prepare Record Drawings showing the following:
 - 1.11.4.1 Inverts of all services entering and leaving the building and at property lines.
 - 1.11.4.2 Dimensions of underground services in relation to building lines at key points of every run.
 - 1.11.4.3 Elevations of underground services in relation to Ground floor level of the building.
 - 1.11.4.4 Dimensioned location of all services embedded in the structure.
 - 1.11.4.5 Dimensioned location of all services left for future Work.
 - 1.11.4.6 All Addendum changes.
 - 1.11.4.7 All changes to the work due to Change Orders.
 - 1.11.4.8 All changes to the Work during construction.
 - 1.11.4.9 Location and designation of all electrically supervised valves and smoke dampers.
 - 1.11.4.10 Location and designation of all items requiring access or service in a hidden location.
 - 1.11.4.11 All changes to Specifications, details and equipment schedules.
 - 1.11.4.12 All duct traverse points and associated airflow rates as reported in final Air Balancing reports.
- 1.11.5 Identify each "Record" drawing as follows, "Record Drawing: This drawing has been revised to show all systems as installed. Remove references to the Consultant.
- 1.11.6 Prior to Testing, Adjusting and Balancing, provide print copies of all current record drawings to the Balancing Subcontractor and the Commissioning Agent.
- 1.12 **PRODUCTS**
 - 1.12.1 Provide only new Products. Where manufacturer is not specified

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provide Products of high commercial standard and quality consistent with the standards of these Specifications.

1.12.2 All Products must bear the approval of the CSA or have special approval of the inspection authority having jurisdiction for their respective functions and environments.

1.12.3 Provide products of same manufacture for similar applications unless noted otherwise in the Contract Documents.

1.12.4 Refer to equipment performance schedules in the respective Specification Section and on the Drawings.

1.13 ALTERNATES AND SUBSTITUTIONS DURING PROGRESS OF WORK

1.13.1 Substitute Products will only be considered when Products specified in the Contract Documents become unobtainable.

1.13.2 Provide detailed Specifications and Shop Drawings with complete performance characteristics of the proposed alternate with the submission to the Consultant.

1.13.3 Assume responsibility and pay for any additional installation costs incurred by the work of all Divisions resulting from the substitution.

1.14 VALUATION OF CHANGES

1.14.1 For each change submit a complete itemized breakdown of labour and material.

1.14.2 Only the net difference between an extra and a credit will be subject to overhead and profit mark-up. Overhead and profit shall be as shown on the Tender Form.

1.15 APPLICATION FOR PAYMENT

1.15.1 Conform to the Consultant's method of submission of application for payment, which will be issued after the award of Contract.

1.16 SUPERINTENDENCE

1.16.1 The supervisory staff assigned to the project shall be fully competent to implement efficiently all requirements for scheduling, coordination, field engineering reviews, inspections and submittals defined in the Specifications.

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1.17 INSTALLATION REQUIREMENTS

- 1.17.1 The Consultant's Drawings and instructions govern the general location of all items.
- 1.17.2 Install all equipment and apparatus to allow free access for maintenance, adjustment and replacement.
- 1.17.3 Install all Products and services in accordance with the manufacturer's requirements and/or recommendations.
- 1.17.4 Do not use explosive activated tools.
- 1.17.5 Install all services capped for future to allow easy access for future tie-in.
- 1.17.6 All equipment installed in parking structure floor slabs, ramps and driving areas shall meet all requirements of CAN/CSA-S413-07 with regard to corrosion protection:
- 1.17.6.1 The use of dissimilar materials shall be avoided, or if unavoidable, electric contact shall be prevented.
- 1.17.6.2 Embedded materials used for floor drains, pipes and other hardware shall be:
- 1.17.6.2.1 Non metallic, or;
- 1.17.6.2.2 A low copper aluminum alloy or an equally corrosion resistant metal, coated on surfaces in contact with concrete to prevent galvanic corrosion with steel reinforcing, or;
- 1.17.6.2.3 Protected against the corrosive effects of de-icing chemicals by an effective and durable coating.
- 1.17.7 Install equipment neatly to the satisfaction of the Consultant. Unless noted otherwise in the Contract Documents, install all Products and services to follow building planes. Installation shall permit free use of space and maximum headroom.
- 1.17.8 Cap off and seal all open ends of installed ductwork, piping and conduits to prevent entrance of foreign matter.
- 1.17.9 Do not install piping in a location or manner, which might result in freezing.

1.18 TEMPORARY SERVICE

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- 1.18.1 Refer to Section 01 50 00 regarding temporary services, Contractor's shop, storage and other facilities.
- 1.18.2 Do not use any of the permanent mechanical systems during construction, unless specific written permission is obtained from the Consultant or unless allowed elsewhere in the Contract Documents.
- 1.18.3 The use of permanent facilities for temporary construction service shall not affect in any way the commencement of the warranty period. The warranty period shall commence as specified in the Contract Documents.
- 1.19 COOPERATION
- 1.19.1 Confer with all Subcontractors installing equipment that may affect the work of this Division, and arrange equipment in proper relation with equipment installed under other Divisions of the Contract.
- 1.19.2 Furnish all items to be built in, in time, complete with all pertinent information, commensurate with the progress of the work.
- 1.19.3 Store materials neatly and out of the way and clean up daily all refuse caused by the work.
- 1.19.4 Coordinate work with the work of all other Divisions. Relocate equipment and/or material installed, but not coordinated with the work of other Divisions, as directed by the Consultant, at no extra cost. Inform other Divisions of the locations of openings, chases, sleeves, supports, services, connections, etc. to be incorporated into the work.
- 1.20 PROTECTION
- 1.20.1 Protect building and structure from damage due to carrying out this work.
- 1.20.2 Protect all mechanical work from damage. Keep all equipment dry and clean at all times.
- 1.20.3 Cover all openings in equipment and materials.
- 1.20.4 Be responsible for and make good any damage caused directly or indirectly to any walls, floors, ceilings, woodwork, brickwork, finishes, etc.
- 1.21 FIELD REVIEW

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- 1.21.1 The Consultants will make periodic visits to the Site during construction to ascertain reasonable conformity to plans and specifications. The Consultant is not responsible for quality control. Contractor shall maintain their own quality control and will be responsible for the execution of their work in conformity with the Contract Documents and with the requirements of authorities.
- 1.21.2 The Owner and Consultant shall have access to the Site at all times for periodic inspections. Maintain a complete set of contract documents on Site for field reference by the Consultant.
- 1.21.3 Provide all gauges, instruments, and other equipment necessary for field review by the Consultant.
- 1.21.4 Application for final review will be considered when the Work has been completed and written declarations submitted that all commissioning, adjustment, set up and documentation is complete. Final review shall be done when:
 - 1.21.4.1 All reported deficiencies have been corrected.
 - 1.21.4.2 All systems have been balanced, tested, commissioned and are operational.
 - 1.21.4.3 The Owner has been instructed in the operation and maintenance of all equipment.
 - 1.21.4.4 All reports have been submitted and reviewed.
 - 1.21.4.5 All instruction manuals have been submitted and reviewed.
 - 1.21.4.6 All tags and nameplates are in place and all data submitted and reviewed.
 - 1.21.4.7 Cleaning up is finished in all respects.
 - 1.21.4.8 All spare parts and replacement parts specified have been provided.
 - 1.21.4.9 All record drawings have been submitted and reviewed.
- 1.22 SERVICES TO EQUIPMENT SUPPLIED BY OTHERS
 - 1.22.1 Provide all necessary connections required for equipment supplied by the Owner and the work of other Divisions. Examine all the Drawings and Specifications and identify all requirements.

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- 1.22.2 Provide valves, unions, caps, and vibration isolation for all services.
- 1.22.3 The Contractor shall be responsible to verify, adjust and coordinate the type, size and location of mechanical services required for all equipment supplied by the Owner and the work of other Divisions.
- 1.23 PROVISION FOR FUTURE EQUIPMENT AND CONSTRUCTION
- 1.23.1 Spaces designated for future equipment or building expansion shall be left clear.
- 1.23.2 Provide services for future extensions complete with Products necessary for present termination and to permit future extension.
- 1.23.3 Identify each service by a permanent marker at its termination point.
- 1.24 CUTTING AND PATCHING
- 1.24.1 Inform all other Divisions in time, concerning required openings. Where this requirement is not met, bear the cost of all cutting and patching, including layout, x-rays, ferros scanning at premium time. Obtain the permission of the Consultant before doing any cutting.
- 1.24.2 Do all necessary cutting and patching of existing work. X-ray all proposed floor-opening locations prior to core drilling. Refer to Section 20 00 55 – Work in Existing Buildings.
- 1.24.3 Obtain the Consultant's approval before doing any cutting and patching. Any structural modifications must not affect structural, fire barrier or vapor barrier integrity.
- 1.24.4 Coordinate with Architectural Section 01 33 00 for all fire stopping requirements.
- 1.25 METALS
- 1.25.1 Metal construction required for the mechanical work and shown on the Structural Drawings will be carried out by Division 05 – Metals.
- 1.25.2 Provide all other metal work necessary for the mechanical work, such as, but not limited to, equipment bases, platforms, catwalks, supports, lintels, ladders, pit and trench covers. Have such work carried out in accordance with Division 05 – Metals.
- 1.25.3 Provide platforms and catwalks complete with safety rails, 6mm

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($\frac{1}{4}$ ") checkered plate or grating cover, suitable for minimum 750mm (30") wide. Provide removable sections where required for equipment removal.

- 1.25.4 Provide ladders using 13mm by 50mm ($\frac{1}{2}$ " by 2") steel bar stringers and 19mm ($\frac{3}{4}$ ") diameter steel bar rungs fastened through and welded to stringers at 300mm (12") on centers. Fabricate ladders 450mm (18") wide and locate 150mm (6") clear of wall face. Secure stringers at top and bottom and at minimum every 1.8m (6 ft) using welded steel brackets.

1.26 CONCRETE

- 1.26.1 Concrete work required for mechanical work and shown on the structural Drawings will be carried out by Division 03 – Concrete.

- 1.26.2 Provide all other concrete work specified but not shown on structural Drawings, necessary for the mechanical work including but not limited to inertia slabs, housekeeping pads, and pipe cradles. Have such work carried out in accordance with Division 03 – Concrete.

- 1.26.3 Ensure that the ultimate compressible strength after 28 Days shall not be less than:

- 1.26.4 13,790 kPa (2,000 psi) for pipe encasing and backfill or excessive excavations.

- 1.26.5 20,665 kPa (3,000 psi) for all other work.

1.27 EXCAVATION AND BACKFILLING

- 1.27.1 All excavation and backfilling required for the mechanical work will be done under Division 31 – Earthwork of the Specifications, except as noted below. Refer to soil report regarding the type of soil.

- 1.27.2 Ensure that bottom of pipe trench is graded as required.

- 1.27.3 In firm, undisturbed soil, excavation will be carried out under Division 31 – Earthwork, to within 150mm (6") of the bottom of pipes. Excavate under this Division to desired grade, lay pipes directly on the soil and shape soil to fit the lower $\frac{1}{3}$ segment of all pipes and pipe bells. Ensure even bearing along the barrels.

- 1.27.4 In rock and shale and where noted, excavation will be carried out under Division 31 – Earthwork, to 150mm (6") below and minimum

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200mm (8") to either side of the pipe. Fill back under this Division, a bedding of 9mm ($\frac{3}{8}$ ") crushed stone or granular 'A' gravel.

- 1.27.5 In unstable soil, in fill and in all cases where pipe bedding has been removed in earlier excavation, particularly near perimeter walls of building and at catch basins, excavation will be carried out to 200mm (8") below the pipe under Division 31 – Earthwork. Compact to maximum possible density under this Division of Work and support the pipe by a 200mm (8") thick concrete cradle spanning full length, between firm supports. Install reinforcing steel in cradle or construct piers at maximum 2400mm (8 ft) spacing. Provide a minimum of one pier per length of pipe, down to solid load bearing strata. Use same method where pipes cross. Do all excavation for such piers.
- 1.27.6 Provide support over at least the bottom $\frac{1}{3}$ segment of the pipe in all bedding methods.
- 1.27.7 Before backfilling, obtain approval from Consultant.
- 1.27.8 Backfill trenches within the building to a compacted level of 300mm (12") above the top of pipes with clean, sharp sand in individual layers, maximum 150mm (6") thick, hand compacted to a density of 95% Modified Proctor.
- 1.27.9 Backfill trenches outside the building to a compacted level of 300mm (12") above the top of the pipes with individual layers of material up to 150mm (6") thick, hand compacted to a density of 95% Modified Proctor, using Granular 'A' gravel.
- 1.27.10 Obtain written approval of all backfilling done under this Division from Consultant before work commences on additional backfilling under Division 31 – Earthwork.
- 1.28 **PAINTING**
- 1.28.1 Provide all exposed ferrous metal work and Products, except ductwork and piping, with at least one (1) factory prime coat or paint one prime coat on site. Clean up or wire brush all equipment before painting. Unless otherwise noted finish painting will be done under Division 09 – Finishes of these Specifications.
- 1.28.2 If not factory coated or galvanized, clean, wire brush and paint all ferrous supports and hangers concealed in ceiling spaces of kitchens or other similar high humidity areas.

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- 1.28.3 Repaint or refinish all damaged factory applied finishes.
- 1.28.4 Provide oil-base red oxide primer applied as per manufacturer's recommendations.

1.29 ABBREVIATIONS

- 1.29.1 Abbreviations with respect to government agencies, testing agencies, technical societies, approval agencies and technical terminologies are as listed below:

AGA	American Gas Association
AHRI	Air-Conditioning, Heating, and Refrigeration Institute
AMCA	Air Moving and Conditioning Association
ANSI	American National Standards Institute
API	American Petroleum Institute
ARI	Air Conditioning and Refrigeration Institute
ASHRAE	American Society of Heating, Refrigerating, and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASSE	American Society of Safety Engineers
ASTM	American Society for Testing and Materials
AWS	American Welding Society
AWWA	American Water Works Association
BAS	Building Automation System
BC	National or State (US) Building Codes
CGA	Canadian Gas Association
CRN	Canadian Registration Number
CSA	Canadian Standards Association
DDC	Direct Digital Control
ECM	Electronically Commutated Motor
EEMAC	Electrical Equipment Manufacturers Association of Canada

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FM	Factory Mutual
IAO	Insurers' Advisory Organization (CGI Information Systems and Management Consultants Inc.)
IEEE	Institute of Electrical and Electronics Engineers
ISTA	International Safe Transit Association
MERV	Minimum Efficiency Reporting Value
MICA	Midwest Insulation Contractors Association
MSS	Manufacturers Standardization Society of the Valve and Fittings Industry
NBC	National Building Code
NBFU	National Board of Fire Underwriters (currently American Insurance Association)
NC	Noise Criterion
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
NPT	National Pipe Thread
OBC	Ontario Building Code
OESC	Ontario Electrical Safety Code
OSHA	Occupational Safety and Health Administration
PID	Proportional–Integral–Derivative
PSC	Permanent-Split Capacitor
PWM	Pulse-Width Modulation
SCR	Silicon Controlled Rectifier
SMACNA	Sheet Metal and Air Conditioning Contractors National Association
TEMA	Tubular Exchanger Manufacturers Association
ULC/cUL	Underwriters' Laboratories of Canada
VAV	Variable Air Volume

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1.30 MANUFACTURER'S CERTIFICATION

1.30.1 Submit letters from the manufacturers of all equipment certifying that their technical representatives have inspected and tested their equipment, have approved the methods of installation and operation. Where existing systems are extended, provide letters covering both new and existing equipment and connections.

1.30.2 These letters shall state the names of persons present at the inspection and testing, methods used and a list of functions performed with location and room numbers where applicable.

1.30.3 Refer to the respective equipment sections for requirements for letters.

1.31 TRIAL USAGE

1.31.1 The Owner has the privilege of the trial usage of mechanical systems or parts thereof for the purpose of testing and learning the operational procedures.

1.31.2 Carry out the trial usage over a length of time as deemed reasonable by the Consultant, at no extra cost.

1.31.3 Carry out the operations only with the express knowledge and under supervision of the Contractor and/or appropriate Subcontractors who shall not waive any responsibility because of trial usage.

1.31.4 Trial usage shall not be construed as acceptance by the Owner.

1.32 INSTRUCTION TO OWNER

1.32.1 Instruct the Owner's representatives in all aspects of the operation of systems and equipment. Refer to requirements for demonstration in respective equipment sections.

1.32.2 Arrange for, and pay for services of service engineers and other manufacturer's representatives required for instruction on specialized portions of the installation.

1.32.3 Submit to the Consultant at the time of final inspection a complete list of systems stating for each system:

1.32.3.1 Date instructions were given to the Owner's staff.

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- 1.32.3.2 Duration of instruction.
- 1.32.3.3 Names of persons instructed.
- 1.32.3.4 Other parties present (manufacturer's representative, consultants, etc.).
- 1.32.3.5 Signatures of the Owner's staff stating that they properly understood the system installation, operation and maintenance requirements.
- 1.33 EARLY OCCUPANCY
 - 1.33.1 The Owner will negotiate with the Contractor to occupy portions of the building before the Work is complete. Sufficient advance notice will be given to allow scheduling of the mechanical work to meet the Owner's requirements.
 - 1.33.2 Notify the Contractor of any scheduling problems.
 - 1.33.3 Schedule the Work and set construction priorities to satisfy the Owner's requirements.
 - 1.33.4 Schedule the Work of this Division as follows:
 - 1.33.4.1 Relevant equipment is ready for start-up as defined in these Specification Sections.
 - 1.33.4.2 Systems are balanced.
 - 1.33.4.3 Safety controls are in place.
 - 1.33.4.4 Automatic temperature controls are operational.
 - 1.33.4.5 Primary equipment is tested and started-up.
 - 1.33.4.6 All filters are in place.
 - 1.33.5 The Owner will take over individual items of equipment used for Early Occupancy and the warranty period will start when:
 - 1.33.5.1 Conditions of start-up (Item 1.33.4) have been complied with.
 - 1.33.5.2 Air and fluid systems have been balanced.
 - 1.33.6 The Consultant will issue a list of deficiencies covering the individual items of equipment used for Early Occupancy at the time

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of takeover by the Owner.

- 1.33.7 Early Occupancy and the Owner's takeover of individual items of equipment does not relieve the Contractor of their responsibility to test, adjust, balance, commission and demonstrate the systems in accordance with the Contract Documents.

1.34 OPERATION AND MAINTENANCE MANUALS

- 1.34.1 Assemble three (3) manuals, each containing data sheets, brochures, operating, maintenance, recommended spare parts, and lubricating instructions and a complete set of reviewed shop drawings and bind in hard cover. Identify cover "Operation and Maintenance Manual for _____". Manuals shall be separated with dividers in logical sections and volumes.
- 1.34.2 Present one (1) copy for review by Consultant. Make all corrections requested by the Consultant and forward the corrected review copy plus a duplicate to the Owner with a copy of transmittal to Consultant for their records. Include the following information in each manual:
- 1.34.2.1 Refrigeration Equipment
- 1.34.2.1.1 Operating instructions detailing the procedures to be followed for:
- Charging
 - Start-up
 - Changeover from one season to another
 - Shutdown
 - Night operation
 - Maintenance instructions
- 1.34.2.1.2 Lubrication instruction for moving parts detailing type of lubricant to be used and the lubrication intervals in operation hours.
- 1.34.2.1.3 List of safety devices and instructions for their testing and adjusting.
- 1.34.2.1.4 Complete set of shop drawings showing:
- Control sequence with description of the sequences of operation.
 - Detailed layout and sections indicating all maintenance, cleaning and lubrication points.

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- 1.34.2.1.5 List of parts (bill of material) indicating the catalogue number and manufacturer, complete with drawings indicating the location of each part in the complete assembly.
- 1.34.2.1.6 Recommended chemical analysis of chilled water.
- 1.34.2.2 Heat Exchangers and Coils
- 1.34.2.2.1 Equipment layout (plans and section) giving all information on type of flanges, bolts, nuts, studs, tubes, etc.
- 1.34.2.2.2 Tube replacement instructions.
- 1.34.2.2.3 Cleaning instructions.
- 1.34.2.3 Pumps and Fans. Include for each different type and size:
- 1.34.2.3.1 Shop drawings indicating maintenance and lubrication points.
- 1.34.2.3.2 List of parts indicating the catalogue number and manufacturer, complete with drawings indicating the location of each part in the complete assembly.
- 1.34.2.3.3 Performance curves.
- 1.34.2.4 Valves and Fittings
- 1.34.2.4.1 Three (3) copies of framed valve charts for the project.
- 1.34.2.4.2 A list of valves as per the valve chart indicating size, type, catalogue number, make of each valve, strainer and steam trap.
- 1.34.2.5 Instrumentation and Control
- 1.34.2.5.1 Complete instrument list for all gauges, thermometers, gauge glasses and other instruments.
- 1.34.2.5.2 Sequence and description of operation for each control system.
- 1.34.2.5.3 Control diagram for each system complete with equipment summary giving system designation and catalogue number for each component.
- 1.34.2.5.4 Catalogue leaflet of each component used.
- 1.34.2.5.5 Applications programming information and programmer's manual.
- 1.34.2.5.6 Description of operating procedures, including required actions at

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each operator position, operation of computer peripherals, input and output formats and procedures, and emergency alarm and failure recovery procedures. Descriptions of system start-up, back-up equipment operation, and execution of all system functions and operating modes shall be provided.

- 1.34.2.5.7 Provide description of data communication, including data types and formats, data link components and interfaces, and operator test.
- 1.34.2.5.8 Instructions and schedules for inspections, cleaning, lubricating and calibration.
- 1.34.2.6 Other Equipment
 - 1.34.2.6.1 Description of start-up and activating procedures, and commissioning procedures, as well as follow-up instructions to the Owner's operating staff to slowly break-in unit.
 - 1.34.2.6.2 Maintenance instructions for all other equipment containing moving parts or requiring lubrication or chemical charging.
 - 1.34.2.6.3 Include instruction list of parts indicating catalogue number and manufacturer, complete with drawings indicating the location of each part in the complete assembly; performance curves.
 - 1.34.2.7 A list of all motors serving mechanical equipment. Include in the list:
 - 1.34.2.7.1 Location of motor.
 - 1.34.2.7.2 Name of unit served by motor.
 - 1.34.2.7.3 Motor serial number, manufacturer.
 - 1.34.2.7.4 Power rating, voltage, full load current, service factor and rpm of motor (nameplate data), rating and catalogue number of motor starter thermal overload relays.
 - 1.34.2.7.5 Serial number, rpm, airflow, manufacturer, static pressure (or head) of fan or pump.
 - 1.34.2.7.6 Quantity, sizes and V-belt number of belts.
 - 1.34.2.7.7 Sizes and types of drives used.
 - 1.34.2.7.8 Type of oil or grease lubrication of gearbox, lubrication interval in

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hours of operation.

1.34.2.7.9 Type of grease lubrication for driven equipment, lubrication interval in hours of operation.

1.34.2.8 A copy of the following:

1.34.2.8.1 All reviewed sprinkler layouts and hydraulic calculations.

1.34.2.8.2 Final NFPA certification letter. Certification letter shall contain contractor's contact information, the building permit number, certification statement in regard to NFPA compliance and be stamped by a licensed professional engineer.

1.34.2.8.3 Certificates from all equipment manufacturers, duct-cleaning agents, pipe-cleaning agents, chemical treatment agents and local authorities having jurisdiction.

1.34.2.8.4 All pipe and duct pressure test reports.

1.34.2.8.5 Warranties and letters of guarantee from contractors and equipment manufacturers.

1.34.2.8.6 Copies of permits, licenses and certificates.

1.34.2.8.7 Start-up and activation and commissioning procedures and check sheets.

1.35 WARRANTY

1.35.1 Refer to General Conditions of the Contract and Specimen Warranty Form.

1.35.2 Furnish all extended warranty for equipment as required in the Specifications.

END OF SECTION

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1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 – General Requirements shall apply to and govern this Section.

1.2 SHOP DRAWINGS

1.2.1 Provide Shop Drawings for:

1.2.1.1 Access doors and panels.

1.3 MATERIALS AND EQUIPMENT

1.3.1 Use only new materials and equipment of Manufacturer as specified or shown on the Drawings. Ensure that equipment and materials for similar applications are of the same Manufacturer.

1.3.2 If the Subcontractor wishes to substitute materials of Manufacturers other than those named, they shall state in their Tender the name and a complete description of the materials to be substituted, along with the amount of change in the Contract Price.

1.3.3 Ensure that materials not specified to a specific Manufacturer are of high commercial standard and quality.

2 **PRODUCTS**

2.1 ACCESS DOORS AND PANELS

2.1.1 In plaster, gypsum board, tiled or masonry walls for exposed flush installation, provide 203mm by 203mm (8" x 8") prime coated 16 ga. access door with 18 ga. mounting frame, continuous concealed hinge, and screwdriver operated stainless steel cam latch, similar to Acudor UF-5000.

2.1.2 In plaster or tiled walls for recessed installation, provide 305mm by 305mm (12" x 12") 16 ga. access door recessed by 25mm (1"). Door to be complete with 14 ga. mounting frame, concealed pivoting rod type hinge, and flush-to-surface screwdriver operated stainless steel cam latch, similar to Acudor AT-5020.

2.1.3 In gypsum board surfaces or in acoustic tiles for recessed installation in public areas, provide 305mm by 305mm (12" x 12") bauco-plus architectural access door with concealed hardware and gypsum board inlay. Standard features include cam latch flush

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with surface, aluminum frame and glass fibre-reinforced nylon hardware, fully hinged removable door panel and integrated safety catches, perimeter gasket installed onsite.

2.1.3.1 In areas not accessible by public, provide 305mm by 305mm (12" x 12") 16 ga. access door recessed by 25mm (1"). Door to be complete with 14 ga. mounting frame with drywall taping bead on all sides, concealed pivoting rod type hinge, and flush-to-surface screwdriver operated stainless steel cam latch, similar to Acudor DW-5015.

2.1.4 In fire rated walls, provide 305mm by 305mm (12" x 12") 16 ga. rated access door, ULC listed "B" label for 1-1/2 or 2 hours. Door to be complete with 16 ga. mounting frame, concealed hinge, spring closer, and knurled knob operated universal self-latching bolt, similar to Acudor FB-5060.

2.2 BEARINGS AND GEAR BOXES

2.2.1 Provide bearings suitable for application and environment, i.e., dust, corrosive atmospheres, high temperatures, etc. Bearings shall have a lifetime guarantee of not less than five (5) years.

3 **EXECUTION**

3.1 FLASHING

3.1.1 Provide galvanized or aluminum sleeves for piping through roof.

3.1.2 Ensure that the flashing suits roof and extends minimum 450mm (18") on all sides. Leave flashing as directed by the Contractor, to be built into roofing, rendering a watertight connection.

3.1.3 Provide counter flashing on diesel and boiler exhaust stacks, ducts, and pipes passing through roofs to fit over flashing or curb. Coordinate with the Subcontractor responsible for the roofing work of the Contractor.

3.1.4 Sleeve pipes through waterproof floors.

3.1.5 Pay special attention to the waterproofing conditions of basement walls and floors. Co-operate at all times with the water proofing trade and do not cut or destroy any waterproofing seal without the consent of the waterproofing trade. Provide piping sleeves passing through waterproof walls with asphalt roofing felt wrapped around to leave 25mm by 50mm (1" x 2") recess on both sides of the wall.

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These recesses and the space between pipe and sleeve shall be caulked by this Division in accordance with the requirements of Division 07 – Thermal and Moisture Protection.

3.2 BEARINGS AND GEAR BOXES

3.2.1 Run-in all bearings, gearboxes and fluid couplings for a period recommended by the manufacturer. Flush out, and refill with new charge of recommended lubricant.

3.2.2 Provide all necessary lubricating materials and labour for all operating equipment until acceptable for operation and care by the Owner.

3.2.3 Provide oil-lubricated bearings and sumps with level gauge, in easily accessible location. Provide grease-lubricated bearings, if not readily accessible, with extended nipples.

3.3 BELT DRIVES, SHEAVES AND GUARDS

3.3.1 Provide all belt-driven equipment with V-belt drive, designed for at least 130 percent of motor nameplate power rating, and in accordance with manufacturer's recommendations for type of service intended. Belt drives to be at least 95 percent efficient. Balance and properly align drives. Provide matched sets of belts for multiple belt assemblies. Select belts to suit starting torque for driver. Use single belt drives only for motors 1.5kW (2.0 HP) and smaller.

3.4 INSERTS, SLEEVES, ESCUTCHEONS AND CURBS

3.4.1 Use only factory made, threaded, or toggle type inserts as required for supports and anchors, properly sized for the load to be carried. Place inserts only in portions of the main structure and not in any finishing material.

3.4.2 Use factory made expansion shields where inserts cannot be placed, but only where permission is given by the Consultant.

3.4.3 Do not use powder-activated tools except with written permission from the Consultant.

3.4.4 Supply and locate inserts, holes, anchor bolts, and sleeves in time when walls, floors and roof are erected.

3.4.5 Sleeves shall be concentric with pipe and be a minimum of 50mm (2") larger than pipe size.

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- 3.4.6 Pass insulation unbroken where pipe or duct is insulated, except through fire rated walls and floors. Size sleeves to provide 13mm (½") clearance all around.
- 3.4.7 Use the following sleeving material for pipe sleeves:
 - 3.4.7.1 Through interior walls use Schedule 10 steel pipes, machine cut, flush with finished structure. Check room-finish schedules.
 - 3.4.7.2 Through exterior walls above grade use Schedule 10 steel pipes, machine cut, flush with finished structure inside and to suit flashing on outside.
 - 3.4.7.3 Through exterior walls below grade and other waterproof walls use extra heavy weight cast iron or PVC sleeves, machine cut. Check flashing details for further information.
 - 3.4.7.4 Through waterproof floors, through janitor's closets, mechanical rooms, compartment mechanical rooms, showers, kitchens, washrooms, and through roofs, use Schedule 40 sleeves, machine cut. As an alternative, copper DWV sleeves up to and including 150mm (6") sleeve size and rolled 32 ounce copper sleeves for larger than 150mm (6") sleeve size may be used. Extend sleeves 100mm (4") above finished floor upwards and cut flush with underside of floor. Refer to flashing details through waterproof floors.
 - 3.4.7.5 Through other interior floors use Schedule 10 steel pipes, machine cut, flush with finished structure on both sides. Check room-finish schedules for further information.
 - 3.4.7.6 Ensure that watertight concrete curbs, 100mm (4") high by 100mm (4") wide with 19mm (¾") chamfered edges, are furnished around pipes passing through waterproof floors except where furred in. Read Division 03 – Concrete for further information.
- 3.4.8 Pack spaces between the insulated pipe and the sleeve or where uninsulated, between the pipe and the sleeve, with ULC listed fire rated foam. Maintain vapour barrier on cold lines. Seal the annular space both sides as follows:
 - 3.4.8.1 For horizontal sleeves in exposed areas, use a seal equal to or better fire rated than the wall to be sealed. Use "Fire barrier" as distributed by Double A/D Distributors Ltd. (UL No. 4 U 18.7 approved).

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- 3.4.8.2 For horizontal concealed sleeves through firewalls and through walls separating areas of different air pressure, use a permanently resilient (silicone base or equal) sealing compound.
- 3.4.8.3 For vertical sleeves through roofs, janitor's closets, equipment rooms, and where required to provide fire rated separation, use permanently resilient (silicone base or equal) sealing compound, non-flammable and waterproof. Ensure that the seal is compatible with floor and ceiling finishes. Check the room-finish schedules for further information.
- 3.4.8.4 All fire stop materials and methods must be approved in accordance with CAN/ULC-S115-11, and be ULC listed.
- 3.4.8.5 Seal is not required for other sleeves.
- 3.4.9 Cover exposed floor and wall pipe sleeves in finished areas with satin finish chrome or nickel plated solid brass or with satin finish stainless steel escutcheons with non-ferrous set screws. Split cast plates of the screw locking type may be used. Do not use stamped steel friction type split plates.
- 3.4.10 Use the following sleeving for ducts:
 - 3.4.10.1 Unless otherwise noted, use minimum 1.3mm (18 gauge) galvanized steel sleeves.
 - 3.4.10.2 For rectangular duct openings through walls and floors provide a removable wood box-out of the required size.
 - 3.4.10.3 Through firewalls, build fire dampers into wall.
 - 3.4.10.4 Through floors where ducts are not furred in or enclosed in a duct-shaft, ensure the 100mm (4") high by 100mm (4") wide watertight concrete curbs are provided, with 19mm ($\frac{3}{4}$ ") chamfered edges all around. Extend sleeves where used, flush to top of curb. Read Division 03 – Concrete, for further information.
 - 3.4.10.5 Through floors where ducts are enclosed in a duct shaft or furred in, provide the watertight concrete curbs at the extreme top and bottom ends of the shaft only.
 - 3.4.10.6 Through roofs, provide curbs and sleeves as shown on the detail drawings and to suit flashing requirements.
- 3.4.11 After ducts are installed, pack the opening and seal both sides as follows:

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- 3.4.11.1 Use fiberglass insulation for packing, except through curbed concrete floors use "Fire barrier" as distributed by Double A/D Distributors Ltd. (UL No. 4 U 18.7 Approved).
- 3.4.11.2 Seal the packing in openings through floors with permanently resilient (Silicone base or equal) compound, non-flammable and waterproof. Press duct supports firmly into caulking before bolting down to curb.
- 3.4.11.3 Through all vertical walls seal the fibreglass packing using a permanently resilient (silicone base or equal) sealing compound.
- 3.4.11.4 All fire stop materials and methods must be approved in accordance with CAN/ULC-S115-11, and be ULC listed.
- 3.4.11.5 Seal is not required for other packings.
- 3.4.12 Brace duct sleeves and box-outs to retain their position and shape during the pouring of concrete and other work.
- 3.4.13 Provide bracing for each duct at every passing through structure to prevent sagging.
- 3.4.14 Cover exposed duct sleeves and openings in exposed areas only. Use 1.3mm (18 gauge) galvanized steel escutcheons in form of a duct collar. Over curbs extend the collar 25mm (1") down the side of the curb, similar to counter flashing. Fix collar in position with cadmium plated screws.
- 3.5 ACCESS DOORS AND PANELS
- 3.5.1 Install all concealed mechanical equipment requiring adjustment or maintenance in locations easily accessible through access panels or doors. Install systems and components to result in a minimum number of access panels. Indicate access panels on "As Built" drawings.
- 3.5.2 Provide the work of respective Division with panels, doors or the frames therefore; complete with all pertinent information for installation. Arrange with and deliver to the Subcontractor(s) in whose work they occur to install them. Ensure that access doors are installed in a manner to match the building material grids where applicable.
- 3.5.3 Prepare detailed and coordinated drawings showing location and type of all access doors. Submit these drawings to the Consultant

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to review.

3.5.4 Size all access doors to provide adequate access and commensurate with the type of structure and architectural finish, minimum size 150mm (6") by 150mm (6). Should it be necessary for persons to enter, provide a minimum 600mm (24") by 450mm (18") size doors.

3.5.5 Ensure proper fire rating of access doors in fire separations, fire-rated walls and ceilings.

3.5.6 Lay-in type tiles, properly marked, may serve as access panels.

3.6 DRIP PANS

3.6.1 Construct drip pans of min. 1.0mm (20 gauge) galvanized steel sheet with sealed connections. Provide drain lines from drip pans to nearest hub drain, funnel floor drain, janitor's sink or appropriate approved location.

3.6.2 Provide drip pans at the following locations:

3.6.2.1 Beneath all pipes passing through electrical, battery, UPS, elevator machine, diesel generator, and telephone rooms, over horizontal runs of bus ducts, and in locations as indicated on the Drawings.

3.7 WORKMANSHIP

3.7.1 Install ducts and pipes parallel and perpendicular to the building planes and concealed in chases, behind furring or above ceiling, except in unfinished areas. Install all exposed systems neatly and group together, to present a neat appearance.

3.7.2 Install all equipment and apparatus requiring maintenance, adjustment, or replacement with sufficient clearance for servicing.

END OF SECTION

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1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 – General Requirements, shall apply to and govern this section.

1.2 CO-ORDINATION BETWEEN NEW AND EXISTING INSTALLATIONS

1.2.1 Check and co-ordinate all systems in the new building addition which are extended to or from existing systems to ensure their proper operation.

1.2.2 Provide interfacing components between new and existing systems as necessary for proper performance and operation.

1.3 PENETRATIONS IN EXISTING STRUCTURE

1.3.1 Do all cutting and core drilling for the Work of this Division. Obtain Consultant's approval before proceeding.

1.3.2 Provide sleeves and follow Consultant's instructions where necessary to completely penetrate existing floors, walls, ceiling, roof or structural members.

1.3.3 X-ray all proposed penetrations of concrete slabs to locate hidden services before penetrating existing structure. Advise Consultant of any interference.

1.3.4 Do all necessary patching and repairing. Maintain integrity of fire ratings.

1.3.5 Flash all parts passing through or built into a roof, outside wall or waterproof floor.

1.3.6 If any fire proofing material or insulation on building structure is damaged where mechanical equipment has been removed or added, Contractor to repair at this Division's expense.

1.4 USE OF EXISTING MATERIAL AND EQUIPMENT

1.4.1 Test existing equipment, which is to remain in areas being renovated for proper operation. Identify required repairs in written report to Consultant.

1.4.2 Clean, test for proper operation and repair existing equipment to be

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relocated before being put back into service. Identify required repairs in written report to Consultant.

1.4.3 Repair or replace, without adjustment to the Contract price, all existing equipment, which is damaged in process of relocation.

1.4.4 Unless noted otherwise provide additional equipment of the same type and manufacturer where required to supplement existing equipment.

1.4.5 Review existing equipment on site to determine operating conditions prior to Tender.

1.5 SALVAGE MATERIALS

1.5.1 Remove from the site all materials in renovated areas of the existing building which are not to remain or be reused, unless noted as remaining the property of the Owner.

1.6 EXISTING SERVICES

1.6.1 Disconnect and remove all existing products, which are abandoned.

1.6.2 Remove all piping, which is abandoned except inaccessible piping in furred-in space. Cut and cap piping below finished surfaces.

1.6.3 Plug and cap all abandoned drain and vent points in systems, which are being reused. Plug and cap to the approval of the local authorities.

1.6.4 Allow for all work necessary to complete the alterations, rerouting and/or repositioning of existing services and equipment, and all interconnections of new and existing systems.

1.6.5 Verify the location and size of all existing services before proceeding with the work.

1.6.6 Maintain heating and cooling in the building as required to protect the building and equipment or to provide comfort conditions for the occupants.

1.6.7 Keep all sprinkler, standpipe and other fire and life safety protection systems in operation at all time.

1.7 INTERRUPTION OF SERVICES

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- 1.7.1 Co-ordinate all work with the use of the building by the Owner.
- 1.7.2 Maintain all mechanical services to all parts of the building which are in use. Provide temporary services as necessary.
- 1.7.3 Obtain Owner's written approval before interrupting any service.
- 1.7.4 Request permission to interrupt services in writing not less than two (2) weeks in advance and state time(s) and duration(s) of interruptions.
- 1.8 PREMIUM TIME
- 1.8.1 Include cost of premium time in Tender Price for work during nights, weekends or other time outside normal working hours necessary to maintain all mechanical services in operation.
- 1.9 FIRE PROTECTION
- 1.9.1 Maintain fire protection at all times in accordance with governing authorities' rules and regulations.

END OF SECTION

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Section Name: **Electric Motors**
Section No.: **20 05 13**
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1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 – General Requirements, shall apply to and govern this Section.

2 **PRODUCTS**

2.1 MOTORS

2.1.1 Supply and install all motors for Mechanical Equipment.

2.1.2 All motors shall be 60 cycle, 1750 rpm, except where noted otherwise.

0.37kW (1/2 HP) and smaller: 120V, 1 Ph, 60 Hz.

0.56kW (3/4 HP) and larger: 575V, 3 Ph, 60 Hz.

2.1.3 Motors shall be squirrel-cage induction motors, built to CEMA and NEMA motor and generator standards. 2-speed motors shall be single winding variable torque.

2.1.4 The minimum requirement for three phase motors shall be CEMA Design B; Class B insulated for maximum 40°C (104°F) ambient.

2.1.5 Single-phase motors shall be capacitor types, for minimum 10 starts per hour.

2.1.6 Motors 44.7kW (60 HP) and over shall be with inherent overheat protection, consisting of thermistors embedded in each phase of the stator winding and wired to the motor conduit box.

2.1.7 Select motors for quiet, continuous operation to suit loads, which may be imposed by equipment. Recognize that motor powers specified and scheduled are minimum sizes. If larger motors are required, ensure that extra costs of larger motors, starters, power wiring, and additional control wiring are included in the work.

2.1.8 All motor 0.75kW (1 HP) to 373kW (500 HP), unless otherwise specified, shall be T-frame AC three phase, and equal or exceed the motor efficiency levels as tested to CSA-C390-M or the nominal efficiency noted in Tables 10.4.1.A.(a) or 10.4.1.A.(b) of SB-10 of the OBC (premium efficiency/energy efficient), whichever is the highest. Motors to be approved under Canadian Electrical Safety Code.

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- 2.1.9 Motor enclosures shall be as follows:
- 2.1.9.1 If protected from the weather and entraining moisture, use open drip-proof, service factor 1.15.
- 2.1.9.2 Motors located in air streams shall be selected to operate satisfactorily at maximum temperature and moisture levels of surrounding air. Use drip-proof motors with encapsulated windings and weatherproof terminal box.
- 2.1.9.3 For all other locations, use totally enclosed fan-cooled, service factor 1.0.
- 2.1.9.4 Use explosion-proof motors where scheduled.
- 2.1.10 All motors shall be fitted with sealed for life bearing requiring no periodic lubrication.
- 2.1.11 Submit an accurate schedule of all motors. Include for each motor, the motor capacity, speed, nameplate current, equipment served, location, electrical characteristics, and identification number.
- 2.1.12 Provide each motor with a terminal box sized to accommodate the conductors connected thereto. Locate the terminal box to face the outside of the equipment assembly.
- 2.1.13 Provide EEMAC adjustable sliding bases for motors used with belt drives.
- 2.1.14 All motors driven by Variable Frequency Drives (VFD's) shall be NEMA31 design, have class F insulation, and be rated for inverter duty. Refer to Section 20 09 49 – Variable Frequency Drives.

3 **EXECUTION**

Not Used.

END OF SECTION

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1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 - General Requirements, shall apply to and govern this Section.

1.2 SCOPE OF WORK

1.2.1 Division 26 - Electrical will do all line side power wiring for equipment provided by Division 21 – Fire Suppression, Division 22 – Plumbing, Division 23 – HVAC and Division 25 – Integrated Automation, up to the respective starter, motor control center, control panel, disconnect or VFD, also provided under Divisions 21, 22, 23 and 25. Load side power wiring shall be under Divisions 21, 22, 23 and 25.

1.2.2 Divisions 21, 22, 23 and 25 shall provide all disconnect switches for mechanical equipment as required by code. Provide weatherproof switches for all outdoor locations.

1.2.3 Field control wiring of local safeties and interlocks for packaged equipment shall be provided under the respective Sections unless otherwise specified.

1.2.4 Conduit and wiring materials and methods shall be in strict accordance with the requirements of Division 26 - Electrical.

1.2.5 Check all wiring diagrams and control diagrams submitted in shop drawing form. Before submitting these shop drawings to the Consultant, submit these drawings to Division 26 - Electrical Contractor for approval. Have these drawings stamped by Division 26 - Electrical Contractor as verification of their approval before forwarding to the Consultant. Co-operate in the commissioning of all electrically driven equipment with Division 26 - Electrical.

2 **PRODUCTS**

2.1 GENERAL

2.1.1 Conduit and wiring materials and methods shall be in strict accordance with the requirements of Division 26 - Electrical.

3 **EXECUTION**

3.1 GENERAL

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3.1.1 Refer to Division 26 - Electrical.

END OF SECTION

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Project No.: 2021-0245
Section Name: **Meters and Gauges**
Section No.: **20 05 19**
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Project No.: 2021-0245
Section Name: **Meters and Gauges**
Section No.: **20 05 19**
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1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 - General Requirements, shall apply to and govern this Section.

1.2 SCOPE OF WORK

1.2.1 Provide all labour, materials, tools, equipment, training, and certification required to complete the work as shown on the Drawings and specified in this Section, including:

1.2.1.1 Temperature gauges

1.2.1.2 Pressure gauges

1.3 SHOP DRAWINGS

1.3.1 Submit Shop Drawings for the following equipment:

1.3.1.1 Temperature gauges

1.3.1.2 Pressure gauges

2 **PRODUCTS**

2.1 TEMPERATURE GAUGES

2.1.1 Provide thermometers of 229mm (9") straight shank, immersion type, with red liquid fill and adjustable pivot, installed complete with non-ferrous separable well. Provide 150mm (6") long extension neck socket for insulated pipes. Thermometers with plastic case are not acceptable.

2.1.2 Select all thermometers to suit the expected range of temperatures of the medium and ensure that normal working temperature occurs approximately at mid scale.

2.2 GAUGE GLASSES

2.2.1 Provide gauge glasses on all liquid reservoirs, normally not completely filled.

2.2.2 Provide fail-safe type gauge glasses with shut off valve, ball check, flushing facilities, and white enamelled brass backplates, suitable for the intended service.

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2.2.3 Provide gauge glasses complete with tri cocks. Extend tank gauge glasses the full tank height, if necessary through use of multiple gauge glasses in staggered arrangement.

2.3 PRESSURE GAUGES

2.3.1 Provide pressure gauges of the Bourdon type, minimum one percent accuracy through the entire range, complete with bronze Bourdon tube, brass socket, brass rotary movement, bronze bushings, tube and movement independently mounted from case, stainless steel case and ring, inherent shock protection. Furnish gauges having 114mm (4-½") dial, black graduations, black case, silver brazed joints, and adjustable black pointer.

2.3.2 Select gauges to suit fluid working pressure and, if possible, test pressure. If test pressure falls outside safe instrument range, attach a note to this effect on the installation instructions. Ensure that the normal working pressure occurs approximately at mid scale.

2.3.3 Install each gauge complete with DN6 (1/8") or DN8 (1/4") bar stock valve, rated 150°C (300°F) and 6,895 kPa (1,000 psi). Provide pressure snubber on all pump services and coil syphon for steam, air, gas service. Install pressure gauges as noted.

2.3.4 Provide a valved and capped gauge connection at inlet and discharge of all coils and tube bundles in heat exchangers.

2.3.5 Submit a schedule in shop drawing form showing service, location, range, make, and catalogue number for gauges.

3 **EXECUTION**

3.1 PRESSURE GAUGES

3.1.1 Install pressure gauges in the following locations and where shown or specified in the Contract Documents.

3.1.1.1 Suction and discharge of all pumps.

3.1.1.2 High and low sides of all pressure reducing or regulating stations (water, steam, air).

3.1.1.3 Where shown

3.1.2 Provide valved and capped gauge connection at:

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- 3.1.2.1 Entering and leaving side of heat exchangers.
- 3.1.2.2 Entering and leaving side of heating water coils in air supply units.
- 3.1.2.3 Supply and return lines of condenser, chilled, and heating water systems at each branch.
- 3.1.2.4 Where shown.
- 3.2 THERMOMETERS
- 3.2.1 Thermometers to be installed with thermal paste to ensure accurate reading.
- 3.2.2 Install thermometers in the following locations and where shown or specified:
 - 3.2.2.1 Entering and leaving sides of all condenser, chilled, and hot water coils in air supply units.
 - 3.2.2.2 Return lines of main branches of heating, chilled, and condenser water systems.
 - 3.2.2.3 Entering and leaving sides of mixing valves.
 - 3.2.2.4 Supply and return lines at hot water boilers.
 - 3.2.2.5 Supply and return lines on primary heating water loops.
 - 3.2.2.6 Entering and leaving lines of heat exchangers.
 - 3.2.2.7 Where shown in the Contract Documents.

END OF SECTION

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Section Name: **Bases, Hangers and Supports**
Section No.: **20 05 29**
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1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 - General Requirements, shall apply to and govern this Section.

1.2 SHOP DRAWINGS

1.2.1 Provide Shop Drawings for:

1.2.1.1 Hangers and supports

2 **PRODUCTS**

2.1 PIPE ATTACHMENTS

2.1.1 For pipe attachments, review Specification Section 20 07 00 - Mechanical Insulation. Otherwise, adhere to the following:

2.1.1.1 For uninsulated fire servicing piping – ULC and FM approved -, use Taylor Fig. 41 swivel ring hanger.

2.1.1.2 For uninsulated steel pipes, use Taylor Fig. 22Z adjustable clevis up to and including 100mm (4") pipe size, and Taylor Fig. 24 adjustable clevis for sizes 125mm (5") and larger.

2.1.1.3 For uninsulated copper pipes, use Taylor Fig. 52 epoxy coated copper-gard clevis hanger up to and including 100mm (4") pipe size.

2.1.1.4 For uninsulated copper tubing, use Taylor Fig. 42 epoxy coated copper-gard swivel ring hanger up to and including 25mm (1") pipe size.

2.1.1.5 For insulated pipes where the insulation is around the hanger and continuous vapour barrier is not required, use the same hangers as for uninsulated pipes.

2.1.1.6 For insulated pipes where hanger is around insulation, provide galvanized sheet metal insulation shield minimum 250mm (10") long, 1.3mm (18 gauge), between covering and Taylor Fig. 22Z or Fig. 24 clevis, or Taylor Fig. 24L extended clevis, sized to include insulation.

2.2 UPPER ATTACHMENTS

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- 2.2.1 Provide upper attachments as follows:
 - 2.2.1.1 Standard beam clamp for normal service, Taylor Fig. 425.
 - 2.2.1.2 Top beam clamp Taylor Fig. 407.
 - 2.2.1.3 C clamp with locknut, Taylor Fig. 301.
 - 2.2.1.4 Side beam bracket for light duty side mounting, Taylor Fig. 120.

2.3 PIPE SUPPORT

- 2.3.1 For vertical adjustment of hanger rods, provide Taylor Fig. 68 forged steel turnbuckle.
- 2.3.2 Where trapeze hanger is used for a group of pipes, use Taylor Fig. 14 U bolts, except where roller type hanger is indicated on the drawings or in the specifications.
- 2.3.3 For roller type hangers on both hot and cold pipes, provide Taylor Fig. 70 to 75 protection saddles to suit covering thickness. Use Taylor Fig. 93 adjustable roller hanger for pipe sizes up to and including 150mm (6") over insulation. For pipes 200mm (8") and larger over insulation, use Taylor Fig. 95 adjustable 2-rod roller hanger. On trapeze hangers and where pipe is supported from below, use Taylor Fig. 280S adjustable pipe roller stand.
- 2.3.4 For vertical pipe support, provide Taylor Fig. 82Z zinc plated steel riser clamp for steel pipe, and Taylor Fig. 85 epoxy coated copper-gard riser clamp for copper pipe.
- 2.3.5 For guides on vertical pipes, use manufactured pipe alignment guides (e.g. Flexonics). For horizontal pipes, use Taylor Fig. 255 pipe alignment guide. Field fabricated guides with rolled T-section welded to the pipe and guiding shoe, are also acceptable.

3 **EXECUTION**

3.1 GENERAL

- 3.1.1 Provide supports required for the erection and support of the mechanical work. Construct supports of steel, masonry or concrete, as noted or required. Ensure that steel supports in contact with water or high humidity are galvanized members bolted together using cadmium plated bolts, all others primed steel.
- 3.1.2 Ensure that housekeeping pads or concrete bases are provided for

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floor mounted equipment. Make the minimum size, 100mm (4") high for bases or pads, keyed to the floor slab, extending at least 100mm (4") all around the equipment, with 19mm (¾) chamfered edges. Where concrete is provided by Division 03 – Concrete, provide all anchor bolts and setting templates to Division 03 – Concrete.

- 3.1.3 Support suspended equipment from the bottom. Support tanks and other equipment with cast or welded steel saddles having proper curvature and inherent beam strength. Support plenums and sheet metal type air-handling units from auxiliary frames or beams under equipment. Support fans from structural steel frames with steel base plate. Read Division 05 – Metals, for further information.
- 3.1.4 Provide supports and suspended bases having ample strength to safely carry the load under all operating conditions and during testing. Submit support and base details to the Consultant for review. Design supports except springs with a minimum factor of safety of five (5) based on ultimate tensile strength at operating temperature.
- 3.1.5 Ensure that the load onto structures does not exceed the maximum loading as shown on structural drawings or as directed by the Consultant.
- 3.1.6 Take special care in locating hangers and supports to avoid introduction of undue reaction forces onto the structure of the building, to flanges of pumps and equipment, to expansion joints and to the pipe.
- 3.1.7 Install all piping supported from hangers or supports in a manner to ensure that building construction is not weakened or over-stressed, that pipes are secure, vibration free, free to expand and contract and properly graded, and that vertical adjustment of horizontal piping is possible after erection.
- 3.2 HANGERS
 - 3.2.1 For structure attachments, adhere to the following:
 - 3.2.1.1 Support hangers directly from the structure only. Do not support pipes or equipment from other pipes, ducts, equipment, suspended ceiling, etc.
 - 3.2.1.2 Suspend hanger rods generally from certified inserts in concrete or

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by beam clamps. Before welding to steel structure members obtain prior permission of welding method from the Consultant and ensure that loads do not exceed the limit set by the Consultant. Ensure that hanging from floors and roofs made from pre-cast concrete members is from inserts originally cast into the members and provided by this contractor, or by rods passing between the members connected to a steel plate resting on the upper surface.

- 3.2.2 Sliding guides must have sliding surfaces cleaned of all dirt, paint or corrosion and, except for Teflon, have coating of graphite paste added during erection. Adjust guides to allow for free sliding at operating conditions. After assembly, provide these guides with temporary protective cover or wrapping added to keep them free of debris during extent of construction work. When piping is ready to be put into service, remove this protective covering, blow out guides clean of all debris and add paste where applicable. Care must be taken that ample clearance is provided so as not to obstruct free sliding of guide.
- 3.2.3 Install copper, brass, and stainless steel pipes with 3mm ($\frac{1}{8}$ ") thickness of di-electric packing between the pipe and the pipe attachment or use Taylor plastic coated pipe attachments.
- 3.2.4 Install guides on pipes with expansion movement next to expansion joints. Consult expansion joint manufacturer's recommendations and follow their instructions for number and spacing of guides. Use a minimum of two guides on each side of expansion joints.
- 3.2.5 Set hanger rods on steel and copper lines with expansion movement out of plumb in ambient temperature position, a distance equal to one-half pipe movement calculated from anchor point. Base movement on 25mm (1") expansion per 30m (100 ft) of pipe length and 37°C (67°F) temperature difference. Use toggle type insert of beam clamp for such locations.
- 3.2.6 Use roller type hanger only where shown on the drawings.
- 3.2.7 Install all hangers close to points where pipes change direction or where branch piping drops or rises from main.
- 3.2.8 Install vertical riser suitably anchored and guided with manufactured or fabricated guides to maintain accurate vertical position. Protect insulated pipes with 2.2mm (12 gauge) galvanized steel jacket at guides. Guide pipes with expansion movement and definite anchor points up to and including 100mm

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(4") sizes, at every floor or 3m (10 ft). Guide larger pipes and vertical cast iron pipes at every second floor or 7.5m (25 ft).

- 3.2.9 For horizontal cast iron, glass, or polypropylene pipes where packed or friction type mechanical joints are used, provide a support at every joint in straight runs with maximum 1.5m (5 ft) between supports. Where fittings are joined together (elbows, wyes, etc.) provide a separate support for a minimum of every second fitting.
- 3.2.10 For horizontal cast iron, pipes where screwed or bolted type joints are used, the spacing or supports may be increased not to exceed 2.4m (8 ft) between supports, but provide a support for every joint and every second fitting as described above.
- 3.2.11 Use lockwasher with single nut on all bolted connections for pipe supports, anchors, guides and support steel, or use double nuts.
- 3.2.12 During hydrostatic test on all air and vapour piping supported by springs or counterweights, install temporary rigid supports, blocking, etc., or lock the spring against movement to prevent excessive strain on piping or equipment.
- 3.2.13 Use spring hangers where vertical movement of the horizontal pipes may occur due to expansion or contraction. Refer to Sections 20 05 16 – Expansion Compensation and 20 05 48 – Vibration Isolation, for further information.
- 3.2.14 For rod hangers use round steel threaded rod supports on horizontal pipes, spaced at the following maximum intervals and having the minimum diameter as directed.
- 3.2.14.1 For Steel Pipes:

Pipe Diameter mm (in)	Horizontal Spacing of Supports mm (ft)	Single Rod Diameter mm (in)	Double Rod Diameter mm (in)
DN15 (½)	1,524 (5)	9 (¾)	9 (¾)
DN20 (¾)	1,829 (6)	9 (¾)	9 (¾)
DN25 (1)	2,134 (7)	9 (¾)	9 (¾)

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Pipe Diameter mm (in)	Horizontal Spacing of Supports mm (ft)	Single Rod Diameter mm (in)	Double Rod Diameter mm (in)
DN32 (1-¼)	2,438 (8)	9 (¾)	9 (¾)
DN40 (1-½)	2,743 (9)	9 (¾)	9 (¾)
DN50 (2)	3,048 (10)	9 (¾)	9 (¾)
DN65 (2-½)	3,048 (10)	13 (½)	9 (¾)
DN80 (3)	3,658 (12)	13 (½)	9 (¾)
DN100 (4)	4,268 (14)	16 (⅝)	13 (½)
DN125 (5)	4,877 (16)	16 (⅝)	13 (½)
DN150 (6)	5,182 (17)	19 (¾)	16 (⅝)
DN200 (8)	5,791 (19)	22 (⅞)	19 (¾)
DN250 (10)	6,706 (22)	22 (⅞)	19 (¾)
DN300 (12)	7,010 (23)	22 (⅞)	19 (¾)
DN375 (15) and over	max. 7,620 (25)	to suit weight	to suit weight

3.2.14.2 For Copper or Stainless Steel Tubing:

Pipe Diameter mm (in)	Horizontal Spacing of Supports mm (ft)	Single Rod Diameter mm (in)	Double Rod Diameter mm (in)
DN15 (½)	1,524 (5)	9 (¾)	9 (¾)
DN20 (¾)	1,829 (6)	9 (¾)	9 (¾)
DN25 (1)	1,829 (6)	9 (¾)	9 (¾)
DN32 (1-¼)	2,134 (7)	9 (¾)	9 (¾)
DN40 (1-½)	2,438 (8)	9 (¾)	9 (¾)
DN50 (2)	2,743 (9)	9 (¾)	9 (¾)

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Pipe Diameter mm (in)	Horizontal Spacing of Supports mm (ft)	Single Rod Diameter mm (in)	Double Rod Diameter mm (in)
DN65 (2-½)	3,048 (10)	13 (½)	9 (¾)
DN80 (3)	3,048 (10)	13 (½)	9 (¾)
DN100 (4)	3,658 (12)	16 (⅝)	13 (½)

- 3.2.15 Do not use pipe hooks, chains, or perforated straps.
- 3.2.16 Use angle or channel iron welded frames for trapeze hangers.
- 3.2.17 For all drain pipe installed under structural slab on disturbed soil (up fill), suspend piping via galvanized clevis hangers embedded in structural slab. Hanger spacing shall be per pipe manufacturer recommendations, with minimum of two (2) hangers per pipe length.
- 3.3 **ANCHORS**
- 3.3.1 Design pipe anchors to restrain the movement of pipes in all directions.
- 3.3.2 Take special care in locating anchors to avoid introduction of undue reaction forces into the structure of the building, to flanges of pumps and equipment, to expansion joints and to the pipe.
- 3.3.3 Fabricate anchors and guides of structural steel channels, angles or plates secured to building structure. Size cylindrical type guides for full pipe insulation.
- 3.3.4 Submit for review by the Consultant prior to installation, a detailed design prepared in conjunction with the expansion joint manufacturer for anchors, guides, and their proposed connection to the structure, including reaction forces and loads imposed on structure. All Drawings must be signed by a Professional Engineer registered in the Province of Ontario. Do not proceed with installation until after receipt of reviewed drawings.
- 3.4 **DUCT SUPPORT**
- 3.4.1 Provide all foundations and supports required for the proper

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erection of the ductwork. Use concrete, masonry, and steel as specified, shown or required. Provide lightweight concrete fill around buried ductwork.

- 3.4.2 Co-operate with Division 03 – Concrete and Division 05 – Metals, and co-ordinate the work under this Division with those Divisions to ensure that opening required in floors, walls and partitions for the ducts are provided in the exact location required.
- 3.4.3 Where possible, use beam clamps, pre-set sleeves, and inserts for attachment to or passage through work under other Divisions. Do not weld to or cut into the work of other Specification Sections unless with the special permission of the Consultant.
- 3.4.4 Where vibration mountings are required, make necessary provisions in accordance with the recommendations of the equipment manufacturer. Refer to Sections 20 05 16 – Expansion Compensation and 20 05 48 – Vibration Isolation, for further information.
- 3.4.5 Install ducts securely supported from hangers or supports, in a manner to ensure that building construction is not weakened or over-stressed, that ducts are secure, free of vibration, free to expand and contract and properly graded.
- 3.4.6 Bolt steel frames to galvanized steel ducts. Rivet aluminum frames to aluminum ducts. Bolt steel frames to soldered lugs on copper ducts. Use di-electric gaskets. Bolt steel frames to welded lugs on stainless steel ducts.
- 3.4.7 Extend angles 50mm (2") to either side of ducts. For non-ferrous ducts, use di-electric gasket between duct and support. For additional stainless steel ducts use supports not directly attached to the duct. For watertight ducts, use supports not attached to the duct.
- 3.4.8 Support vertical ducts as follows:
 - 3.4.8.1 Support vertical ducts in duct shafts at the top and the bottom of the shafts and at every floor in between. Supply auxiliary steel structural steel, sized as required.
 - 3.4.8.2 Support other vertical ducts at the passage through every floor.
- 3.4.9 Support round and oval ducts using a 38mm by 3mm (1-1/2" x 1/8") split ring bolted at each end, extending minimum 75mm (3") on

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each side.

3.4.10 Support rectangular ducts using a bolted or tack welded frame on 38mm by 38mm by 3mm (1-½" x 1-½" x 1/8") angle steel.

3.4.11 In T-bar ceilings, attach diffusers connected to flexible duct directly to the ceiling suspension system main runners. Use this method for diffusers or mechanical items weighing less than 9 kg (20 lbs.). Support diffusers or equipment weighing more than 9 kg (20 lbs.) directly from the roof or floor.

3.5 EQUIPMENT SUPPORT

3.5.1 Place all suspended equipment on welded steel bases of up to 150mm (6") profile steel, stiffened with 3mm (1/8") checkered steel plate. Co-ordinate with Division 05 – Metals.

3.5.2 Place floor plates on 100mm (4") concrete housekeeping pads. Ensure that the load on the structure does not exceed 488 kg per square meter (100 lbs. per square feet) projected floor area within the perimeter of the supports.

END OF SECTION

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1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 - General Requirements, shall apply to and govern this Section.

1.2 SCOPE OF WORK

1.2.1 Provide all labour, materials, tools equipment, training commissioning and certification required to complete the work as shown on the Drawings and specified in this Section, including:

1.2.1.1 All necessary vibration isolation elements for piping and equipment, and vibration isolation bases for equipment to prevent noise levels from exceeding the room criteria listed in Table 1, Chapter 48 of the ASHRAE 2011 HVAC Applications Handbook.

1.2.2 Manufacturer of vibration isolation equipment shall have the following responsibilities:

1.2.2.1 Determine vibration isolation sizes and locations.

1.2.2.2 Provide piping and equipment isolation systems as scheduled or specified in the Contract Documents.

1.2.2.3 Guarantee specified isolation system deflection.

1.2.2.4 Provide installation instructions, drawings, and field supervision to assure proper installation and performance.

1.2.3 In addition to the work of this Section, comply with description of individual systems and general requirements of all other Specification Sections of this Division.

1.3 SUBMITTALS

1.3.1 The Contractor shall supply to the manufacturer approved drawings of all equipment to be isolated.

1.3.2 The manufacturer shall supply shop drawings of all vibration control components to be used on the project.

1.3.3 As a minimum provide the following information:

1.3.3.1 Catalogue cuts and data sheets on specific vibration isolators to be utilized showing compliance with the specifications.

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- 1.3.3.2 An itemized list showing the items of equipment or piping to be isolated, the isolator type of model number selected, isolator loading and deflection, and reference to specific drawings showing base and construction where applicable.
- 1.3.3.3 Grooved joint couplings and fittings shall be shown on drawings and product submittals, and shall be specifically identified with the applicable style or series designation.
- 1.3.3.4 Written approval of the base design to be used, obtained from the equipment manufacturer.
- 1.3.3.5 Drawings showing equipment base constructions for each machine, including dimensions, structural member sizes and support point locations.
- 1.3.3.6 Drawings showing methods for isolation of pipes and ductwork piercing walls and slabs.
- 1.3.4 Submit letter from manufacturer certifying that vibration isolation equipment have been installed in accordance with their recommendations and the Contract Documents, and that it operates to their satisfaction.
- 1.4 QUALITY ASSURANCE
- 1.4.1 It is the objective of this Specification Section to provide the necessary design for the control of excessive noise and vibration in the Building due to the operation of machinery or equipment, and/or due to interconnected piping, ductwork, or conduit. The installation of all vibration isolation units, and associated hangers and bases, shall be under the direct supervision of the vibration isolation manufacturer's representative.
- 1.4.2 All vibration isolators shall have either known undeflected heights or calibration markings so that, after adjustment, when carrying their load, the deflection under load can be verified, thus determining that the load is within the proper range of the device and that the correct degree of vibration isolation is being provided according to the design.
- 1.4.3 All isolators shall operate in the linear portion of their load versus deflection curve. Load versus deflection curves shall be furnished by the manufacturer and must be linear over a deflection range of not less than 50% above the design deflection.

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- 1.4.4 The theoretical vertical natural frequency for each support point, based upon load per isolator and isolator stiffness, shall not differ from the design objectives for the equipment as a whole by more than "10%.
- 1.4.5 All neoprene mountings shall have a Shore hardness of 30 to 60 "5, after minimum aging of 20 days or corresponding oven-aging.
- 1.4.6 All grooved joint couplings and specialties shall be the products of a single manufacturer.

2 **PRODUCTS**

2.1 GENERAL

- 2.1.1 All vibration isolation devices shall be the product of a single manufacturer.

2.2 TYPE A SPRING ISOLATORS

- 2.2.1 Spring isolators shall be free standing and laterally stable without any housing and complete with a molded neoprene cup or 6mm (1/4") neoprene acoustical friction pad between the baseplate and the support. All mountings shall have leveling bolts that must be rigidly bolted to the equipment. Installed and operating heights shall be equal. The ratio of the spring diameter divided by the compressed spring height shall be no less than 0.8. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection.
- 2.2.2 Corrosion resistance where exposed to corrosive/outdoor environment shall be with:
 - 2.2.2.1 Springs neoprene coated.
 - 2.2.2.2 Hardware cadmium plated.
 - 2.2.2.3 All other metal parts hot-dip galvanized.
- 2.2.3 Designed and installed so that ends of springs remain parallel.
- 2.2.4 Non-resonant with equipment forcing frequencies or support structure natural frequencies.
- 2.2.5 Submittals shall include spring diameters, deflection, compressed spring height and solid spring height.

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2.2.6 Type A spring isolators to be Mason Type SLF.

2.3 TYPE B SPRING ISOLATORS

2.3.1 Isolators shall be same as Type A, except:

2.3.1.1 Provide built-in resilient vertical limit stops.

2.3.1.2 All restraining bolts shall have large rubber grommets to provide cushioning in the vertical as well as horizontal modes. The hole through the bushing shall be a minimum of 20mm (0.75") larger in diameter than the restraining bolt. Horizontal clearance on the sides between the spring assembly and the housing shall be a minimum of 12mm (0.5") to avoid bumping and interfering with the spring action. Vertical limit stops shall be out of contact during normal operation.

2.3.1.3 Provide tapped holes in top plate for bolting to equipment.

2.3.1.4 Isolators shall be capable of supporting equipment at a fixed elevation during equipment erection.

2.3.2 Housings and springs shall be powder coated and hardware electro-galvanized.

2.3.3 Type B spring isolators to be Mason Type SLR.

2.4 TYPE C SPRING HANGER ROD ISOLATORS

2.4.1 Hangers shall be manufactured with minimum characteristics as Type A isolators, but without the neoprene element:

2.4.1.1 Springs are seated in a steel washer reinforced neoprene cup that has a neoprene bushing projecting through the bottom hole to prevent rod to hanger contact.

2.4.1.2 Spring diameters and the lower hole sizes shall be large enough to allow the hanger rod to swing through a 30° arc from side to side before contacting the cup bushing.

2.4.1.3 If ducts are suspended by flat strap iron, the hanger assembly shall be modified by the manufacturer with an eye on top of the box and on the bottom of the spring hanger rod to allow for bolting to the hanger straps.

2.4.2 Submittals on either of the above hangers shall include a scaled drawing of the hanger showing the 30° capability.

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2.4.3 Where operating weight differs from installed weight provide built-in adjustable limit stops to prevent equipment rising when weight is removed. Stops shall not be in contact during normal operation.

2.4.4 Type C spring hanger rod isolators to be Mason Type 30 or for straps W30.

2.5 TYPE D ELASTOMETER MOUNTING TYPES

2.5.1 Neoprene mountings shall have a minimum static deflection of 9mm (0.35"). All metal surfaces shall be oil-resistant neoprene covered and have friction pads both top and bottom. Bolt holes shall be provided on the bottom and a tapped hole and cap screw on top. Steel rails shall be used above the mountings under equipment such as small vent sets to compensate for the overhang.

2.5.2 Neoprene to be compounded to hardness no greater than 70 durometer.

2.5.3 Mounts to have straight line deflection curve.

2.5.4 Type D elastomer isolators to be Mason Type ND.

2.6 TYPE E ELASTOMETER HANGER ROD ISOLATORS

2.6.1 Isolators shall incorporate a moulded unit type neoprene element and steel retainer box encasing the neoprene mounting.

2.6.2 Neoprene to be compounded to hardness no greater than 70 durometer.

2.6.3 Isolator to have sufficient clearance between mounting hanger rod and steel retainer box.

2.6.4 Type E hanger rod isolators to be Mason Type HD.

2.7 TYPE F PAD TYPE ELASTOMETER MOUNTINGS

2.7.1 Elastomer pads to incorporate the following:

2.7.1.1 20mm (3/4") minimum thickness per layer of pad.

2.7.1.2 Suitable top bearing plate provided to uniformly distribute load.

2.7.1.3 Ribbed or waffled design.

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- 2.7.1.4 15% deflection.
- 2.7.1.5 Standard neoprene with moderate oil-resistance, compounded to hardness no greater than 70 durometer.
- 2.7.1.6 1.6mm (16 ga.) galvanized steel plate between multiple layers of pad thickness.
- 2.7.1.7 Bolts through equipment and pad shall be oversized and provided with resilient washers and bushings.
- 2.7.2 Type F pad to be Mason Type Super W.
- 2.8 TYPE G PAD TYPE ELASTOMETER MOUNTINGS
 - 2.8.1 Elastomer pads to incorporate the following:
 - 2.8.1.1 High quality bridge bearing neoprene.
 - 2.8.1.2 3mm (1/8") deflection.
 - 2.8.1.3 Maximum loading 6,895 kPa (1000 psi).
 - 2.8.1.4 Suitable bearing plate to distribute load.
 - 2.8.1.5 Minimum thickness 25mm (1").
 - 2.8.2 Type G pad to be Mason Type BBNR.
- 2.9 TYPE H COMBINATION SPRING/ELASTOMETER HANGER ROD ISOLATORS
 - 2.9.1 Hangers shall consist of rigid steel frames containing minimum 32mm (1-1/4") thick neoprene elements at the top and a steel spring with general characteristics as described in Type C, seated in a steel washer reinforced neoprene cup on the bottom. The neoprene element and the cup shall have neoprene bushings projecting through the steel box. In order to maintain stability the boxes shall not be articulated as clevis hangers nor the neoprene element stacked on top of the spring. Spring diameters and hanger box lower hole sizes shall be large enough to permit the hanger rod to swing through a 30° arc from side to side before contacting the cup bushing and short circuiting the spring.
 - 2.9.2 Neoprene to be compounded to hardness no greater than 70 durometer.

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- 2.9.3 Submittals shall include a hanger drawing showing the 30° capability.
- 2.9.4 Type H isolator to be Mason Type 30N.
- 2.10 INTEGRAL STRUCTURAL STEEL BASE, TYPE B-1
- 2.10.1 Base to be reinforced as required to prevent base flexure at start-up and misalignment of drive and driven units. Rectangular bases are preferred for all equipment. Centrifugal refrigeration machines and pump bases may be T or L shaped. Pump bases for split case pumps shall be large enough to support suction and discharge elbows. Centrifugal fan bases to be complete with motor slide rails, drilled for drive and driven unit mounting template.
- 2.10.2 All perimeter members shall be steel beams with a minimum depth equal to 1/10 of the longest dimension of the base. Base depth need not exceed 350mm (14") provided that the deflection and misalignment is kept within acceptable limits as determined by the manufacturer. Height saving brackets shall be employed in all mounting locations to provide a base clearance of 25mm (1").
- 2.10.3 Type B-1 base to be Mason Type WF.
- 2.11 CONCRETE INERTIA BASE, TYPE B-2
- 2.11.1 Concrete inertia bases shall be formed in a structural steel perimeter base, reinforced as required to prevent flexure, misalignment of drive and driven unit or stress transfer into equipment.
- 2.11.2 The base shall be complete with motor slide rails, pump base elbow supports, and complete with equipment bolting provisions and isolators. Bases shall be a minimum of 1/12 of the longest dimension of the base but not less than 150mm (6"). The base depth need not exceed 300mm (12") unless specifically recommended by the base manufacturer for mass or rigidity. Forms shall include minimum concrete reinforcing consisting of 12mm (1/2") bars welded in place on 150mm (6") centers running both ways in a layer 40mm (1-1/2") above the bottom. Forms shall be furnished with steel templates to hold the anchor bolt sleeves and anchor bolts while concrete is being poured. Height saving brackets shall be employed in all mounting locations to maintain a 25mm (1") minimum clearance between base and housekeeping pad. Wooden formed bases leaving a concrete rather than a steel finish are not acceptable.

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2.11.3 Minimum thickness of the inertia base shall be according to the following tabulation:

<u>Motor Size</u> kW (hp)	<u>Min. Thickness</u> mm (inches)
up to 11 (15)	150 (6)
15-37 (20-50)	200 (8)
45-55 (60-75)	250 (10)
75-185 (100-250)	300 (12)
225-375 (300-500)	400 (16)

2.11.4 Type B-2 inertia base to be Mason Type BMK or K.

2.12 SPRING ISOLATED ROOF CURB, TYPE B-3

2.12.1 Structural roof curb assembly to have a top and bottom frame resiliently connected by spring isolator complying with specification Type A.

2.12.2 The lower member shall consist of a sheet metal Z section containing adjustable and removable steel springs that support the upper floating section. The upper frame must provide continuous support for the equipment and must be captive so as to resiliently resist wind forces. All directional neoprene snubber bushings shall be a minimum of 6mm (1/4") thick. Steel springs shall be laterally stable and rest on 6mm (1/4") thick neoprene acoustical pads. Hardware must be plated and the springs provided with a rust resistant finish. The curb's waterproofing shall consist of a continuous galvanized flexible counter flashing nailed over the lower curb's waterproofing and joined at the corners by EPDM bellows. All spring locations shall have access ports with removable waterproof covers. Lower curbs shall have provision for 50mm (2") of insulation.

2.12.3 Type B-3 curb to be Mason Type RSC.

2.13 MOUNTING TYPES AND STATIC DEFLECTION SCHEDULE

Equipment	Slab on Grade	Suspended Slabs
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Type	Category	HP or Other	RPM	Base Type	Isolator Type	Min. Defl. mm (in.)	Base Type	Isolator Type	Min. Defl. mm (in.)
Refrigeration Machines and Chillers	Reciprocating	All	All	(1)	D	6 (¼")	(1)	B	38 (1-½")
	Centrifugal scroll	All	All	(1)	F	6 (¼")	(1)	B	38 (1-½")
	Screw	All	All	(1)	F	25 (1")	(1)	B	64 (2-½")
	Absorption	All	All	(1)	F	6 (¼")	(1)	B	38 (1-½")
	Air-cooled recip, scroll	All	All	(1)	D	6 (¼")	(1)	B	38 (1-½")
	Air-cooled screw	All	All	(1)	B	25 (1")	B-1	B	64 (2-½")
Air Compressors and Vacuum Pumps	Tank-mtd horiz.	≤10	All	(1)	A	19 (¾")	(1)	A	38 (1-½")
		≥15	All	B-2	A	19 (¾")	B-2	A	38 (1-½")
	Tank-mtd vert.	All	All	B-2	A	19 (¾")	B-2	A	38 (1-½")
	Base-mtd	All	All	B-2	A	19 (¾")	B-2	A	38 (1-½")
	Large recip	All	All	B-2	A	19 (¾")	B-2	A	38 (1-½")
Pumps	Close coupled	≤7.5	All	B-1	D	6 (¼")	B-2	A	19 (¾")
		≥10	All	B-2	A	19 (¾")	B-2	A	38 (1-½")
	Inline	5 to 25	All	(1)	A	19 (¾")	(1)	A	38 (1-½")
		≥30	All	(1)	A	38 (1-½")	(1)	A	38 (1-½")
	End suction, double suction	≤40	All	B-2	A	19 (¾")	B-2	A	38 (1-½")
		50 to 125	All	B-2	A	19 (¾")	B-2	A	38 (1-½")
	split case	≥150	All	B-2	A	19 (¾")	B-2	A	64 (2-½")
	Packaged pump	All	All	(1)	A	19 (¾")	B-2	A	38 (1-½")
Cooling towers	All	All	≤300	(1)	G	6 (¼")	(1)	B	89 (3-½")
			301to500	(1)	G	6 (¼")	(1)	B	64 (2-½")
			≥501	(1)	G	6 (¼")	(1)	B	19 (¾")
Boilers	Fire-tube	All	All	(1)	F	6 (¼")	B-1	B	38 (1-½")
	Water-tube	All	All	(1)	F	3 (⅛")	(1)	F	3 (⅛")
	Steam	All	All	(1)	F	6 (¼")	B-1	B	38 (1-½")
Fans: axial, plenum, cabinet, inline	≤ 22 in dia.	All	All	(1)	D	6 (¼")	B-2	A	19 (¾")
	≥ 24 in dia.	≤2 in SP	≤300	B-1	A	64 (2-½")	B-2	A	89 (3-½")
			301to500	B-1	A	19 (¾")	B-2	A	64 (2-½")
			≥501	B-1	A	19 (¾")	B-1	A	38 (1-½")
		>2 in SP	≤300	B-2	A	64 (2-½")	B-2	A	89 (3-½")
			301to500	B-2	A	38 (1-½")	B-2	A	64 (2-½")
			≥501	B-2	A	19 (¾")	B-2	A	38 (1-½")
Centrifugal fans	≤ 22 in dia.	All	All	B-1	D	6 (¼")	B-1	A	19 (¾")
	≥ 24 in dia.	≤40	≤300	B-1	A	64 (2-½")	B-1	A	89 (3-½")
			301to500	B-1	A	38 (1-½")	B-1	A	64 (2-½")
			≥501	B-1	A	19 (¾")	B-1	A	19 (¾")
		≥50	≤300	B-2	A	64 (2-½")	B-2	A	89 (3-½")
			301to500	B-2	A	38 (1-½")	B-2	A	64 (2-½")
			≥501	B-2	A	25 (1")	B-2	A	38 (1-½")
Propeller	Wall-mounted	All	All	(1)	F	6 (¼")	(1)	F	6 (¼")

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fans	Roof-exhauster	All	All	(1)	F	6 (1/4")	B-3	B	38 (1-1/2")
Heat pumps, fan coils, CRAC units	All	All	All	(1)	A	19 (3/4")	(1)	A	19 (3/4")
Condensing units	All	All	All	(1)	F	6 (1/4")	(1)	B	38 (1-1/2")
AHUs, AC, heating and ventilation units	All	≤10	All	(1)	A	19 (3/4")	(1)	A	19 (3/4")
	All	≤15,	≤300	(1)	A	19 (3/4")	B-2	A	89 (3-1/2")
		≤4 in SP	301to500	(1)	A	19 (3/4")	(1)	A	64 (2-1/2")
			≥501	(1)	A	19 (3/4")	(1)	A	38 (1-1/2")
		>15,	≤300	B-1	A	19 (3/4")	B-2	A	89 (3-1/2")
		>4 in SP	301to500	B-1	A	19 (3/4")	B-2	A	64 (2-1/2")
			≥501	B-1	A	19 (3/4")	B-2	A	38 (1-1/2")
Packaged RTUs	All	All	All	(1)	G	6 (1/4")	B-3	A	19 (3/4")
Ducted rotating equipment	Small fans, fan powered boxes	≤600 cfm		(1)	A	13 (1/2")	(1)	A	13 (1/2")
		>600 cfm		(1)	A	19 (3/4")	(1)	A	19 (3/4")
Generators	All	All	All	(1)	A	19 (3/4")	B-2	A	64 (2-1/2")
Heat exchangers, tanks	Plate and frame			(2)	F	3 (1/8")	(2)	F	3 (1/8")
Piping (see specs)	Floor supported			-	B	25 (1")	-	B	25 (1")
	Suspended						-	H	32 (1-1/4")
Transformer, dry type	Floor mounted			(2)	D	6 (1/4")	(2)	D	6 (1/4")
	Suspended						(2)	E	6 (1/4")
	Wall mounted						(2)	D	6 (1/4")

2.13.1

Notes:

- (1) No base, isolator directly attached to equipment.
- (2) Base as recommended and/or provided by manufacturer.

3

EXECUTION

3.1

GENERAL

3.1.1

Have all materials and systems for vibration isolation designed and supplied by one company, referred to in this Section as the 'manufacturer'.

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- 3.1.2 Install all products in accordance with manufacturer's written instructions. Vibration isolators must not cause any change or position of equipment or piping resulting in piping stresses or misalignment.
- 3.1.3 Provide through the manufacturer all vibration isolation equipment work and measures to prevent the transmission of objectionable vibration to the building structure and from one area to another area. Provide all necessary drawings indicating isolator locations and base dimensions. Have the installation directed and supervised by the manufacturer. Supply to the manufacturer the necessary copies of all drawings of equipment to be isolated.
- 3.1.4 Consider the areas classified as follows for selection of vibration control devices:
 - 3.1.4.1 Mechanical rooms or equipment locations in basement or sub-basement areas only and not bordering areas regularly occupied are 'non-critical'.
 - 3.1.4.2 Mechanical rooms or equipment locations bordering habitable suites, boardrooms, conference rooms, private offices are 'ultra-critical'. This shall include all mechanical penthouses and all mechanical compartment rooms.
- 3.1.5 Vibration isolation is not required for the following equipment between equipment and building only, but provide isolated connection to these for pipes and ducts:
 - 3.1.5.1 Fire pumps
 - 3.1.5.2 Sump pumps, sewage pumps
- 3.1.6 All piping and ductwork to be isolated shall freely pass through walls and floors without rigid connections. Penetration points shall be sleeved using acoustical sleeves, or otherwise formed to allow passage of piping or ductwork, and maintain 20mm ($\frac{3}{4}$ ") to 32mm ($1\frac{1}{4}$ ") clearance around the outside surfaces. This clearance space shall be tightly packed with fiberglass, and caulked airtight after installation of piping or ductwork.
- 3.1.7 No rigid connections between equipment and building structure shall be made that degrades the noise and vibration isolation system specified in this Section.
- 3.1.8 Electrical conduit connections to isolated equipment shall be

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flexible to allow free motion of isolated equipment.

- 3.1.9 Do not install any equipment, piping, or conduit, which makes rigid contact with the building unless permitted in this Specification. Building includes, but is not limited to, slabs, beams, columns, studs, and walls.
- 3.1.10 Coordinate work with other trades to avoid rigid contact with the building. Inform other trades following work, such as plastering or electrical, to avoid any contact which would reduce the vibration isolation.
- 3.1.11 Bring to the Consultant's attention prior to installation any conflicts with other trades, which will result in unavoidable rigid contact with equipment or piping as described herein, due to inadequate space or other unforeseen conditions. Corrective work necessitated by conflicts after installation shall be at the responsible contractor's expense.
- 3.1.12 Obtain inspection and approval of any installation to be covered or enclosed, prior to such closure.
- 3.1.13 Diagonal restraints shall be attached at the centerline of thrust.
- 3.1.14 Vertical piping loads, including water strainers, valves between pump base elbow supports and the suction and discharge header piping, shall be supported by the pump base spring isolators without stress or strain to the pump housing.
- 3.1.15 Correct, at no additional cost, all installations, which are deemed defective in workmanship or materials.

3.2 EQUIPMENT ISOLATORS

- 3.2.1 Mount floor mounted equipment on 100mm (4") concrete housekeeping pads over complete floor area of equipment. Mount vibration isolating devices and related inertia blocks on concrete pad.
- 3.2.2 Each fan and motor assembly shall be supported on a single structural steel frame. Provide all ductwork connected to vibration-isolated equipment at both inlet and outlet with flexible connectors having sufficient length and flexibility to eliminate vibration transmission and to not short circuit the effectiveness of the vibration isolation. Make flexible connections of glass fibreglass cloth sleeves, sealed to prevent air leakage. Install a minimum

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length of flexible connection on both sides equal to static pressure of the fan in inches but not less than 150mm (6").

- 3.2.3 The machine to be isolated shall be supported by a structural steel frame or concrete inertia base.
- 3.2.4 Brackets shall be provided to accommodate the isolator. The vertical position and size of the bracket shall be specified by the isolation manufacturer.
- 3.2.5 The minimum operating clearance between the equipment frame or rigid steel base frame and the housekeeping pad or floor shall be 25mm (1"). Minimum operating clearance between concrete inertia and base and housekeeping pad or floor shall be 50mm (2").
- 3.2.6 The equipment structural steel or concrete inertia base shall be placed in position and supported temporarily by blocks or shims, as appropriate, prior to the installation of the machine or isolators.
- 3.2.7 The isolators shall be installed without raising the machine and frame assembly.
- 3.2.8 After the entire installation is complete and under full operational load, the isolators shall be adjusted so that the load is transferred from the blocks to the isolators. When all isolators are properly adjusted, the blocks or shims shall be barely free and shall be removed.
- 3.2.9 Air handling equipment and centrifugal fans shall be protected using horizontal thrust restraints against excessive displacement weight which results from high air thrust when thrust forces exceed 10% of the equipment.
- 3.2.10 Rooftop equipment isolators must be bolted to the equipment and structure. Mountings must be designed to resist 160 km/h (100mph) wind loads.
- 3.2.11 Isolation mounting deflection shall be the minimum as specified or scheduled on the Drawings.
- 3.2.12 Verify that all installed isolator and mounting systems permit equipment motion in all directions. Adjust or provide additional resilient restraints to flexibly limit start-up equipment lateral motion to 6mm (¼").

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3.2.13 Prior to start-up, clean out all foreign matter between bases and equipment. Verify that there are no isolation short circuits in the base or isolators.

3.3 PIPING ISOLATORS

3.3.1 All piping isolators are included under this Section.

3.3.2 Where piping connects to mechanical equipment install expansion joints, or stainless hoses if expansion joints are not suitable for the service. All piping passing through the equipment walls, floors or ceilings shall be protected against sound leakage by means of an acoustical seal.

3.3.3 Isolate piping outside the shafts as follows:

3.3.3.1 All water piping in machine rooms, including strainers, filters, valves and associated equipment with water systems.

3.3.3.2 Piping and associated equipment where exposed on roof.

3.3.3.3 Water piping within 12.2m (40 ft) or 100 x pipe diameters, whichever is greater, from connected rotating equipment, using Type H hangers with the same static deflection as specified for the equipment. If piping is connected to equipment located beneath occupied spaces and hangs from ceilings under occupied spaces, the first four hangers shall have a minimum deflection of 20mm ($\frac{3}{4}$ ") for pipe sizes up to and including 75mm (3"), 40mm (1-1/2") deflection for pipe sizes over 75mm (3") and up to and including 150mm (6"), and 65mm (2-1/2") deflection thereafter.

3.3.4 The isolators shall be installed with the isolator hanger box attached to, or hung as close as possible to, the main structural elements of the building.

3.3.5 The isolators shall be suspended from substantial structural members, not from slab diaphragm unless specifically permitted.

3.3.6 Hanger rods shall be aligned to clear the hanger box.

3.3.7 Horizontal suspended pipe 50mm (2") and smaller and all steam piping shall be suspended by Type E isolator with a minimum 6mm ($\frac{1}{4}$ ") deflection. Water pipe larger than 50mm (2") shall be supported by Type H isolator with a minimum 32mm (1-1/2") static deflection.

3.3.8 Horizontal pipe floor supported at slab shall be supported via Type

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A or B, with a minimum static deflection of 25mm (1") or same deflection as isolated equipment to which pipe connects whichever is the greater.

3.3.9 All vertical risers shall be supported by spring isolators designed to support the riser filled with water, if it is a water line. Assigned loads must be within the building design limits at the support points. Neutral central resilient anchors shall direct movement up and down. The anchors shall be capable of holding an upward force equal to the water weight when the system is drained. If one level cannot accommodate this force, anchors can be located on two or three adjacent floors. Resilient guides shall be spaced and sized properly depending on the pipe diameter. The initial spring deflection shall be a minimum of 20mm ($\frac{3}{4}$ ") or four times the thermal movement at the isolator location, whichever is greater. Proper provision shall be made for seismic protection in seismic zones. Support spring mountings shall be Type A, anchors and telescoping guides as described under the Products section.

3.3.10 Pipe sway braces, where required, shall utilize two (2) neoprene elements (type D to accommodate tension and compression forces).

3.3.11 Pipe extension and alignment connectors: Provide connector at riser takeoffs, cooling and heating coils, and elsewhere as required to accommodate thermal expansion and misalignment.

3.4 DUCT ISOLATORS

3.4.1 All air ducts with a cross section of 0.19m² (2ft²) or larger shall be isolated from the building structure by Type C hangers or Type A floor supports with a minimum deflection of 20mm ($\frac{3}{4}$ "). Isolators shall continue for minimum 15m (50 ft) from the equipment. If air velocity exceeds 5.3 mps (1000 fpm), hangers or supports shall continue for an additional 15m (50 ft) or as shown on the Drawings

3.5 ISOLATOR POSITION

3.5.1 Close to building structure.

3.5.2 Between building structure and supplementary steel if required.

3.5.3 Suspend isolators from rigid and massive support points.

3.5.4 Supplementary steel to be sized for a maximum deflection of 1.6mm ($\frac{1}{16}$ ") at center span.

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3.5.5 Support piping in shafts and floor supports entering shaft with Type B isolators or Type H hangers depending on piping loads and support point space conditions within shafts.

3.5.6 Guide piping in shafts as required with approved mounting designs incorporating Mason Type ADA mountings to building. Prevent direct contact of piping with building structure.

3.6 MANUFACTURER'S REVIEW

3.6.1 On completion of installation of all vibration isolation and expansion compensation devices specified in this Section, the manufacturer shall inspect the completed system; check the vibration levels in the areas as requested by the Consultant, and report in writing any installation error, improperly selected isolation devices, or other faults in the system that could affect the performance of the system. A written report shall be submitted outlining corrective work necessary to comply with the above specifications. Corrective work shall be the responsibility of the installing Subcontractor.

END OF SECTION

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1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 - General Requirements, shall apply to and govern this Section.

2 **PRODUCTS**

Not Used

3 **EXECUTION**

3.1 PIPE SYSTEMS

3.1.1 After finished painting is complete, identify each pipe with stencils and stencil paint. Alternatively, use SMS Coil-Mark or adhesive style building service pipe markers.

3.1.2 Use capital letters minimum 51mm (2") high for DN80 (3") diameter piping or larger, including insulation, and 19mm ($\frac{3}{4}$ ") size capital letters on smaller diameters.

3.1.3 Use flow arrows to indicate direction of flow. Use double arrow where flow is reversible. Arrow shall be solid black or white; minimum 152mm (6") long by 51mm (2") wide for DN80 (3") diameter piping or larger, including insulation, and 102mm (4") long by 19mm ($\frac{3}{4}$ ") wide on smaller diameters.

3.1.4 Locate identification and flow arrows as follows:

3.1.4.1 Behind each access door.

3.1.4.2 At each change of direction and take-off.

3.1.4.3 Not more than 12.2m (40 ft) apart on all pipes exposed and/or located behind accessible ceiling.

3.1.4.4 On both sides of sleeves.

3.1.4.5 Adjacent to valves.

3.1.4.6 Above each floor or platform for vertical exposed pipes approximately 1,524mm (5 ft.) above floor.

3.1.5 Stenciling to be performed in a neat, quality manner. Upon completion of project, provide one complete set of stencils used for

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the Owner.

- 3.1.6 Use wording shown on the Legend on the Drawings or as instructed by the Consultant. Special system designations and abbreviations shall be submitted to Consultant for approval prior to use.
- 3.1.7 Colour coding to be as per the following schedule. For all other services, provide colour coding in conformance with CAN/CGSB-24.3 and ANSI A131.

MARKER LEGEND

CLASSIFICATION COLOUR

Description and Service	Primary	Secondary
City Water	Green	
Cold Water	Green	
Cooling Tower Water	Green	
Chilled Water	Green	
Ice Water	Green	
Domestic Hot Water	Green	
Domestic Hot Water Recirculation	Green	
Low Temp. Heating Water (Up To 121°C / 250°F)	Yellow	Black
High Temp. Heating Water (Over 121°C / 250°F)	Yellow	Black
Make-Up Water	Yellow	Black
Boiler Feed Water	Yellow	Black
Condensate	Yellow	Black
Blow-Off Water	Yellow	Black
Treated Water	Green	
Brine	Green	
Waste Water	Green	

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MARKER LEGEND

CLASSIFICATION COLOUR

Description and Service	Primary	Secondary
Storm Water	Green	
Acid Drain	Yellow	Black
Fire Protection Water	Red	White
Sprinkler Water	Red	White
Carbon Dioxide (Fire Protection)	Red	White
Plumbing Vent	Green	
Heating Vent	Yellow	Black
Low Pressure Steam (103 kPa / 15 psi Or Less)	Yellow	Black
High Pressure Steam (Above 103 kPa / 15 psi)	Yellow	Black
Hydraulic Oil	Yellow	Black
Instrument Air	Green	
Diesel Exhaust	Yellow	Black
Fuel Oil	Yellow	Orange
LP Gas	Yellow	Orange
Natural Gas	Yellow	Orange
Chlorine	Yellow	Black
Nitrogen	Blue	Yellow
Vacuum	Green	
Compressed Air (690 kPa / 100 psi Or Less)	Green	
Compressed Air (Above 690 kPa / 100 psi)	Yellow	Black

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3.1.8 Use primary colours for full length of piping or in minimum 914mm (36") long sections; use minimum 457mm (18") long sections on each side of valves. Use secondary colours in min. 51mm (2") wide bands.

3.1.9 Install pipe identification in accordance with the manufacturer's recommendations.

3.2 VALVES

3.2.1 Supply and attach to each valve (except fixture stops) a lamacoid tag 32mm (1-1/4") in diameter or 38mm (1-1/2") square, similar to SMS RP/SP-1500 series. The system code to be 5mm (3/16") high characters on the top line, valve numbers to be 9mm (3/8") high on the bottom line. Tags to be colour coded in conformance with piping system colours as per CAN/CGSB-24.3.

3.2.2 Attach tag to valve with a brass chain.

3.2.3 Schedule the valve numbers using a sequential numbering system. For fire protection valves, co-ordinate valve numbers with the annunciator panel numbering system.

3.2.4 Prepare and submit valve directories and charts giving number, size, location, purpose, and normal position (opened or closed) for each valve.

3.2.5 Provide two (2) framed copies of the valve charts and locate where directed by the Consultant.

3.2.6 All control, drain, and test connection valves shall be provided with signs indicating their purpose.

3.3 EQUIPMENT

3.3.1 Identify all fans, pumps, controls, starters, switches, pushbuttons, and all other equipment as to service by a white lamacoid engraved nameplate on black background. Submit sample plates and lettering to the Consultant. Attach plates only after all painting work is completed. Use mechanical fastening devices acceptable to the Consultant.

3.3.2 Manufacturer's nameplates shall be affixed to all equipment, serial number and all information usually provided, including voltage, cycle, phase, motor power, etc., name of the manufacturer and their address. All stamped etched or engraved lettering on plates

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shall be perfectly legible. Do not paint over nameplates and, where apparatus is to be concealed, attach the nameplates in an approved location on the equipment support or frame.

- 3.3.3 Identify all equipment with the corresponding remote controls.
- 3.3.4 Equipment plates shall have 9mm ($\frac{3}{8}$ ") capital letters; starter plates shall have 3mm ($\frac{1}{8}$ ") capital letters. All plates shall be sized to accommodate required description. Locate plates conspicuously and secure with self-tapping sheet metal screws where possible, or with double sided adhesive tape. Recognizable abbreviations will be acceptable, other proposed abbreviations to be approved by Consultant.
- 3.4 DUCTWORK
- 3.4.1 Identify all ductwork with 51mm (2") high stencils using black or white ink to contrast surface being identified.
- 3.4.2 Identification location shall conform to guidelines for pipe systems, and shall indicate flow medium, function, and direction.
- 3.4.3 Stenciling to be performed in a neat, quality manner. Upon completion of project, provide one complete set of stencils used for the Owner.

END OF SECTION

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1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 - General Requirements, shall apply to and govern this Section.

1.2 GENERAL REQUIREMENTS

1.2.1 Test, balance and adjust all systems to the Drawings and Specifications, in accordance with the intent and requirements of the ASHRAE Guide - Testing, Adjusting and Balancing (TAB) (Chapter 38, 2011 ASHRAE Application Handbook).

1.3 QUALIFICATION

1.3.1 The Testing, Balancing and Adjusting (TAB) Contractor must be a member in good standing with the National Environmental Balancing Bureau (NEBB), the Canadian Associated Air Balance Council (CAABC) or the National Building Comfort Testing Association (NBCTA).

1.4 SCOPE OF WORK

1.4.1 The TAB Contractor shall:

1.4.1.1 Within fourteen (14) days after award of contract, submit proof of certification for CAABC / NBCTA / NEBB.

1.4.1.2 Within thirty (30) days after award of contract, submit a report to the consultant summarizing the TAB Contractor's comments and recommendations regarding their review of the contract documents. Meet with the Contractor, Owner and Consultant as necessary to discuss.

1.4.1.3 Within thirty (30) days after Contract award, submit an outline of proposed TAB procedures, or alternatively, provide a copy of the latest edition of CAABC / NBCTA / NEBB Procedural Standards.

1.4.1.4 Conduct ongoing reviews of all related construction documentation, including co-ordination Drawings and shop drawings.

1.4.1.5 Visit the Site a minimum of once per month during construction, commencing when the pipe and/or duct installation starts. Submit a written report to the Consultant, including date of visit, areas

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observed, and any anticipated problems, which could adversely affect the TAB work.

- 1.4.1.6 Prior to commencing the TAB work, the TAB Subcontractor shall submit the list of instruments they will use on the project, together with a record of calibration dates and procedures.
- 1.4.1.7 Perform all prebalancing work as specified in respective procedures.
- 1.4.1.8 Furnish all TAB labour, instruments and services necessary to complete the TAB work for air systems and water systems to achieve the required air and water flow rates. For fans with fixed drives, provide preliminary balance for first set of sheaves, advise the Division 23 - HVAC Subcontractor of results, install new sheaves, and rebalance system following installation of second set of sheaves. Adjust adjustable drives for required rpm and airflow. Adjust VAV box minimum and maximum airflows. Adjust and set all volume control devices to achieve proper air distribution, pressures and patterns in all parts of supply return and exhaust air systems. Adjust and set all pumps, balancing valves and other flow devices to achieve optimum water distribution in all parts of the circulating water systems.
- 1.4.1.9 Document any deficiencies that prevent the system from being properly balanced and advise the respective installing Subcontractor (Division 21, 22 or 23). Rebalance all affected systems following correction by the respective installing Subcontractor (Division 21, 22 or 23) at no additional cost to the Owner.
- 1.4.1.10 Record the existing capacities of all existing fans, pumps, main duct branches, and partial systems remaining as part of the renovated work, before demolition occurs. Provide a separate report to the Consultant summarizing all measurements.
- 1.4.1.11 Balance all existing air and water systems altered under this project in accordance with values on the drawings and/or pre-demolition measurements made by the TAB Subcontractor.
- 1.4.1.12 Report on any noise and vibration problems that are discovered during the course of balancing.
- 1.4.1.13 Submit a Balancing Report to the Consultant.
- 1.4.1.14 Repeat the balancing procedures for up to 10% of the system at

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the request of the Consultant. Should the retest data differ by more than $\pm 5\%$ from the originally reported values, the TAB Contractor shall be obligated to repeat the balancing of the entire system or systems at no additional cost to the Owner, if so requested by the Consultant.

1.4.1.15 Include for premium time where schedule requires that TAB work be undertaken after hours.

1.5 CO-ORDINATION

1.5.1 The respective installing Subcontractor (Division 21, 22 or 23) shall be responsible to ensure that all systems are complete and ready for testing, balancing and adjusting by the TAB Contractor. The respective installing Subcontractor (Division 21, 22 or 23) shall:

1.5.1.1 Confirm the complete operational readiness of the building, including sealed walls, doors, and ceilings to allow the balancing to be performed and required pressures to be set and maintained.

1.5.1.2 Allow access to all components requiring testing, balancing, and servicing. This includes permanently installed ladders and catwalks.

1.5.1.3 Maintain a construction schedule that allows the test and balance (TAB) firm to complete contract work prior to occupancy.

1.5.1.4 Verify the installation conformity to the design drawings and specifications.

1.5.1.5 Promptly correct deficiencies of materials and work that may delay completion of the TAB work.

1.5.1.6 Provide operation and maintenance manuals. Manuals must include the following:

1.5.1.6.1 The manufacturers' method for adjusting and setting components for correct operation under actual load conditions.

1.5.1.6.2 The manufacturers' recommended tolerance for maximum and minimum operating conditions.

1.5.1.6.3 The recommended correction or A_k factors, to allow adjustment of flow, rpm, etc.

1.5.1.6.4 A list of spare parts, identification numbers, and diagrams of their proper locations.

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- 1.5.1.6.5 Pressure drops for air and hydronic flows through the component or unit at design flow rate.
- 1.5.1.7 Start up all HVAC systems, according to the following conditions:
 - 1.5.1.7.1 Proper lubrication of rotating or sliding parts is verified.
 - 1.5.1.7.2 Motors, fans, and all HVAC equipment have the correct rotation.
 - 1.5.1.7.3 Installation of the correct drive (package) is checked.
 - 1.5.1.7.4 Belt tension is appropriate for the type of drive.
 - 1.5.1.7.5 Vibration isolators and bases are properly installed and are the correct type.
 - 1.5.1.7.6 Smoke and fire damper operation (left in full open position) is correct.
 - 1.5.1.7.7 Volume and control dampers (left in a neutral or wide-open position) function properly.
 - 1.5.1.7.8 Verification that duct-leakage test has been performed and ducts are sealed to the minimum tolerance specified in the Contract Documents.
 - 1.5.1.7.9 Verification that all registers, grilles, and diffusers are of the correct type, are properly installed, and are in the open position.
 - 1.5.1.7.10 Verification that all terminal boxes are the correct type and are properly installed according to the manufacturer's recommendations.
 - 1.5.1.7.11 Verification that motors, starters, and variable speed controllers with overload safety devices are the correct size and are operating properly.
 - 1.5.1.7.12 Verification that automatic controls are installed correctly and include all components specified, including interlocks, freeze stats, damper controllers, minimum positioning switches, control valves, actuators, and sensors.
 - 1.5.1.7.13 Verification that hydronic pumps and related components are properly installed and operate correctly.
 - 1.5.1.7.14 Verification that strainers are clean and that the system is vented and free of air.

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- 1.5.1.7.15 Verification that expansion tanks are properly installed and working.
- 1.5.1.7.16 Verification that coils are piped correctly and are clean.
- 1.5.1.7.17 The motor, amps, volts, and rpm, are compared with nameplate data and are adjusted within a motor-rated hp or amperes.
- 1.5.1.7.18 Verification that fan and pump power and speed are within design range.
- 1.5.1.7.19 Verification that the controls are complete and operational.
- 1.5.1.7.20 Verification of the correct type, quantity, and cleanliness of installed filters.
- 1.5.2 During testing and balancing; the respective installing Subcontractor (Division 21, 22 or 23) shall:
 - 1.5.2.1 Operate and maintain all systems requiring balancing during the balancing period.
 - 1.5.2.2 Ensure that the control system responds to the testing and balancing requirements. Provide all necessary personnel, equipment and software to make adjustments to controls as required to achieve design condition.
 - 1.5.2.3 Furnish and install drives and motors as required to accomplish design requirements.
 - 1.5.2.4 Provide all equipment, labour, instruments and incidentals and pay for all power and fuel to carry out the tests.
- 1.5.3 Start-Up Report:
 - 1.5.3.1 The Contractor shall provide a copy of a detailed start-up report, including initial tabulated data required for the start-up of systems, to the test and balance agency for reference in the balancing work.
- 1.5.4 Joint effort of Contractors:
 - 1.5.4.1 Upon completion of balancing, the TAB Subcontractor shall provide flows, pressures, and temperatures to the control contractor for final calibration of the automatic control system. The Division 25 – Integrated Automation Subcontractor shall provide access to computerized data and equipment and/or provide operating personnel.

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1.5.4.2 After balancing, the TAB Subcontractor shall provide water flow rates, etc. to the chiller, cooling tower, and boiler suppliers for final setup and performance verification.

2 **PRODUCTS**

Not Used

3 **EXECUTION**

3.1 GENERAL

3.1.1 TAB work shall be undertaken in accordance with the following descriptions. Procedures not specifically described herein or requiring amplification shall be in accordance with CAABC / NBCTA / NEBB standards, as applicable.

3.2 AIR SYSTEM BALANCING

3.2.1 Air quantities in main ducts shall be measured by Pitot tube traverses of the entire cross section area of the duct. Openings in ducts for Pitot tube insertion shall be sealed with approved plugs. Outlet and inlet air quantities shall be determined in accordance with CAABC / NBCTA / NEBB procedures.

3.2.2 Total air quantities shall be obtained by adjustment of fan speeds. Branch duct air quantities shall be adjusted by volume dampers. Damper positions shall be permanently marked after TAB work is complete.

3.2.3 For systems handling outdoor air, the system shall be balanced at the normal minimum outdoor air condition. Where the system is designed to deliver 100% return air or a variable amount of outdoor air, the total airflow tests shall be repeated for 100% maximum outdoor air and shall agree with conditions measured under minimum outdoor air operation before the system is considered to be in balance.

3.2.4 Adjusting of individual outlets shall be performed as per CAABC / NBCTA / NEBB procedures or as otherwise approved by the Consultant. Outlets shall be set for the air pattern required and all main supply air dampers shall be adjusted and set for the design indicated. All required changes in air patterns or setting necessary to achieve correct air balance and to minimize drafts shall be performed by the TAB Subcontractor.

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- 3.2.5 All measured air quantities shall be within $\pm 5\%$ of design air quantities where achievable.
- 3.2.6 Each Variable Air Volume (VAV), Fan Powered VAV (both Series and Parallel type), and Constant Volume (CV) supply, return air and exhaust terminal unit shall be adjusted to deliver the maximum and minimum air quantities specified in all specified modes of operation. (Use the prescribed procedures for each type terminal device). The individual supply outlets for each zone shall be adjusted after the respective control unit is manually set (Pneumatic and/or Direct Digital Control (DDC)) to design airflow settings (Minimum and Maximum). Factory calibration of all types of VAV and High Velocity Fan Powered/Reheat Units shall be verified and reset as required by the TAB Subcontractor.
- 3.2.7 The TAB Subcontractor shall perform the test and compile the data required. In addition to the tabulation forms, the TAB Subcontractor shall provide schematic diagrams showing all system components cross-referenced to form tabulations. The lists provided hereinafter shall be considered minimum requirements. All information required to prove system balance shall be provided by the TAB Subcontractor.
- 3.2.8 Air Handling Equipment Tests and Data
- 3.2.8.1 Tabulate design conditions from documents and installed conditions from shop drawings:
- 3.2.8.1.1 Fan, unit or system number.
- 3.2.8.1.2 Location.
- 3.2.8.1.3 Area served.
- 3.2.8.1.4 Manufacturer, model and serial number of air unit, motor(s), pulley and belts.
- 3.2.8.1.5 Motor nameplate power (kilowatts), amperage, voltage, phase, hertz, frame type, and service factor.
- 3.2.8.1.6 Sheave Manufacturer, model number, grooves, and pitch diameter, adjustable or fixed. Include pitch diameter settings on adjustable sheaves.
- 3.2.8.1.7 Fan and motor rpm.
- 3.2.8.1.8 Fan or unit static pressure profile. Measure and record pressure

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differentials across coils, filters, dampers, etc.

- 3.2.8.1.9 Total airflow, Outdoor Air, Return Air, Exhaust Air, Relief Air, and Outlet Air (Maximum and Minimum).
- 3.2.8.1.10 Terminal Manufacturer and type.
- 3.2.8.1.11 Outlet or inlet size, effective area and A_k Factor, except when using a direct reading flow hood.
- 3.2.8.1.12 Design temperature differences.
- 3.2.8.1.13 Design brake horsepower (kilowatts).
- 3.2.8.1.14 Check that stratification has been eliminated before taking measurements. Make temperature traverse readings after each mixing compartment. Advise the Division 23 – HVAC Subcontractor if any stratification is present.
- 3.2.8.2 Tabulate from equipment field tests.
 - 3.2.8.2.1 Fan and motor rpm.
 - 3.2.8.2.2 Motor amperage for each phase.
 - 3.2.8.2.3 Voltage for each phase.
- 3.2.8.3 Tabulate from air data from field test (for each required condition).
 - 3.2.8.3.1 Total air quantity for each outlet or inlet and for Supply air, Return Air, Exhaust Air, Relief Air and Outdoor Air for each system.
 - 3.2.8.3.2 Pressure reading at most distant point of system (Pa / mm w.g. for VAV systems only).
 - 3.2.8.3.3 Pressure drops across filters, boxes, coils and air-to-air heat exchangers.
 - 3.2.8.3.4 Supply, Return and Exhaust fan pressure differentials.
 - 3.2.8.3.5 Temperature differences across coils and air-to-air heat exchangers.
 - 3.2.8.3.6 Traverse locations and grid with actual velocities. Record duct static pressure at each traverse location. Provide traverses at all points necessary for balancing.

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3.3 WATER SYSTEM BALANCING

- 3.3.1 Water flows shall be balanced by venturi and calibrated orifices with portable type flow meters, where provided by the respective installing Subcontractor (Division 21, 22 or 23), or calibrated meters provided by the TAB Subcontractor.
- 3.3.2 Pump flow capacities shall be determined by venturies, orifices, or multi-duty valves. All settings of balancing valves shall be permanently marked after balance is complete.
- 3.3.3 The TAB Subcontractor shall compare design documents with the shop drawings. If discrepancies are found, TAB Subcontractor shall submit a request for information to resolve the discrepancies.
- 3.3.4 Pump Test and Data.
 - 3.3.4.1 Tabulate tests and data: (Confirm in field)
 - 3.3.4.1.1 Pump number and service.
 - 3.3.4.1.2 Location.
 - 3.3.4.1.3 Area served and type of system served.
 - 3.3.4.1.4 Manufacturer, model, serial number of pump.
 - 3.3.4.1.5 Motor nameplate power (watts), amperage, voltage, phase, Hertz, frame type and service factor.
 - 3.3.4.1.6 Pump and motor rpm.
 - 3.3.4.1.7 Pump suction and discharge pressure at operating conditions.
 - 3.3.4.1.8 System flow.
 - 3.3.4.2 Tabulate from field tests:
 - 3.3.4.2.1 Pump and motor rpm.
 - 3.3.4.2.2 Motor amperage for each phase.
 - 3.3.4.2.3 Voltage for each phase.
 - 3.3.4.3 Tabulate from pump field test:
 - 3.3.4.3.1 Total flow.

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- 3.3.4.3.2 Discharge and suction pressure for operating and shut off conditions.
- 3.3.5 Heat Transfer Equipment Tests and Data
 - 3.3.5.1 Tabulate design conditions from documents and installed conditions from shop drawings.
 - 3.3.5.1.1 Identification, location and service.
 - 3.3.5.1.2 Transferred heat (kW).
 - 3.3.5.1.3 Manufacturer.
 - 3.3.5.1.4 Model and serial number.
 - 3.3.5.1.5 Pipe size (mm).
 - 3.3.5.1.6 Design pressure differential (kPa / psi) and flow rates (L/s / USgpm).
 - 3.3.5.1.7 Design leaving and entering conditions.
 - 3.3.5.1.8 Type motor used.
 - 3.3.5.2 Tabulate from field tests:
 - 3.3.5.2.1 Pressure differential (kPa / psi).
 - 3.3.5.2.2 Total flow (L/s / USgpm).
 - 3.3.5.2.3 Entering and leaving temperature and conditions.
 - 3.3.5.3 For heating systems where automatic control valves are not used for each radiator or convector, adjust to equal temperature drop through each unit. Submit the temperature readings taken by contact pyrometer on inlet and outlet pipes to the top and bottom units on each riser.
- 3.3.6 Cooling Tower Test and Tabulations:
 - 3.3.6.1 The tower water distribution system shall be balanced to ensure an even water flow to each tower cell. The fan(s) speed, rotation, motor voltage and amperage shall be checked and recorded.
 - 3.3.6.2 The TAB Subcontractor shall perform tests on cooling towers in accordance with CAABC / NBCTA / NEBB procedures and shall

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provide the following information:

- 3.3.6.2.1 Pump and cooling tower nomenclature.
- 3.3.6.2.2 Size and capacities.
- 3.3.6.2.3 Pump motor and fan motor operating information and characteristics.
- 3.3.6.2.4 Pump flows, discharge head, and Total Dynamic Head (TDH).
- 3.3.6.2.5 Fan airflow and velocities if applicable.
- 3.3.6.2.6 Wet and dry bulb air temperatures of inlet and outlet.
- 3.3.6.2.7 Water temperature of hot water, cold water and make-up water.
- 3.3.7 Boilers and Furnaces
 - 3.3.7.1 For boilers and furnaces, test flue gas using Orsat flue gas analyzer for carbon dioxide, oxygen and carbon monoxide. Measure and record fuel consumption. Perform test at each firing rate.
- 3.3.8 Systems installed with pressure independent control valves shall not require terminal level hydronic system balancing. Total system flow shall be verified to be within +/-10% of system design. 10% of the total installed product shall be randomly checked for individual conformance. Exact locations of tested product to be coordinated with the design engineer. Any individual adjustments for the pressure independent valve assembly (valve and actuator combination) for field conditions shall be performed using the pressure independent control valve manufacturer's documented procedure following the guidelines of CAABC / NBCTA / NEBB.
- 3.4 DEMONSTRATION
 - 3.4.1 At the request of the Consultant, the TAB Subcontractor shall repeat the balancing procedure for any system or portion of a system. The TAB Subcontractor shall repeat the balancing procedure on 10% (as selected by the Consultant) of systems. If the data is within $\pm 5\%$ of the reported data, the system shall be considered acceptable and the report accepted. If the data is not within $\pm 5\%$ of the reported data, the Consultant can request that the entire system or systems be rebalanced.
- 3.5 REPORTS

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- 3.5.1 Submit written reports, during the course of construction, of potential developing problems relating to the work being provided under other sections of the specifications where such problems may adversely affect the proper balancing of the equipment or systems.
- 3.5.2 Submit written reports for review upon completion of each major phase of the balancing work.
- 3.5.3 The TAB Subcontractor shall prepare and submit three (3) copies of the Balancing Report to the Consultant for review and evaluation prior to final acceptance of the project. The Balancing Report shall include the data outlined above, but may be expanded or modified to be compatible with the requirements of the installed equipment and systems.
- 3.5.3.1 The cover of the TAB Report must show the "CAABC / NBCTA / NEBB" Logo, Name and Address of the project, Architect, Mechanical Engineer, Installing Contractor, Date the report is issued, Address and Phone Number of the TAB Subcontractor. The CAABC / NBCTA / NEBB Seal and Signature of the TAB Supervisor who is in charge of the reported project must be submitted on the "Certification" Report Form (TAB 2-98)
- 3.5.3.2 Identification of all types of instruments used and their last dates of calibration shall be submitted with the Final Report.
- 3.5.3.3 Once the Consultant's comments have been incorporated in the report, submit four (4) copies of the Final Report to the Consultant.
- 3.6 QUALITY ASSURANCE
- 3.6.1 The Tab Subcontractor shall guarantee that all work will be performed in accordance with the applicable CAABC / NBCTA / NEBB Standards and Procedures. The TAB Subcontractor's Certification Number must be provided to the Consultant.

END OF SECTION

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1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 – General Requirements, shall apply to and govern this Section.

1.1.2 All insulation shall comply with minimum R-value requirements listed in ASHRAE Energy Standard 90.1, 2013 edition.

1.1.3 All insulation materials and installation must meet the requirements of applicable codes and standards, and be appropriately labeled.

1.2 SCOPE OF WORK

1.2.1 Provide all labour, materials, tools, equipment, training, commissioning and certification required to complete the work as shown on the Drawings and specified in this Section, including:

1.2.1.1 Piping insulation.

1.2.1.2 Equipment insulation, including tanks.

1.2.1.3 Breeching insulation.

1.2.1.4 Engine exhaust insulation.

1.2.1.5 Thermal duct insulation.

1.2.1.6 Adhesives, tie wires, tapes.

1.2.1.7 Recovery jackets.

1.3 SUBMITTALS

1.3.1 Submit Shop Drawings for:

1.3.1.1 Insulation products.

1.3.1.2 Recovery jackets.

1.3.1.3 Adhesives and sealants.

1.3.2 Submittal to include product description, manufacturer's installation instructions, and appropriate specification compliance.

1.3.3 Submit samples of all insulation materials to the Consultant mounted on a board, and labeled for intended services, including

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'k' factors. Obtain the Consultant's comments prior to ordering insulation and proceeding with the installation.

1.4 QUALITY ASSURANCE

- 1.4.1 Glass mineral wool insulation products to have UL GREENGUARD Gold Certification and be formaldehyde free as certified by UL Environment; whenever possible.
- 1.4.2 Products shall contain no polybrominated diphenyl ethers (PBDE) such as Penta-BDE, Octa-BDE or Deca-BDE fire retardants.
- 1.4.3 The Contractor shall take precaution to protect insulation materials from moisture exposure or physical damage. Any glass mineral wool insulation that becomes wet or damaged shall be replaced at no additional cost.
 - 1.4.3.1 HVAC ductwork insulation used in the air stream must be discarded if exposed to liquid water.
 - 1.4.3.2 Pipe insulation with factory applied all service jacket with self-sealing lap (ASJ+) facing having been installed per manufacturer's installation recommendation which may experience intermittent exposure to liquid water after installation may be exempted from removal and replacement requirements.

2 **PRODUCTS**

2.1 INSULATION MATERIAL

- 2.1.1 Unless otherwise noted, insulating materials are based on Knauf Fiber Glass GmbH.
- 2.1.2 All insulation materials, adhesive sealants and coatings, shall be ULC listed, non-hygroscopic, and mould-proof. Insulation products shall not contain asbestos, lead, mercury, mercury compounds, or formaldehyde.
- 2.1.3 All insulation system materials inside the building must meet the requirements of NFPA 90A, with a flame spread rating of less than 25, and smoke developed rating of less than 50, when tested in accordance with CAN/ULC-S102. Insulation materials shall not flame, smolder, glow or smoke at their service temperatures.
- 2.1.4 Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795. Insulation materials applied to carbon steel shall be Mass Load Corrosion

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Rate (MLCR) tested per ASTM C 1617.

- 2.1.5 Pipe insulation: Knauf Earthwool™ 1000° glass mineral wool pipe insulation, UL/ULc classified, rigid, molded, k value: 0.033 (0.23) at 24°C (75°F) mean temperature; 0.049 (0.34) at 149°C (300°F) mean temperature. Maximum service temperature 538°C (1000°F). Vapor retarder jacket: ASJ+ conforming to ASTM C 1136 Type I, II, III, IV, & VIII secured with self-sealing longitudinal laps and matching ASJ+ butt strips.
- 2.1.6 Semi-rigid pipe and tank insulation: Knauf Pipe & Tank glass mineral wool insulation, limited combustible, k value: 0.036 (0.25) at 24°C (75°F) mean temperature. Maximum service temperature 454°C (850°F). Compressive strength: not less than 5.75 kPa (120 PSF) @ 10% deformation per ASTM C 165. Vapor retarder jacket: ASJ conforming to ASTM C 1136 Type II.
- 2.1.7 Semi-rigid blanket for equipment: Knauf KwikFlex™ glass mineral wool; in roll form, k value: 0.035 (0.24) at 24°C (75°F) mean temperature; 0.056 (0.39) at 149°C (300°F) mean temperature. Maximum service temperature 454°C (850°F), maximum surface temperature for faced product: 66°C (150°F), maximum thickness @ 454°C (850°F): 102mm (4"). Compressive strength: not less than 1.2 kPa (25 PSF) @ 10% deformation per ASTM C 165. Vapor retarder jacket: ASJ, FSK or PSK conforming to ASTM E 96, Procedure A.
- 2.1.8 Fitting insulation: insulate using pre-formed PVC fitting covers with glass mineral wool inserts. Alternatively, preformed molded, formaldehyde free glass mineral wool; minimum 50% post-consumer recycled glass content, or mitered glass mineral wool pipe insulation sections. These fittings shall be further protected by field-applied PVC fitting covers, metal fitting covers, or glass fabric and mastic sealed as necessary.
- 2.1.9 Duct wrap: Knauf Friendly Feel® glass mineral wool blanket; flexible, limited combustible, k value: 0.042 (0.29) at 24°C (75°F) mean temperature. Maximum service temperature: faced 121°C (250°F), unfaced 177°C (350°F). Maximum allowable compression is 25%. Density: concealed areas: minimum 12 kg/m³ (0.75 PCF); exposed areas: minimum 16 kg/m³ (1.0 PCF). Vapor retarder jacket: FSK or PSK conforming to ASTM C 1136 Type II.
- 2.1.10 Rigid duct insulation: Knauf Insulation Board, rigid glass mineral wool board. Maximum service temperature 232°C (450°F). Concealed areas: Density: Minimum 48 kg/m³ (3 PCF). k value:

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0.033 (0.23) at 24°C (75°F) mean temperature. Vapor retarder jacket: ASJ conforming to ASTM C 1136 Type I, or FSK or PSK conforming to ASTM C 1136 Type II.

Exposed Areas: Density: Minimum 96 kg/m³ (6 PCF). k value: 0.032 (0.22) at 24°C (75°F) mean temperature. Vapor retarder jacket: ASJ conforming to ASTM C 1136 Type I, or FSK or PSK conforming to ASTM C 1136 Type II in combination with protective jacket where necessary.

2.1.11 Factory applied jackets:

2.1.11.1 All service jacket with advanced closure system self-sealing lap (ASJ+). All service jacket composed of aluminum foil reinforced with glass scrim bonded to a kraft paper interleaving with an outer film layer leaving no paper exposed.; conforming to ASTM C 1136 Type I, II, III, IV, and VIII; vapor retarder; with a self-sealing adhesive.

2.1.11.2 All service jacket (ASJ). White kraft paper bonded to aluminum foil and reinforced with glass fibers; conforming to ASTM C 1136; vapor retarder.

2.1.11.3 Foil scrim kraft (FSK). Aluminum foil, fiberglass reinforced scrim with kraft backing; conforming to ASTM C 1136 Type 1; vapor retarder.

2.1.11.4 Poly scrim kraft (PSK). Metalized polypropylene, fiberglass reinforced scrim with kraft backing; conforming to ASTM C 1136 Type 1; vapor retarder.

2.1.11.5 Redi-Klad Jacket: VentureClad 5-ply weather and abuse resistant with self-seal lap, zero permeability per ASTM E 96-05; puncture resistance 35.4 kg (189.3 N) per ASTM D 1000; tear strength 19.4 N (4.3 lbs) per ASTM D 624; thickness 14.5 mils (0.0145"); tensile strength 306 N (31 kg)/25 mm (68.0 lb./inch) width.

2.1.12 Field applied jackets:

2.1.12.1 PVC: Proto Corporation 25/50 or Indoor/Outdoor, UV resistant fittings, jacketing and accessories, white or colored. Fitting cover system consists of pre-molded, high-impact PVC materials with glass mineral wool inserts. Glass mineral wool insert has a thermal conductivity (k value) of 0.037 (0.26) at 24°C (75°F) mean temperature. Closures: stainless steel tacks, matching PVC tape, or PVC adhesive per manufacturer's recommendations.

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- 2.1.12.2 Aluminum Jacket: Alloy 3003 or 3105, minimum thickness per ASTM C 1729, smooth, corrugated or stucco embossed with factory-applied moisture barrier. Overlap shall be 50mm (2 inch) minimum. Jacket shall be banded in place with 12mm x 5mm (½" x 0.20") aluminum strapping fastened with aluminum wing seals.
- 2.1.12.3 Stainless Steel Jacket: T-304, minimum per ASTM C 1729, smooth, corrugated or embossed with factory-applied moisture barrier. Overlap shall be 50mm (2 inch) minimum. Jacket shall be banded in place with 10mm x 5mm (⅜" x 0.20") aluminum strapping fastened with stainless steel wing seals.
- 2.1.12.4 Laminated Self-Adhesive Water and Weather Seals: permanent acrylic self-adhesive system; weather resistant, high puncture and tear resistance; meeting or exceeding requirements of UL 723; and applied in strict accordance with manufacturers' recommendations.
- 2.1.12.5 Canvas jackets: 1.83kg/m2 (6oz./sq.ft) plain weave cotton fabric sealed with dilute fire retardant, waterproof, ULC listed lagging adhesive.
- 2.1.13 Jacketing for outdoor ductwork
- 2.1.13.1 Aluminum Jacket: 0.406mm (0.016 inch) thick in smooth, corrugated, or embossed finish with factory applied moisture barrier. Overlap shall be 50mm (2 inch) minimum.
- 2.1.13.2 PVC Jacket: Proto Corporation Indoor/Outdoor, UV resistant, white. Closure shall be solvent weld adhesive or per manufacturers' recommendations.
- 2.1.13.3 Laminated Self-Adhesive Water and Weather Seals: applied per manufacturer's recommendations.
- 2.1.14 Mastics:
- 2.1.14.1 Vapor Retarder Mastics: Knauf Insulation EXPERT Mastics: KI-900 ASJ or KI-905 ASJ+; water vapor permeance:, 0.026 metric perm (0.04 perm) at 40 mil dry film thickness. Service Temperature Range: -29°C to 82.2°C (-20°F to 180°F). Color: White
- 2.1.15 Weather Barrier Mastics: Knauf Insulation EXPERT Mastics: KI-700 ASJ or KI-705 ASJ+; water vapor permeance:, 1.2 metric perm (1.8 perm). Service Temperature: -17.8°C to 82.2°C (0°F to 180°F) constant; -29°C to 93°C (-20°F to 200°F) intermittent.

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Solids: 58% by weight; 50% by volume. Color: White

2.1.16 Tapes:

2.1.16.1 ASJ Tape: Knauf Insulation EXPERT ASJ Tape or ASJ+ Tape. Width: 75mm (3 inches) or 102mm (4 inches). Thickness (Total): 0.36 mm (14.3 mil) – ASJ; 0.34mm (13.3 mil) – ASJ+. Adhesion: >840 N/m (4.8 Lbf / in.)

2.1.16.2 FSK Tape: Knauf Insulation EXPERT FSK Tape. Width: 75mm (3 inches) or 102mm (4 inches). Thickness (Total): 0.34mm (13.3 mil). Adhesion: 1,138 N/m (6.5 Lbf / in.)

2.1.16.3 Aluminum Foil Tape: Knauf Insulation EXPERT 2 Mil Foil Tape. Width: 75mm (3 inches) or 102mm (4 inches). Thickness (Total): 0.19mm (7.3 mil). Adhesion: 700 N/m (4.0 Lbf / in.)

2.2 APPLICATION

2.2.1 The following areas are designated as “exposed” where the term is applied to covering:

2.2.1.1 Mechanical and electrical equipment rooms, penthouses, parking garage, loading dock, shipping/receiving areas.

2.2.1.2 Mechanical plenum spaces.

2.2.1.3 Below suspended ceiling level in occupied areas or below slab where no ceiling occurs.

2.2.1.4 Duct shafts and/or pipe shafts serviced via “walk-in” type access doors.

2.2.1.5 Crawl spaces, tunnels.

2.2.2 Cover duct and pipes exposed to weather or dampness with 75mm (3") thick insulation and a final application of tape adequately overlapped to render it water tight. The following areas are designated as “exposed to weather or dampness” and are applicable for this treatment:

2.2.2.1 Air intake, relief, and exhaust plenums directly connected to the outside of the building.

2.2.2.2 Underground service trenches.

2.2.2.3 Buried below ground level.

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2.2.2.4 Areas subject to high humidity.

2.2.2.5 Ductwork and piping exposed on the roof.

2.3 COLD PIPING

2.3.1 Cover 'cold' piping (operating temperature below 16°C/61°F) with rigid pipe insulation with factory applied vapour barrier jacket and aluminum foil vapour barrier with self-sealed lap. Butt joints sealed with butt strips or aluminum tape. Recover pipe in exposed areas with field applied jacket.

2.3.2 Insulation thickness shall be as follows:

- 2.3.2.1 25mm (1")
- unburied domestic cold water piping
 - chilled drinking water
 - unburied apparatus drains
 - horizontal unburied rain water piping, including the piping up to and including roof hoppers or drain fixtures
 - horizontal unburied sanitary drains
 - cast iron fittings on transite rainwater piping
 - gray water piping
 - fire standpipe, wet sprinkler and drainage piping in loading dock, parking garage and other unheated areas
 - refrigerant suction piping
 - auxiliary water piping on refrigeration compressors
 - cooling tower make-up water, overflow, bleed and drain pipes inside and outside building
 - chilled water/glycol supply and return at 5°C (41°F) and above

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- condenser water used for low temperature cooling (water side free cooling) inside building

- 2.3.2.2 40mm (1-½") - chilled water/glycol supply and return below 4°C (39°F) for pipes equal to or greater than DN200 (8") dia.
- 2.3.2.3 40mm (1-½") - chilled water/glycol supply and return below 5°C (41°F) for pipes greater than DN25 (1") dia.
- 2.3.2.4 50mm (2") - electrically traced piping, including drum drips of dry sprinkler system
- 2.3.3 Cover 'cold' piping running outside the building envelope with insulation thickness as follows:
- 2.3.3.1 65mm (2-½") - pipes up to and including DN50 (2") dia.
- 2.3.3.2 80mm (3") - pipes DN65 (2-½") up to and including DN100 (4") dia.
- 2.3.3.3 90mm (3-½") - pipes above DN100 (4") dia.
- 2.3.4 In lieu of the above specified insulation, Armstrong AP/Armaflex flexible elastomeric expanded closed-cell insulation with same thickness may be substituted for the following services:
- horizontal unburied rain water piping, including the piping up to and including roof hoppers or drain fixtures
 - horizontal unburied sanitary drains
 - refrigerant suction piping, 16mm (5/8") thickness
 - auxiliary water piping on refrigeration compressors

2.4 HOT PIPING

- 2.4.1 Cover 'hot' piping – heating water/glycol, domestic hot water supply and recirculation, condenser water, hot-gas bypass, drip and blowdown lines, steam and condensate, at operating temperatures above 41°C/106°F – with rigid pipe insulation with

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factory applied kraft paper jacket bonded to aluminum foil vapour barrier with self-sealed lap. Hold insulation in place with flare type staples. Recover pipe in exposed areas with field applied jacket.

2.4.2 Insulation thickness shall be as follows:

2.4.2.1 25mm (1") - 'hot' piping up to 60°C (140°F) operating temperature, for pipes less than or equal to 100mm (4") dia.

- 'hot' piping up to 93°C (180°F) operating temperature, for pipes less than or equal to 50mm (2") dia.

2.4.2.2 40mm (1-½") - 'hot' piping up to 60°C (140°F) operating temperature, greater than 100mm (4") dia.

- 'hot' piping up to 93°C (180°F) operating temperature, greater than 50mm (2") dia.

- 'hot' piping up to 121°C (250°F) operating temperature, less than or equal to 50mm (2") dia.

2.4.2.3 50mm (2") - 'hot' piping up to 121°C (250°F) operating temperature, greater than 50mm (2") dia.

- electrically traced piping

2.4.3 Cover 'hot' piping running outside the building envelope with insulation thickness as follows:

2.4.3.1 65mm (2-½") - pipes up to and including DN50 (2") dia.

2.4.3.2 80mm (3") - pipes DN65 (2-½") up to and including DN100 (4") dia.

2.4.3.3 90mm (3-½") - pipes above DN100 (4") dia.

2.5 DUCTS

2.5.1 Insulate round supply ducts up to 750mm (30") diameter and rectangular supply ducts up to 750mm (30") width with 25mm (1") thick flexible duct insulation. Adhere insulation to duct surface with adhesive applied in strips 150mm (6") wide on 300mm (12") centres. Use fiberglass tying cord or 16 gauge annealed wire until the adhesive sets. Butt edges of insulation tightly together, and

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seal all breaks and joints with self-adhering aluminum tape.

- 2.5.2 Insulate round supply ducts over 750mm (30") diameter and rectangular supply ducts over 750mm (30") width with 25mm (1") thick rigid duct insulation board. Fasten the insulation with welded pins and speed washers on maximum 300mm (12") centres. Use a minimum of two (2) rows of fasteners per side. Butt edges of insulation tightly together, and seal all breaks and joints with self-adhering aluminum tape.
- 2.5.3 Where angles or standing seams extend beyond the insulation and before the final finish, apply a compressed layer of 25mm (1") flexible duct insulation over the angles and standing seams. Extend the insulation 75mm (3") on each side of the angle and place tightly around the projecting leg of the angle. Apply the insulation overlapping the edge so that the vertical part of the insulated angle will project throughout the work.
- 2.5.4 Where interior acoustic insulation is required, decrease the exterior insulation by equal thickness. Overlap the exterior insulation by at least 300mm (12"), upstream and downstream.
- 2.5.5 Apply vapour barrier over insulation on cold and dual temperature ducts.
- 2.5.6 Insulate all ductwork running outside the building with 75mm (3") rigid board insulation and weatherproof jacket.
- 2.5.7 Insulate the following duct:
 - 2.5.7.1 Air conditioning supply ducts from apparatus casings to air terminal control units, reheat coils, or duct termination.
 - 2.5.7.2 Tempered air supply ducts in unheated space.
 - 2.5.7.3 Air supply duct downstream of energy/heat recovery ventilators.
 - 2.5.7.4 All rigid supply ducts downstream from air terminal control units, reheat coils and hydronic terminal units.
- 2.5.8 Air intakes and exhaust:
 - 2.5.8.1 Insulate with rigid vapour seal insulation board.
 - 2.5.8.2 Impale the insulation in place with suitable speed washers or clips. Where angles or standing seams extend beyond the insulation, apply a compressed layer of 25mm (1") flexible duct wrap over the

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angles and standing seams. The wrap shall extend 75mm (3") on each side of the angle and placed tightly around the projecting leg of the angle. Apply the insulation overlapping the edge of the wrap on the angle so that the vertical part of the insulated angle will project throughout the work.

- 2.5.8.3 Seal all breaks and joints by adhering a 75mm (3") aluminum foil vapour barrier tape with fire retardant adhesive. Cover with canvas adhered with resin base lagging adhesive. Finish with one coat of the same lagging adhesive.
- 2.5.8.4 Insulate the following intakes and exhaust:
 - 2.5.8.4.1 All outdoor air intake ductwork from outside louvres to air handling units.
 - 2.5.8.4.2 All exhaust and relief ductwork from outside louvres to 1.5m (5 ft) upstream of motorized dampers or where there are no motorized dampers, from louver to fan discharge in 50mm (2") thickness.
 - 2.5.8.4.3 All exhaust and relief ductwork from outside louvres to heat recovery units located inside mechanical spaces/rooms in 50mm (2") thickness.
 - 2.5.8.4.4 All exhaust and relief ductwork from outside louvres to energy/heat recovery ventilators inside ceiling bulkheads and spaces in 40mm (1-1/2") thickness.
 - 2.5.8.4.5 Mixed air plenums in 50mm (2") thickness.
 - 2.5.8.4.6 Behind unused portion of louvers in 50mm (2") thickness.
- 2.5.9 Ensure that access doors of casings and plenums are supplied pre-insulated. Do not apply additional insulation.
- 2.6 BOILER BREECHING, GENERATOR EXHAUST PIPES AND MUFFLER
 - 2.6.1 Up to 482°C (900°F) operating temperature: Cover uninsulated boiler breeching, generator exhaust pipes and muffler with 128 kg/m³ (8.0 lb/ft³) density, 50mm (2") thick Roxul ProRox PS 960 pre-formed mineral fiber pipe insulation. For irregular shapes, use 50mm (2") thick Roxul MA 940 high temperature rated mineral fiber flexible wrap insulation.
 - 2.6.2 Between 482°C (900°F) and 650°C (1,200°F) operating temperature: Use the same insulation types as noted under **Error!**

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Reference source not found. however in 75mm (3") thickness.

2.6.3 Between 650°C (1,200°F) and 1,093°C (2,000°F) operating temperature: Cover uninsulated boiler breeching, generator exhaust pipes and muffler with 96 kg/m³ (6.0 lb/ft³), 25mm (1") thick Morgan Thermal Ceramics model Kaowool S ceramic fiber blanket insulation. Outside the blanket, apply 128 kg/m³ (8.0 lb/ft³) density Roxul ProRox PS 960 pre-formed mineral fiber pipe insulation in 50mm (2") thickness.

2.7 COLD EQUIPMENT

2.7.1 Cover 'cold' equipment with 25mm (1") thick Armstrong AP/Armaflex flexible elastomeric expanded closed-cell insulation. Apply to clean and dry surfaces, using 100% Armstrong 520 adhesive coverage on both surfaces to be joined. Use manufacturer's compression fit method of butt joining sheets.

2.7.2 Insulate the following equipment as 'cold' equipment. Finish insulation with two coats of Armaflex Finish. Color selection to be determined.

2.7.2.1 Refrigeration machine evaporators, suction lines, chiller shells, shell ends and sumps, except pre-insulated units

2.7.2.2 Water meters and irregular shapes.

2.7.2.3 Strainer heads in cold lines.

2.7.2.4 Cold water booster pumps.

2.7.2.5 Condensation trays.

2.7.2.6 Spray pumps, piping, valves, and fittings.

2.7.2.7 Flat plate heat exchangers.

2.7.3 Provide removable 1.3mm (16 ga.) aluminum sheet metal enclosure with insulation applied as above to inside of cover, for the following 'cold' equipment:

2.7.3.1 Chilled water pumps

2.7.3.2 Chilled water pump suction and discharge guides

2.7.3.3 Condenser water pumps

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- 2.7.3.4 Condenser water pump suction and discharge guides
- 2.7.4 Cover cooling tower sumps (if electrically traced) with 50mm (2") thick semi-rigid fiberglass board insulation with factory applied vapour barrier. Cut and mitre insulation to suit surface contours. Impale insulation on mechanically fastened pins, located at not greater than 300mm (12") centres. Apply expanded metal lath and lace edges with 1.63mm (16 ga.) galvanized annealed wire. Secure insulation and metal lath with speed washers.
- 2.7.4.1 Recover sumps with 0.5mm (24 ga.) thick sheet aluminum fabricated to the shape of the sump. Mechanically fasten in place with bands, sheet metal screws or pop rivets. All corners shall be square and raw metal edges concealed.
- 2.7.5 Under each dehumidifier and cooling coil drip pan, place 50mm (2") thick foam glass with all joints sealed with cold adhesive cement.
- 2.7.6 Cover chilled water storage tanks with 50mm (2") thick rigid fiberglass board insulation, scored to suit curved surface. Impale insulation on suitable welded fasteners on 300mm (12") centres secured in place with speed washers. Recover with field applied jacket.
- 2.8 HOT EQUIPMENT
- 2.8.1 Cover 'hot' equipment (for temperatures not exceeding 232°C/450°F) with 50mm (2") thick semi-rigid fiberglass board insulation. The insulation shall be held in place with 19mm (¾") metal bands on maximum 450mm (18") centres. For large, flat or irregular surfaces, impale the insulation over suitable welded fasteners on 300mm (12") centres secured in place with speed washers. Lace the metal edges that butt together with 1.63mm (16 ga.) galvanized annealed wire. Insulation shall not be compressed beyond a maximum of 5% at any point. Recover with field applied jacket.
- 2.8.2 Insulate the following equipment as 'hot' equipment:
- 2.8.2.1 Converters, shell and tube heat exchangers (including glycol).
- 2.8.2.2 Domestic hot water tanks and water heaters except pre-insulated units.
- 2.8.2.3 Refrigeration condensers, except pre-insulated units.

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2.8.2.4 Steam ancillaries.

2.8.3 Insulate flat plate heat exchangers with 25mm (1") thick Armaflex insulation. Refer to Paragraph 2.7.1 for details.

3 **EXECUTION**

3.1 APPLICATION

3.1.1 Do not apply insulation before piping ductwork and equipment has been tested and accepted.

3.1.2 All insulation shall be supplied and installed by a qualified insulation applicator in accordance with the latest MICA Commercial and Industrial Insulation Standard.

3.1.3 All insulation shall be applied in full accordance with the insulation manufacturer's recommendations, and shall present a neat professional appearance upon completion.

3.1.4 Apply all insulation in a manner to facilitate replacing and/or servicing of equipment. All insulation for equipment shall be removable and reusable.

3.1.5 Use insulation, wrapping, vapour barriers and adhesive materials having flame spread, fuel contributed and smoke developed ratings in accordance with rulings and regulations of authorities. Follow all rules, regulations, and instructions of the Fire Marshall's office and all authorities having jurisdiction.

3.1.6 Do not apply any insulation or finishing when the ambient temperature in the space is less than 10°C (50°F).

3.1.7 Apply insulation only on clean and dry surfaces.

3.1.8 On cold surfaces where a vapor seal must be maintained, insulation shall be applied with a continuous, unbroken moisture and vapor retarder. All hangers, supports, anchors, or other projections secured to cold surfaces shall be insulated and vapor sealed to prevent condensation. Wheatpaste must not be used.

3.1.9 All pipe insulation shall be continuous through walls, ceiling or floor openings or sleeves except where firestop materials are required.

3.1.10 Install multiple layers of insulation with longitudinal and circumferential joints staggered.

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- 3.1.11 Galvanized sheet metal shields, minimum 250mm (10") long and 1.3mm (18 gauge) thickness, shall be installed between hangers or supports and the piping insulation. Rigid insulation inserts shall be installed as required between the pipe and the insulation shields. Inserts shall be of equal thickness to the adjacent insulation and shall be vapor sealed as required. Inserts made of wood are not acceptable. Insulation inserts shall be no less than the following lengths:
- 3.1.11.1 40mm (1½") to 65mm (2½") IPS 250mm (10") long
- 3.1.11.2 75mm (3") to 150mm (6") IPS 300mm (12") long
- 3.1.11.3 200mm (8") to 250mm (10") IPS 400mm (16") long
- 3.1.11.4 300mm (12") and over IPS 550mm (22") long
- 3.1.12 For piping, ductwork or equipment exposed in mechanical rooms or high traffic areas, insulation shall be protected from abuse by the use of appropriate thickness of PVC jacketing, metal jacketing or laminated self-adhesive water and weather seals.
- 3.1.13 On boiler breeching, generator exhaust pipes and mufflers stagger half sections and butt one-piece sections firmly together. Recover insulation with glassfiber cloth, adhered with fire retardant and high temperature rated adhesive. Insulation shall be banded securely in place with 20mm x 0.5mm (¾" x 0.02") stainless steel bands on maximum 300mm (12") centres and recovered with metal jacketing secured using additional banding or sheet metal screws. Position bands at butt joint overlaps and in between joints to secure jacket.
- 3.1.14 Insulate over flanges and mechanical couplings with specified insulation and thickness, sized to suit flange diameters. Fill spaces between insulation and adjoining pipe insulation with similar material. Recover in exposed areas with canvas or PVC jackets.
- 3.1.15 If not using preformed insulation, wrap all valves and inline components in cold piping and in hot piping above 60°C (140°F) operating temperature with flexible duct insulation, under compression at 2 to 1 ratio. Recover in exposed areas with field applied jackets.
- 3.1.16 Cover the first 150mm (6") of hanger rods directly connected to cold piping, with block or sectional insulation. Finish to match jacket on piping. Recover in exposed areas with canvas jacket.

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- 3.1.17 Cover all insulated electrically traced piping, and all insulated piping, ductwork or equipment exposed to the outside with weatherproof field applied jacket.
- 3.1.18 Insulate all silencer casings where no internal media contacts wall.
- 3.1.19 All aluminum and PVC recovery jackets shall be removable and reusable.
- 3.1.20 Dampers, supports, anchors, etc. that are secured directly to cold surfaces must be adequately insulated and vapour sealed to prevent condensation.
- 3.1.21 Cover expansion joints first with a 0.7mm (24 gauge) galvanized metal sleeve and then insulate to provide equivalent thickness to that on adjoining pipe.
- 3.1.22 Ensure insulation is continuous through non-fire rated walls and floors. Terminate insulation neatly on either side of a fire rated barrier. Fill space between pipe and construction with fire retardant sealant. Insulation or recovery jacket shall not penetrate fire-rated construction.
- 3.1.22.1 Outdoor ductwork or insulation shall be installed so as to shed water and not allow standing water.
- 3.1.23 Insulate electrically traced piping and equipment only after pipe tracing has been installed and tested.
- 3.1.24 Repair/replace all insulation damaged during construction with the thickness, quality, and finish of original insulation.
- 3.1.25 Make good and refinish cracks, undulation or any other deficiencies occurring in the insulation or vapour barrier. Priming or painting of insulation will be done under Division 9 – Finishes.

END OF SECTION



DIVISION 21 – FIRE SUPPRESSION
SPECIFICATIONS
FOR THE
CITY OF TORONTO - DAYCARE CENTRE (METRO HALL)
55 JOHN STREET
TORONTO, ONTARIO

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Our Project No. 2021-0245

Issued for Approval
Design Development

October 1, 2024

DISCIPLINES MECHANICAL
ELECTRICAL
PLUMBING
LIGHTING DESIGN
COMMUNICATIONS & AV
SECURITY & RISK
COMMISSIONING
ENERGY SERVICES

SEAL:



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Section 21 12 00	Fire Standpipe Systems
Section 21 13 00	Sprinkler Systems

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3.2	Valves

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Section No.: **21 05 23**
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1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 - General Requirements, shall apply to and govern this Section.

1.2 SHOP DRAWINGS

1.2.1 Submit shop drawings for all fire protection valves.

2 **PRODUCTS**

2.1 GENERAL

2.1.1 All valves to be used on the fire protection system shall be approved by Underwriters Laboratories of Canada or Associated Factory Mutual Fire Assurance companies and shall bear identifying mark or label such as F.M., U.L.C., and I.A.O.

2.2 VALVES

2.2.1 Gate Valves

2.2.1.1 Up to DN50 (2") – shall be bronze O.S. & Y, rising spindle, double disc, 1,379kPa (200 psi).

Threaded ends - Jenkins Fig. 820J.

2.2.1.2 DN65 (2-½") and up – shall be iron body to ASTM A126-95 Class B, bronze mounted, O.S.&Y. solid wedge, rising spindle, double disc, flanged ends, 1,379kPa (200 psi) water, oil and gas.

2.2.1.3 Grooved end gate valves, DN65 (2-½") and up, shall be ductile iron body to ASTM A536, Grade 65-45-12, bronze mounted, O.S.&Y. resilient wedge, brass rising stem, cast iron, EPDM coated disc, grooved ends, 1725kPa (250 psi) CWP. Victaulic FireLock Series 771.

2.2.2 Butterfly Valves

2.2.2.1 DN65 (2-½") and up – shall be ductile iron body to ASTM A536, Grade 65-45-12, ductile iron disc with EPDM coating, weatherproof actuator with pre-wired supervisory switches, grooved ends, 2,065kPa (300 psi) CWP. Victaulic FireLock Series 705W.

2.2.3 Ball Valves

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2.2.3.1 Up to DN50 (2") – shall be bronze body, standard port, chrome-plated brass ball, stainless steel stem, TFE seats, grooved or threaded ends with brass gear box. Victaulic FireLock Series 728.

2.2.4 Check Valves

2.2.4.1 DN65 (2-½") and up – shall be iron body to ASTM A126-95 Class B, bronze mounted, swing check with renewable bronze disc and seat ring.

Flanged ends - Jenkins Fig. 477J
- Mueller 101M-AP

Valves on Siamese connection to have rubber faced disc.

Flanged ends - Jenkins Fig. 477J RD

2.2.4.2 Grooved end check valves, DN65 (2 ½") and up, shall be ductile iron body to ASTM A-536, Grade 65-45-12, non-slam aluminum bronze or elastomer coated ductile iron disc, stainless steel spring and shaft, PPS coated or welded-in nickel seat, grooved ends. Victaulic FireLock Series 717 or 717R.

2.3 ELECTRICAL SUPERVISION

2.3.1 Install supervisory switches on all system shutoff valves, suitable for operation with building fire alarm system. For OS & Y valves, switches shall be ULC, FM Potter OSYSU-A1 or OSYSI-A2 as required. All butterfly valves shall be factory assembled with ULC listed and FM approved internal monitor switches, one single-pole double-throw or two single-pole double-throw switches as required. Switches shall be installed inside the gearbox and preset at the factory.

2.3.2 Where it is impractical to use one of the switches described above (i.e., for drain valves, etc.), use Potter PMS type or System Sensor switches.

2.3.3 Wiring of valve monitors to annunciator panel shall be by Division 26 - Electrical.

3 **EXECUTION**

3.1 GENERAL

3.1.1 Valves shall be same size as line in which installed.

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- 3.1.2 Valves shall be located in such a manner that the top works, operators, and bonnets may be easily removed.
- 3.1.3 Stems of valves shall be positioned for maximum ease of use, but in no event in a manner causing a hazard, or with stem down unless specifically shown as such in the Contract Documents.
- 3.1.4 Provide valves where shown on the Drawings, or on schematic diagrams, or in details, or as specified.
- 3.2 VALVES
- 3.2.1 Provide valves on all mains and sub-mains to completely control, shut off and drain the system.
- 3.2.2 Provide all necessary drips and drains to completely empty the system.
- 3.2.3 Provide all necessary test and flushing connections. Provide sight flow connections where flow cannot be seen from shut-off valve location. Install chain operators and chains on valves 1.8m (6 ft.) or higher above floor. Keep chains out of working areas or ceilings.
- 3.2.4 Install a shut-off valve on each riser.
- 3.2.5 Shut-off valves upstream of fire pumps shall be supervised O.S.&Y. gate valves.

END OF SECTION

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1 GENERAL

1.1 GENERAL

1.1.1 Section 20 00 00 – General Requirements, shall apply to and govern this Section.

1.2 SCOPE OF WORK

1.2.1 Provide all labour, materials, tools, equipment, training, commissioning and certification required to complete the Work as shown on the Drawings and specified in this Section, including:

1.2.1.1 Complete fire standpipe piping system.

1.2.1.2 Connection to onsite fire hydrant, and connection to municipal water supply.

1.2.1.3 Provision of flanged connection for sprinkler systems.

1.2.2 Complete sprinkler system including piping will be provided under Section 21 13 00 – Sprinkler Systems.

1.3 REGULATORY REQUIREMENTS

1.3.1 In addition to specific requirements for pipe fittings as further specified in this document and where applicable, the equipment shall comply with the Boiler and Pressure Vessels Act and CSA Standard B51.

1.3.2 In compliance with the Act and relevant Codes, all fittings shall be registered by the manufacturer, and shall be identified by the appropriate Canadian registration number.

1.3.3 Where fittings are provided without the appropriate Canadian registration number, the Contractor shall obtain a copy of the manufacturer's Statutory Declaration as provided to the authorities having jurisdiction.

1.3.4 All welding and fabrication shall be to the requirements of the ANSI/ASME B31.1 code for pressure piping and CSA standard B51 code for the Construction and Inspection of Boilers and Pressure Vessels.

2 PRODUCTS

2.1 PIPES AND FITTINGS

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- 2.1.1 For 860 kPa (125 psi) or less operating pressure use 860 kPa (125 psi) rated fittings. For 860 kPa to 1,730 kPa (125 psi to 250 psi) operating pressure use 1,730 kPa (250 psi) rated fittings.
- 2.1.2 Piping shall be Schedule 40 ASTM-A53 with screwed fittings up to 65mm (2-1/2") dia. and Schedule 40 standard steel butt-welding fittings for 75mm (3") dia. pipe and above. Where approved by the Authorities, lightwall piping may be used for piping of 50mm (2") dia. and over.
- 2.1.3 Mechanical couplings such as Victaulic may be used. Couplings shall be ULC listed and FM approved.
 - 2.1.3.1 All couplings shall be by one manufacturer, suitable for pressure and temperature of respective system.
 - 2.1.3.2 Mechanical couplings shall consist of two ASTM A536 ductile iron housings, pressure-responsive synthetic rubber gasket (grade to suit the intended service) and plated steel bolts and nuts.
 - 2.1.3.3 Rigid Type Couplings: Housings shall be cast with offsetting, angle-pattern bolt pads to provide system rigidity and support and hanging in accordance with NFPA 13. Tongue and recess rigid type couplings shall only be permitted if the Subcontractor uses a torque wrench for installation. Required torque shall be in accordance with the manufacturer's recommendations. The Subcontractor shall remove and replace any improperly installed joints.
 - 2.1.3.3.1 DN30 – DN100 (1-1/4" thru 4"): "Installation Ready" rigid type coupling designed for direct "stab" installation onto grooved end pipe without prior disassembly of the coupling equal to Victaulic FireLock® EZ Style 009.
 - 2.1.3.3.2 DN125 (5") and larger: standard rigid joint, Victaulic FireLock® Style 005 or Style 07 Zero-Flex®.
 - 2.1.3.4 Flexible type couplings: use in seismic areas where required by NFPA 13. Victaulic Style 75 or 77.
 - 2.1.3.5 Grooved end fittings: ASTM A536 ductile iron, short radius, full flow (FireLock®), or standard ASTM A536 ductile iron, forged steel or ASTM A53 fabricated carbon steel fittings, factory grooved, designed to accept grooved end couplings.
 - 2.1.3.6 Grooved joint flange adapters: ASTM A536 ductile iron casting,

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flat faced, for incorporating flanged components with ANSI Class 125, 150 and 300 bolt-hole patterns to a grooved system. Victaulic Style 741, 743 or 744.

3 EXECUTION

3.1 GENERAL

- 3.1.1 Piping shall be installed in accordance with NFPA-20.
- 3.1.2 Ream all piping and keep plugged to prevent entry of dirt. Use pipes, which conform to CSA and ASTM standards.
- 3.1.3 Provide unions, couplings, or flanges at all connections to equipment or fixtures requiring servicing or replacement.
- 3.1.4 Provide Underwriter approved hangers, and support all piping from building structure. Under no circumstances shall piping be hung from ductwork or steel roof-deck. Provide secondary steel supports where piping under ducts cannot be supported directly from structure. Where pipes are hung from joists, they shall be hung from top cord.
- 3.1.5 Install piping in a professional manner and in accordance with the practices of the trade.
- 3.1.6 Consider the piping shown on the Drawings as diagrammatic, for clearness in indicating the general runs and connections and that the piping may, or may not, in all parts be shown in the true position. This does not relieve the responsibility for the proper erection of the systems of piping in every respect suitable for the work intended.
- 3.1.7 Ensure that welding is performed, using either gas or electric welding equipment. Thoroughly clean pipe surfaces and level the ends of each pipe and fitting before welding. Securely align and space piping so that the width of circumferential welds is two and one-half times the pipe wall thickness. Ensure that the deposited metal forms a gradual increase in thickness from the outside surface to the centre of the weld.
- 3.1.8 Ensure that the pipe welding is done by a welder holding a certificate from TSSA or from the Canadian Welding Bureau (CWB) for the class of piping to be welded.
- 3.1.9 When welding or cutting with a torch, take every precaution to

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prevent fire. Ensure that welding or torch cutting operators have a fully charged 4.5kg (10 lb.) carbon dioxide fire extinguisher with them, when welding or cutting in building, or tunnels. Protect wooden structures with asbestos blanket.

- 3.1.10 Ensure that fabrication, welded or otherwise, meets the requirements of the ASA B31.1 Code for Pressure Piping, the CSA B51 Code for Boiler, Pressure Vessel, and Pressure Piping, and all requirements of the Boilers and Pressure Vessels Act of the Province of Ontario.
- 3.1.11 Use only fittings, or other materials to be incorporated in the work, which are approved by TSSA's Boiler and Pressure Vessels Safety Program, for the class of work for which they are used.
- 3.1.12 Grooved joint piping systems shall be installed in accordance with the manufacturer's guidelines and recommendations. The gasket style and elastomeric material (grade) shall be verified as suitable for the intended service as specified in the Contract Documents. Gaskets shall be supplied by coupling manufacturer. Grooved end shall be clean and free from indentations, projections and roll marks in the area from pipe end to groove. A factory trained field representative shall provide on Site training to Subcontractor's field personnel in the installation of grooved piping products. Factory trained representative shall periodically review the Product installation. Subcontractor shall remove and replace any improperly installed Products.
- 3.1.13 Provide thrust restraints on mechanical pipe joints where required to accommodate axial thrust.
- 3.1.14 Provide a DN50 (2") drain valve and piping at the lowest point to permit draining.
- 3.2 TESTING
- 3.2.1 After all pipes have been placed in position, test the tightness of all joints and the soundness of all pipes.
- 3.2.2 Make all tests before piping is furred in.
- 3.2.3 Notify the Consultant at least 48 hours before commencing with test, and give the Consultant a written certificate confirming these tests.
- 3.2.4 Test all fire suppression lines hydrostatically at two (2) times the

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working pressure or as required by authorities having jurisdiction, for a period of not less than four (4) hours without any drop in pressure. Do testing before piping is buried or furred in and before pressure sensitive devices are installed in the pipework. Correct all defects disclosed by tests. Retest until all results are acceptable.

- 3.2.5 If any leaks are discovered by the above tests, remove and replace the faulty portions of the systems and repeat the test. Repeat this procedure until the system is accepted by the Consultant's representative on the Site. Do not caulk threaded joints.

3.3 FLUSHING AND CLEANING

3.3.1 General

- 3.3.1.1 Inspect the systems, and remove any heavy debris and excessive oil and dirt.

- 3.3.1.2 Flush all completed systems with clear water at the highest obtainable pressure and velocity.

- 3.3.1.3 During flushing and cleaning, maintain all isolating valves in the open position.

3.4 STREET SERVICES

- 3.4.1 Connect building fire main water line to street main where shown, and make all necessary arrangements with authorities and utilities involved. Pay for all permits and inspections and for all work to be done by the local authorities and utility companies.

- 3.4.2 Check and verify all invert elevations before proceeding with any of the work of this Section.

3.5 COMPLETION

- 3.5.1 Provide a declaration, signed by a responsible officer of the Company indicating that the following procedures and tests have been performed in accordance with the Drawings and Specifications. Provide two (2) copies of the signed declaration to the Consultant.

- 3.5.1.1 Water pressure test performed and leak free.

- 3.5.1.2 Plumbing inspections made and issue necessary certificates.

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3.5.2 Identify and colour code piping in accordance with Section 20 05
53 – Identification.

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1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 – General Mechanical Requirements, shall apply to and govern this Section.

1.2 SCOPE OF WORK

1.2.1 Provide all labour, materials, tools equipment, training, commissioning and certification required to complete the work as shown on the Drawings and specified in this Section, including:

1.2.1.1 Complete fire standpipe system, including valves, fire hose cabinets, fire department connections, fire hydrants, fire extinguishers, and electrical valve supervision.

1.2.2 Refer to Section 21 05 23 – Fire Protection Valves for valves.

1.2.3 Refer to Section 21 11 00 – Fire Suppression Piping for piping.

1.2.4 Refer to Section 21 11 16 – Fire Hydrants for hydrants.

1.2.5 Refer to Section 21 11 19 – Fire Department Connections for Siamese connections.

1.2.6 Refer to Section 21 30 00 – Fire Pumps for fire standpipe pumps.

1.2.7 Provide all electrical supervision devices for each shutoff valve in system. Refer to Section 21 05 23 – Fire Protection Valves.

1.2.8 All pipe sizes and layout of new systems shown on drawings are to assist tender coordination only. It is the responsibility of the Contractor to ensure adequate hose coverage, extinguisher coverage, pipe sizing, zoning and valving for the system as per NFPA 14 hazard occupancies, Owner's Insurer' standards, OBC, and authorities having jurisdiction. Install additional valves and resize piping as required at no additional cost to the owner. Re-routing of fire standpipe mains shall be approved in advance by the Consultant.

1.2.9 Identify all changes to the fire alarm system resulting from shop drawings. All cost related to changes initiated by the Sprinkler Designer shall be included in the Contract Price.

1.2.10 Obtain flow and pressure available from city main and obtain approval from IAO before commencing work. Verify flow and

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pressure data shown on contract documents with local authorities. Undertake flow test were required, at no additional cost to the owner. Conduct test in accordance with IAO Standards.

1.3 QUALITY ASSURANCE

1.3.1 Materials shall be listed by UL or ULC.

1.3.2 Comply with all codes, including the Ontario Building Code, local authorities, IAO and NFPA regulations.

1.4 SHOP DRAWINGS

1.4.1 Submit shop drawings for all fire standpipe equipment.

2 **PRODUCTS**

2.1 VALVES

2.1.1 Refer to Section 21 05 23 – Fire Protection Valves.

2.1.2 Dry-pipe valve shall be Simplex Grinnell Model 'E-2' with A-2 trim, compressed air connection, pressure gauges, alarm test bypass, air compressor and air maintenance devices.

2.2 FIRE HOSE CABINETS

2.2.1 Recessed fire hose cabinets shall be National Fire Equipment Model CK-2002, 762mm x 762mm x 203mm (30" x 30" x 8"). Cabinet shall be constructed of 1.19mm (18-gauge) baked white enamel corrosion protected steel tub with 2mm (14-gauge) grey baked enamel steel door and frame with hollow channel reinforcement. Front section to have 51mm (2") adjustment to wall surface and complete with 13mm (1/2") turn back frame. Door shall be fitted with full panel of 5mm (3/16") clear glass, full-length semi-concealed piano hinges, and flush stainless steel door latch. Provide plexi panel instead of glass for parking garage.

2.2.2 Surface mount fire hose cabinets shall be National Fire Equipment Model CS-800, 762mm x 762mm x 203mm (30" x 30" x 8"). Cabinet shall be constructed of 1.19mm (18-gauge) baked grey enamel corrosion protected steel tub with 2mm (14-gauge) grey baked enamel steel door and frame with hollow channel reinforcement. The frame section shall be site adjustable for left or right door swing. Door shall be fitted with full panel of 5mm (3/16") clear glass, full-length semi-concealed piano hinges, and flush stainless steel door latch. Provide plexi panel instead of glass for

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parking garage.

- 2.2.3 All equipment inside the fire hose cabinets shall be highly polished chrome plated finish.
- 2.2.4 Each cabinet shall contain the following equipment:
 - 2.2.4.1 DN65 (2-1/2") dia. model A56 cast brass Fire Department valve with cap and chain.
 - 2.2.4.2 DN40 (1-1/2") dia. model A51 cast brass angle valve with hydrolator.
 - 2.2.4.3 30m (100 ft) x DN40 (1-1/2") dia. peerless 100% synthetic, hose, 3,450 kPa (500 psi) rated, complete with forgeline brass couplings.
 - 2.2.4.4 Model 1575 moulded polycarbonate combination fog nozzle.
 - 2.2.4.5 Model HR semi-automatic swing hose rack.
 - 2.2.4.6 Model PWS-25-F – 9.5-litres (2.5 US gallons) stainless steel pressurized water extinguisher. (Except in parking garage, use PDC-10, dry chemical type, 60BC rating).
 - 2.2.4.7 Three (3) hose wrenches.
- 2.2.5 Where the residual or static pressure at any DN40 (1-1/2") standpipe outlet exceeds 689 kPa (100 psi), provide an approved pressure-regulating valve, similar to Model UR25-15, to reduce the residual and static pressures with the required flow at the outlet to 689 kPa (100 psi).
 - 2.2.5.1 In lieu of pressure regulating valve, approved pressure-restricting valve, similar to Model A156, may be used where the residual pressure is between 689 kPa (100 psi) and 1,206 kPa (175 psi).
- 2.2.6 Where the residual or static pressure at any DN65 (2-1/2") standpipe outlet exceeds 1,206 kPa (175 psi), provide an approved pressure-regulating valve, similar to Model A202, to reduce the residual and static pressures with the required flow at the outlet to 1,206 kPa (175 psi).
- 2.3 HOSES
 - 2.3.1 Single 30m (100 ft) x DN40 (1-1/2") dia. peerless 100% synthetic, hose, 3,450 kPa (500 psi) rated, complete with forgeline brass couplings and Model 1575 moulded polycarbonate combination fog

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nozzle to be stored in or near CACF room.

2.4 FIRE EXTINGUISHERS

- 2.4.1 Provide Model ABC-10, 4.5 kg (10 lbs) multi purpose dry chemical fire extinguisher with 4A80BC rating in all finished areas where shown on plans and as required to meet coverage and maximum travel distance requirements per the Ontario Fire Code. Mount extinguisher in recessed cabinet NFE Model #CTE-300. Cabinet shall be constructed of 1.19mm (18-gauge) baked grey enamel corrosion protected steel tub with 2mm (14-gauge) grey baked enamel steel door and frame with hollow channel reinforcement. The frame section shall be site adjustable for left or right door swing. Door shall be fitted with full panel of 5mm ($\frac{3}{16}$ ") clear glass, full-length semi-concealed piano hinges, and flush stainless steel door latch.
- 2.4.2 Provide Model ABC-10-G, 4.5 kg (10 lbs) multi purpose dry chemical fire extinguisher with 4A60BC rating in the mechanical rooms, electrical room, diesel room, U.P.S., battery room, switchgear room, and transformer vault. Mount extinguisher near the door with an approved aluminum wall bracket.
- 2.4.3 Provide Model PDC-10, 4.5 kg (10 lbs) standard dry chemical type fire extinguisher, with a minimum rating of 60BC in the parking garage. Mount extinguisher in surface mounted cabinet equal to NFE Model #ECS-999, 267mm (10.5") W x 607mm (24") H x 159mm (6.25") D. Cabinets shall be complete with cylinder lock and break glass mechanism.
- 2.4.4 Provide Model F260 6 liters (1.6 US gallons) class 'K' extinguisher with 1BC rating complete with wall bracket for kitchen areas.

3 **EXECUTION**

3.1 FIRE HOSE/VALVE CABINETS

- 3.1.1 Height of cabinets shall be as directed and in accordance with local authorities.

3.2 STANDPIPE PROTECTION

- 3.2.1 For non-sprinklered buildings, protect all feed mains, standpipes, horizontal standpipes and branch lines located outside a rated shaft or exit staircase by wrapping the above piping with 3M Fire Barrier Plenum Wrap 5A+ to a fire resistance rating equal to the

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exit staircase.

- 3.2.2 For sprinklered buildings, protect all standpipes, horizontal standpipes and branch lines located outside a rated shaft or exit staircase by wrapping the above piping with 3M Fire Barrier Plenum Wrap 5A+ to a fire resistance rating equal to the exit staircase.

3.3 TESTING

- 3.3.1 Test fire standpipe system in accordance with NFPA-20.

3.4 WATER SUPPLY

- 3.4.1 Provide a low-pressure alarm switch, complete with hydraulic connection and Trerice No. 872 pressure snubber, in the water service main upstream of any pressure booster pump.

3.5 CONFORMANCE LETTER

- 3.5.1 Final NFPA certification letter shall be provided before mechanical compliance letter is issued. Certification letter shall contain contractor's contact information, the building permit number, certification statement in regard to NFPA compliance and be stamped by a licensed professional engineer.

END OF SECTION

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1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 - General Requirements, shall apply to and govern this Section.

1.1.2 All equipment and accessories shall be I.A.O., UL, ULC, or FM labelled and/or approved.

1.1.3 All systems shall be designed to NFPA-13 standards, all applicable codes and standards, authority having jurisdiction and the Owner's Insurance Underwriters approval.

1.2 SCOPE OF WORK

1.2.1 Provide all labour, materials, tools, equipment, training, commissioning and certification required to complete the work as shown on the drawings and specified herein, including:

1.2.1.1 Modifications to existing wet sprinkler systems.

1.2.2 Apply and pay for all permits.

1.2.3 Provide all electrical supervision devices for each shutoff valve in system. Refer to Section 21 05 23 – Fire Protection Valves.

1.2.4 Provide all required additional electrical work for this Section not specified in Sections 20 05 13 – Electric Motors, 20 05 14 – Electrical Wiring, and Division 26 – Electrical. Complete electrical work in accordance with Division 26 – Electrical.

1.2.5 Provide all additional working plans or load calculations as may be required by the bodies having jurisdiction. Include all costs pertaining to the review of these plans and calculations. All working plans and calculations shall be submitted to the Owner's insurer and local Fire Department for approval as required prior to construction commencement.

1.2.6 All pipe sizes, head location, head quantity, and layout of new systems shown on Drawings are to assist tender coordination only. It is the responsibility of the Contractor to ensure adequate head coverage, head quantities, pipe sizing, zoning, and valving for the system as per NFPA 13 hazard occupancies, Owner's Insurers' standards, all applicable codes and standards, and authorities having jurisdiction. Install additional heads, valves, and resize piping as required at no additional cost to the Owner. Size

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reduction of sprinkler main shall not be accepted unless approved by the Consultant. Re-routing of sprinkler main, or repositioning of heads in finished ceiling areas, shall be approved in advance by the Consultant.

1.2.7 Identify all changes to the fire alarm system resulting from sprinkler shop drawings. All cost related to changes initiated by the Sprinkler Designer shall be the responsibility of Division 21 – Fire Suppression.

1.2.8 Obtain flow and pressure available from city main and obtain approval from IAO before commencing work. Verify flow and pressure data shown on contract documents with local authorities. Undertake flow test were required, at no additional cost to the Owner. Conduct test in accordance with IAO Standards.

1.3 QUALITY ASSURANCE

1.3.1 The system installation shall be carried out by a sprinkler company who is a member in good standing of the Canadian Automatic Sprinkler Association.

1.3.2 To assure uniformity and compatibility of piping components in grooved piping systems, all grooved products utilized shall be from the same manufacturer. Grooving tools shall be supplied by the same manufacturer as the grooved components.

1.4 LAYOUT DRAWINGS

1.4.1 Sprinkler layout as shown on the Drawings is diagrammatic. Refer to latest Architectural Drawings for final layout of wall, partitions, ceilings, bulkheads, and occupancy areas.

1.4.2 Sprinkler contractor must check and verify all dimensions and conditions on the job, and ensure that the Work can be performed as indicated. Report all discrepancies to the Consultant before proceeding with the Work.

1.4.3 Prepare complete sprinkler layout drawings, arranging piping runs and sprinkler heads in proper relation to other equipment such as light fixtures, ducts, etc., to ensure clear ceiling heights indicated on Drawings. Coordinate location of sprinkler heads in suspended ceilings with the location of lighting, grilles, diffusers, and similar items. Maintain maximum headroom in areas with no ceilings.

1.4.4 Layout drawings shall also include all hydraulic calculations.

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- 1.4.5 Obtain approval of the sprinkler layout drawings by an Insurers' Advisory Organization, Factory Mutual, and the Consultant before any work is started.
- 1.4.6 Sprinkler layout drawings shall take into consideration, architectural, structural, mechanical and electrical layouts of the building and sprinkler mains and branches must be arranged to not interfere with any of the aforementioned.
- 1.4.7 Submit drawings, support details, and weights to structural engineer for review.
- 1.4.8 Sprinkler heads are to be installed symmetrically in ceiling tiles.
- 1.4.9 Layout drawings are to be sealed by a Registered Professional Engineer, registered in the Province of Ontario.
- 1.4.10 Submit drawings to the Consultant for review only after they have been approved by the local authorities and the Owner's Insurer.
- 1.5 SUBMITTALS
 - 1.5.1 Submit shop drawings for the following:
 - 1.5.1.1 Sprinkler system layout, including hydraulic calculations
 - 1.5.1.2 Sprinkler heads
 - 1.5.1.3 Insulator switches
 - 1.5.1.4 Alarm valves - wet and dry
 - 1.5.1.5 Flow switches
 - 1.5.1.6 Low pressure switches
 - 1.5.1.7 Pre-action valves and trim
 - 1.5.1.8 Heat detectors
 - 1.5.2 Layout drawings shall be approved by local Fire Department and Owner's Insurer prior submission to Consultant. All costs related to obtaining agency approval shall be borne by this Contractor.
 - 1.5.3 Submit samples of all sprinkler heads to be used to the Consultant.
 - 1.5.4 Forward to the Owner on completion of the contract the final

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unconditional acceptance certificates of the authorities.

- 1.5.5 Grooved joint couplings and fittings shall be shown on drawings and product submittals, and be specifically identified with the applicable style or series number.
- 1.5.6 Sprinklers shall be referred to on drawings, submittals and other documentation, by the sprinkler identification or model number as specifically published in the appropriate agency listing or approval. Trade names or other abbreviated designations shall not be allowed.
- 1.6 **DESIGN REQUIREMENTS**
 - 1.6.1 Size piping on basis of hydraulic design.
 - 1.6.2 Do all necessary hydraulic design, piping calculations, and submit to governing authorities for approval.
- 1.7 **HYDRAULIC CALCULATIONS**
 - 1.7.1 Office Areas.
 - 1.7.1.1 System shall be hydraulically designed.
 - 1.7.1.2 Hazard classification – Light Hazard.
 - 1.7.1.3 Rate of water application (density) 0.068 L/s/m² (0.1 gpm/ft²) over 139 m² (1,500 ft²).
 - 1.7.1.4 Pipe sizes shall be based on 16.3 m² (175 ft²) per head.
 - 1.7.1.5 The reflected ceiling layout as prepared by the Consultant shall not be altered or revised by this requirement. The number and location of heads shown shall remain as shown as a minimum.
 - 1.7.2 Residential Suites, Corridors and Amenity Areas.
 - 1.7.2.1 System shall be hydraulically designed.
 - 1.7.2.2 Hazard classification – Light Hazard.
 - 1.7.2.3 Rate of water application (density) 0.068 L/s/m² (0.05 gpm/ft²) over 139 m² (1,500 ft²), or 83.6 m² (900 ft²) using quick response sprinkler heads in low ceiling areas (less than 3.0m).
 - 1.7.3 Service Spaces (Electrical Rooms, Telecom Rooms, Garbage

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Room, Loading Dock etc.) and Penthouse Mechanical Room.

- 1.7.3.1 System shall be hydraulically designed.
- 1.7.3.2 Hazard Classification – Ordinary Hazard Group 1.
- 1.7.3.3 Rate of water application (density) 0.102 L/s/m² (0.15 gpm/ft²) over 139 m² (1,500 ft²).
- 1.7.4 Parking Garage Dry System.
- 1.7.4.1 System shall be hydraulically designed.
- 1.7.4.2 Hazard Classification – Ordinary Hazard Group 1.
- 1.7.4.3 Rate of water application (density) 0.102 L/s/m² (0.15 gpm/ft²) over 181.2 m² (1,950 ft²).
- 1.7.5 Retail Areas.
- 1.7.5.1 System shall be hydraulically designed.
- 1.7.5.2 Hazard Classification – Ordinary Hazard Group 2.
- 1.7.5.3 Rate of water application (density) 0.136 L/s/m² (0.2 gpm/ft²) over 139 m² (1,500 ft²).
- 1.7.6 Diesel Tank Room and Diesel Generator Rooms.
- 1.7.6.1 System shall be hydraulically designed.
- 1.7.6.2 Hazard Classification – Extra Hazard.
- 1.7.6.3 Rate of water application (density) 0.17 L/s/m² (0.25 gpm/ft²) over 23 m² (250 ft²).

2 **PRODUCTS**

2.1 VALVES

- 2.1.1 Refer to Section 21 05 23 – Fire Protection Valves.
- 2.1.2 Alarm valves shall be Tyco Model AV-1-300 Alarm Check Valve rated for 2,068 kPa (300 psi): Alarm check valves shall be specifically listed for use in wet pipe systems. Alarm check valves shall be of a ductile iron construction intended for use in either the vertical or horizontal position. When variable water supply pressures exist, alarm check valves shall be installed with a retard

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chamber. Alarm check valves shall be connected to a water motor-operated mechanical alarm or a pressure switch equal to Potter PS10A, for initiating electrical alarms, or both. Valves shall be complete with external bypass, test bypass, pressure gauges, and drain connections. Pipe relief and drain valves to hub drain.

- 2.1.3 Dry-pipe valves shall be Tyco Model DPV. Dry pipe valves shall be of a ductile iron construction installed in the vertical position. Dry pipe valves shall be rated for use at a maximum service pressure of 1,724 kPa (250 psi). Valves shall be mechanically latching and externally resettable. Dry pipe valves shall be of the differential type, having a differential of approximately 5.5:1. Valve to be complete with compressed air connection, alarm switches, accelerator, drain connection, pressure gauges, alarm test bypass, air compressor and air maintenance devices.

2.2 ELECTRIC SUPERVISION

- 2.2.1 Provide each O.S. & Y. gate valve with an electric monitor switch. Refer to Section 21 05 23 – Fire Protection Valves.
- 2.2.2 The sprinkler system shall be electrically supervised to indicate a trouble signal on the building fire alarm system annunciator for each of the following:
- 2.2.2.1 Movement of control valve handle.
 - 2.2.2.2 Loss of excess water pressure required to prevent false alarms in a wet pipe system.
 - 2.2.2.3 Loss of air pressure in a dry pipe system.
 - 2.2.2.4 Loss of air pressure in a pressure tank.
 - 2.2.2.5 Loss of electrical power or phase reversal in any automatically starting electrical fire pump.
 - 2.2.2.6 Fire pump running.
 - 2.2.2.7 Sprinkler zone flow alarm.
 - 2.2.2.8 Failure of the electric tracing system.
 - 2.2.2.9 Pre-action system first and second stage alarms.
 - 2.2.2.10 CO₂ system activation.

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2.3 TEST AND DRAIN FITTINGS

2.3.1 For each system, provide Tyco Model F350 Sectional Test and Drain or Victaulic Style 720 TestMaster II combined test and drain fitting with orifice sized according to the installed sprinkler heads.

2.3.2 Pipe discharge to outside or the nearest floor drain. Outside drains shall be complete with 65mm (2-1/2") connections with cap and chain. Wall plate shall match the siamese connection.

2.4 SPRINKLER HEADS

2.4.1 Provide Tyco Model TY-FRB pendant automatic semi-recessed sprinklers complete with mounting plates all chrome plated in suspended ceilings.

2.4.2 Provide Tyco Model RFII concealed clean line sprinkler heads in all drywall ceilings. Plate cover colour to be selected by Consultant.

2.4.3 Provide Tyco Model TY-FRB rough brass upright or pendant sprinkler heads in areas without suspended ceilings.

2.4.4 Sidewall sprinkler heads shall be Tyco Model TY-FRB, all chrome plated.

2.4.5 Sprinkler heads for kitchen walk-in coolers and freezers shall be Tyco Model DS-1 dry pendant quick response type.

2.4.6 Temperature ratings of sprinkler heads shall be suitable for the particular location, i.e. in general 75°C (167°F) heads shall be used, with higher temperature heads adjacent to unit heaters, etc.

2.4.7 Sprinklers shall be glass bulb type. Body shall be die-cast brass with hex-shaped wrench boss cast into the body to facilitate installation and reduce the risk of damage during installation.

2.4.8 Provide sprinkler guards for sprinkler heads in storage areas, mechanical rooms, and receiving area. Sprinkler guards shall be listed, supplied, and approved for use with the sprinkler by the sprinkler manufacturer.

2.4.9 The sprinkler bulb protector must remain in place until the sprinkler is completely installed and before the system is placed in service. Remove bulb protectors carefully by hand after installation. Do not use any tools to remove bulb protectors.

2.5 PIPE AND FITTINGS

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- 2.5.1 Unburied piping shall be standard Schedule 40 black steel pipe, stretch reduced continuous weld up to and including 100mm (4") dia. and for 125mm dia. (5") and over, electric resistance weld. Where approved by the Authorities, lightwall piping may be used for piping of 50mm (2") dia. and over.
- 2.5.2 Fittings shall be standard screwed iron fittings.
- 2.5.3 Fittings shall be standard welding fittings if approved by authorities having jurisdiction.
- 2.5.4 Mechanical couplings such as Victaulic or Tyco/Grinnell may be used. Couplings shall be ULC listed and FM approved.
 - 2.5.4.1 Mechanical couplings shall consist of two ASTM A536 ductile iron housings, pressure-responsive synthetic rubber gasket (grade to suit the intended service) and plated steel bolts and nuts.
 - 2.5.4.2 Rigid Type Couplings: Housings shall be cast with offsetting, angle-pattern bolt pads to provide system rigidity and support and hanging in accordance with NFPA 13. Tongue and recess rigid type couplings shall only be permitted if the contractor uses a torque wrench for installation. Required torque shall be in accordance with the manufacturer's recommendations. Contractor shall remove and replace any improperly installed joints.
 - 2.5.4.3 32mm – 100mm (1-1/4" thru 4"): "Installation Ready" rigid type coupling designed for direct "stab" installation onto grooved end pipe without prior disassembly of the coupling equal to Victaulic FireLock® EZ Style 009.
 - 2.5.4.4 125mm (5") and larger: standard rigid joint, Victaulic FireLock® Style 005 or Style 07 Zero-Flex®.
 - 2.5.4.5 Flexible type couplings: use in seismic areas where required by NFPA 13. Victaulic Style 75 or 77.
 - 2.5.4.6 Grooved end fittings: ASTM A536 ductile iron, short radius, full flow (FireLock®), or standard ASTM A536 ductile iron, forged steel or ASTM A53 fabricated carbon steel fittings, factory grooved, designed to accept Victaulic couplings.
 - 2.5.4.7 Grooved joint flange adapters: ASTM A536 ductile iron casting, flat faced, for incorporating flanged components with ANSI Class 125, 150 and 300 bolt-hole patterns to a grooved system. Victaulic Style 741, 743 or 744.

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2.5.5 Piping for dry-pipe systems, including pre-action, shall be galvanized.

2.6 FLEXIBLE SPRINKLER PIPE FITTINGS

2.6.1 Flexible sprinkler pipe fittings shall be Victaulic VicFlex Series or approved equal.

2.6.2 Shall consist of a braided type 304 stainless steel flexible tube, zinc plated steel male threaded nipple for connection to branch-line piping, and a zinc plated steel reducer with a female thread for connection to the sprinkler head.

2.6.3 Coupling shall be single-bolt, consisting of two ductile iron housings, Grade E "EPDM" gasket, and a zinc electroplated steel bolt and nut conforming to ASTM A449.

2.6.4 The drop shall include a UL approved braided hose with a bend radius to 2" to allow for proper installation in confined spaces. The hose shall be listed for [(4) bends at 31" length] [(5) bends at 36" length] [(8) bends at 48" length] [(10) bends at 60" length] [(12) bends at 72" length].

2.6.5 Union joints shall be provided for ease of installation. The flexible drop shall attach to the ceiling grid using a one-piece open gate bracket. The bracket shall allow installation before the ceiling tile is in place. The braided drop system is UL listed for sprinkler services to 175 psi (1206 kPa) and FM Approved to 200 psi (1380 kPa).

2.6.6 For cold storage applications, bracket shall withstand differential movement, protect against condensation and stay intact.

2.6.7 All hoses shall be factory-pressure tested to 400 psi. (2760 kPa).

2.6.8 Sprinkler fittings shall have the following approvals:

2.6.8.1 1) FM-1637

2.6.8.2 2) UL 2443

2.7 PIPING "LOW PRESSURE" ALARM SENSOR

2.7.1 ULC listed, 115 Volt or 24 Volt (to suit fire alarm system) adjustable piping mounted pressure sensor with contacts arranged to actuate a fire alarm system trouble signal if piping pressure drops to a pressure below the switch setting.

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2.8 WATER FLOW ALARM SWITCHES

2.8.1 Potter Model VSR-F, ULC listed and FM approved, pipe mounting water flow alarm switch 50mm (2") to 200mm (8"), complete with:

2.8.1.1 A vane type sensor operating two single-pole, double-throw, snap action switches when sustained water flow exceeds 0.63 L/s (10 USgpm).

2.8.1.2 An integral, field adjustable retard device with automatic reset to delay switch operation to reduce the possibility of false alarms caused by a single or series of transient water flow surges.

2.8.1.3 A tamper-proof cover.

2.8.1.4 A U-bolt and piping saddle.

2.8.2 Where grooved end mechanical coupling joint piping is used, Victaulic Model WFD ULC listed and FM approved water flow alarm switch is also acceptable.

2.9 SPRINKLER ZONE ALARM, TEST AND DRAIN ASSEMBLIES

2.9.1 Tyco ULC listed and FM approved Model F350 Series factory assembled sprinkler zone alarm, pressure gauge, test and drain assemblies, each consisting of a water flow alarm, test and drain valves, a water flow sight glass, and interconnecting black steel piping and accessories, 50mm (2"), 65mm (2-1/2"), and 80mm (3") sizes.

2.9.2 Victaulic Style 747M zone control riser module assembly is also acceptable.

2.9.3 Install sprinkler zone alarm assembly in NFE Model #CV-200 lockable cabinet. Cabinet shall be constructed of 1.19mm (18-gauge) baked white enamel corrosion protected steel tub with 2mm (14-gauge) grey baked enamel steel door and frame with hollow channel reinforcement. Front section to have 51mm (2") adjustment to wall surface and complete with 13mm (1/2") turn back frame. Full metal door shall be fitted with full-length semi-concealed piano hinges, and flush stainless steel door latch.

2.9.4 Pipe module to drain.

2.10 PRESSURE GAUGES

2.10.1 Pressure gauges shall be ULC listed.

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- 2.10.2 Provide pressure gauges of the Bourdon type, minimum one percent accuracy through the entire range, complete with bronze Bourdon tube, brass socket, brass rotary movement, bronze bushings, tube and movement independently mounted from case, stainless steel case and ring, inherent shock protection. Furnish gauges having 114mm (4-½") dial, black graduations, black case, silver brazed joints, and adjustable black pointer.
- 2.10.3 Select gauges to suit fluid working pressure and, if possible, test pressure. If test pressure falls outside safe instrument range, attach a note to this effect on the installation instructions. Ensure that the normal working pressure occurs approximately at mid scale.
- 2.10.4 Install each gauge complete with 6mm (⅛") or 8mm (¼") bar stock valve, rated 150°C (300°F) and 6,895 kPa (1,000 psi). Provide pressure snubber on all pump services. Install pressure gauges as noted.
- 2.10.5 Submit a schedule in shop drawing form showing service, location, range, make, and catalogue number for gauges.

3 **EXECUTION**

3.1 PIPE AND FITTINGS

- 3.1.1 Provide unions, couplings, or flanges at all connections to equipment or fixtures requiring servicing or replacement.
- 3.1.2 Provide Underwriter approved hangers, and support all piping from building structure. Under no circumstances shall piping be hung from ductwork or steel roof-deck. Provide secondary steel supports where piping under ducts cannot be supported directly from structure. Where pipes are hung from joists, they shall be hung from top cord.
- 3.1.3 Sprinkler mains and branch headers shall be routed to avoid electrical, battery, UPS, elevator machine, diesel generator, switch gear and telephone rooms, unless prior approval is obtained from Consultant.
- 3.1.4 Grooved joint piping systems shall be installed in accordance with the manufacturer's guidelines and recommendations. The gasket style and elastomeric material (grade) shall be verified as suitable for the intended service as specified. Gaskets shall be supplied by coupling manufacturer. Grooved end shall be clean and free from

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indentations, projections and roll marks in the area from pipe end to groove. A factory trained field representative shall provide on-site training to contractor's field personnel in the installation of grooved piping products. Factory trained representative shall periodically review the product installation. Contractor shall remove and replace any improperly installed products.

3.2 FLEXIBLE SPRINKLER PIPE FITTINGS

3.2.1 Contractor to refer to manufacturer's insulation manual and design guide to ensure proper installation of fittings.

3.2.2 Ceiling grids shall be able to withstand the force of a discharging flexible sprinkler fitting. Ceiling grid shall comply with ASTM C 635 and ASTM C 636.

3.3 EXCESS PRESSURE PUMPS

3.3.1 Support pumps rigidly by steel mounting plate attached to the flange above the alarm valve.

3.4 EXTRA STOCK OF SPRINKLER HEADS

3.4.1 Provide one (1) wall mounted steel cabinet with sprinkler wrench and six (6) heads of each type used in the installation. Cabinet shall have baked on enamel finish.

3.5 ELECTRICAL WORK

3.5.1 All wiring from the alarm valve, monitor switches and flow switches shall be done by Division 26 - Electrical.

3.5.2 All power wiring shall be by Division 26 - Electrical.

3.5.3 Provide all other field wiring required.

3.6 TESTING, ADJUSTING, FLUSHING, BOILING OUT AND CLEANING

3.6.1 After system is complete, flush and test entire system in accordance with NFPA-13.

3.6.2 Test all sprinkler lines hydrostatically at 2 times the working pressure or as required by the authorities but at not less than 1,380 kPa (200 psi), for a period of not less than four (4) hours without any drop in pressure. Do testing before piping is buried or furred in and before pressure sensitive devices are installed in the pipework.

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Correct all defects disclosed by tests. Retest until all results are acceptable.

3.6.3 If any leaks are discovered by the above tests, remove and replace the faulty portions of the systems and repeat the test. Repeat this procedure until the system is accepted by the consultant's representative on the site. Do not caulk threaded joints.

3.6.4 Check horizontal pipe with an accurate level for any alterations in pitch. Inspect laterals and cross arms, eliminate pockets.

3.6.5 Flush the system at full flow rate for ten (10) minutes, or until all foreign materials have been removed and the work is clear. Provide a standard certificate that flushing has been properly carried out and submit to Consultant.

3.7 DEMONSTRATION

3.7.1 Prior to final acceptance, the Contractor shall provide operational training in all aspects of the system to the Owner's key personnel. Training shall include emergency procedures, safety requirements, and demonstration of the system, including all interfaces with the Fire Alarm and Building Automation Systems.

3.8 CONFORMANCE LETTER

3.8.1 Final NFPA certification letter shall be provided before mechanical compliance letter is issued. Certification letter shall contain contractor's contact information, the building permit number, certification statement in regard to NFPA compliance and be stamped by a licensed professional engineer.

END OF SECTION



DIVISION 22 – PLUMBING
SPECIFICATIONS
FOR THE
CITY OF TORONTO - DAYCARE CENTRE (METRO HALL)
55 JOHN STREET
TORONTO, ONTARIO

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DISCIPLINES MECHANICAL
ELECTRICAL
PLUMBING
LIGHTING DESIGN
COMMUNICATIONS & AV
SECURITY & RISK
COMMISSIONING
ENERGY SERVICES

Our Project No. 2021-0245

Issued for Approval
Design Development

October 1, 2024



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Project No.: 2021-0245
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Appendix A	Plumbing Fixtures

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1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 - General Requirements, shall apply to and govern this Section.

1.2 SHOP DRAWINGS

1.2.1 Submit Shop Drawings for:

1.2.1.1 All plumbing valves.

2 **PRODUCTS**

2.1 GENERAL

2.1.1 All valves shall be of one manufacture unless stated otherwise and should have the manufacturer's name and pressure ratings clearly marked on body. Valves to conform to the current of ANSI, ASTM, ASME standards, and to the applicable MSS.

2.1.2 Bronze valves up to and including 1034kPa (150 psi) steam pressure to be manufactured to ASTM B62-93 standard. Bronze valves up to 1379kPa (200 psi) and 2068kPa (300 psi) steam pressure to be manufactured to ASTM B61-93 standard. Bronze valves used in water systems may be cast bronze to ASTM B584-87 alloy CDA-836.

2.1.3 Iron body valves shall be ductile iron manufactured to ASTM A536-84 Grade 65-45-12 or cast iron ASTM A126-95 Class B standard where ductile iron is not available.

2.1.4 All valves shall have a CRN registration number.

2.1.5 Valve Materials

2.1.5.1 Bronze: to ASTM B62 or B61 as applicable

2.1.5.2 Brass: to ASTM B283 C3770

2.1.5.3 Cast Iron: to ASTM A126, Class B

2.1.5.4 Forge Steel: to ASTM A105N

2.1.5.5 Cast Steel: to ASTM A216WCB

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2.1.6 Valve Markings

2.1.6.1 All pressure ratings, manufacturers' trademark and size to conform as per MSS-SP-25.

2.1.7 End Connections

2.1.7.1 Threaded ends: to ASME B1.20.1

2.1.7.2 Solder ends: to ASME B16.18

2.1.7.3 Flanged ends: to ASME B16.1 (Class 125)

2.1.7.4 Face To Face dimensions: to ASME B16.10

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2.1.8 Testing & Design

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2.1.8.7 API 598 - Cast Steel Valves, Forge Steel Valves (Testing)

2.1.8.8 API 609 - WKM High Performance BFV

2.1.8.9 API 600 - Cast Steel Valves (Design)

2.2 VALVES FOR LOW PRESSURE SERVICE

2.2.1 This section applies to valves used in domestic cold water, domestic hot water and natural gas systems up to 1,034 kPa (150 psi) system operating pressure.

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2.2.2 Gate Valves

2.2.2.1 50mm (2") dia. or less - shall be Class 125, all bronze, with solid wedge disc, non-rising stem, lead-free (NSF-61).

Threaded ends - Kitz 827
 - Toyo 206A-LF
 - Crane LF-438
 - Apollo 102TLF

Soldered ends - Kitz 828
 - Toyo 207A-LF
 - Crane LF-1320
 - Apollo 102SLF

2.2.3 Globe Valves

2.2.3.1 50mm (2") dia. or less - shall be Class 125, all bronze, with rising stem, fitted with PTFE disc, lead-free (NSF-61).

Threaded ends - Kitz 811
 - Toyo 211A-LF
 - Apollo 120TLF

Soldered ends - Kitz 812
 - Toyo 212A-LF
 - Apollo 120SLF

2.2.4 Butterfly Valves

2.2.4.1 65mm (2-½") dia. and over - shall be Class 125, ductile iron full lug body with aluminum bronze or stainless steel disk, stainless steel stems, EPDM resilient seat, lead-free (NSF-372), with a 1379kPa (200 psi) single flange shut off rating (dead end service) and 121°C (250°F) temperature rating.

2.2.4.2 Valves 65mm (2-½") dia. and up to 100mm (4") dia. shall have a 10-position lever. Valves 150mm (6") dia. and above shall have hand wheel gear activator.

Lug Style - Kitz 6122EL/G
 - MAS D-Series LD4AELH/G
 - Center Line 200XXBG064052/5
 - Apollo LD141-XX-SE1-X

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Grooved ends - Victaulic Series 608N (for copper piping)
 - Victaulic Series 861 Vic-300 (for SS piping)

2.2.5 Check Valves

2.2.5.1 50mm (2") dia. or less - shall be Class 125, brass or copper alloy body, brass disc, PTFE gasket, lead-free (NSF-61), Y pattern swing check.

Threaded ends - Kitz 822
 - Toyo 236A-LF
 - Apollo 163TLF

Soldered ends - Kitz 823
 - Toyo 237A-LF
 - Apollo 163SLF

2.2.5.2 65mm (2-½") dia. and over - shall be Class 150, stainless steel body and trim, PTFE or fluoroelastomer gaskets.

Flanged ends - Kitz 150UOAM

Grooved ends - Victaulic Series 816

2.2.5.3 Wafer Check Valves – stainless steel body, shaft, disc and spring.

Single Flap - Moygro W15A-666

Double Door - Mueller 72-HHH-H-H
 - Powell 3070YMO

2.2.5.4 Silent Check Valves – carbon steel or stainless steel body, stainless steel trim, spring loaded center guided disc, stainless steel spring and shaft.

Flanged ends - Mueller 101MHT (wafer)
 - Mueller 105MHT (globe style)

2.2.6 Ball Valves

2.2.6.1 100mm (4") dia. or less - shall be rated for 1034kPa (150 psi) steam, 4137kPa (600 psi) non-shock cold water or oil, with full or standard port brass or bronze body, lead-free (NSF-61) brass or stainless steel ball, PTFE seats and packing.

Threaded ends - Kitz 858
 - Toyo 5044A-LF

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- Apollo 70LF-100 series
- MAS B-3LF

- Soldered ends
- Kitz 859
 - Toyo 5049A-LF
 - Apollo 70LF-200 series
 - MAS B-4LF

Note: Ball valves may be used in lieu of gate or globe valves for pipe sizes of 100mm (4") dia. or less.

2.2.6.2 Gas ball valves:

2.2.6.2.1 50mm (2") dia. or less - shall be rated for 1034kPa (150 psi) steam, 4137kPa (600 psi) non-shock cold water or oil, with full or standard port brass or bronze body, brass chrome plated ball, Teflon seats and packing, lever handle, CSA approved (CGA 3.16).

- Threaded
- Toyo 5044A
 - Kitz 58
 - MAS B3

2.2.6.2.2 65mm (2-½") dia. and over - shall be Class 150, carbon steel body, stainless steel ball and stem, Teflon packing and gaskets, locking lever and/or gear.

- Flanged
- Kitz 150 SCTAM (1 piece)
 - Kitz 150 SCTBZM (2 piece, full port)

2.2.7 Plug Valves

2.2.7.1 DN80 (3") dia. or less - shall be bronze eccentric plug valve, 1,379kPa (200 psi) non-shock cold water or oil, with memory stop and drip cap, grooved, flanged or screwed ends, as appropriate for piping system.

- DeZurik PEC Series

2.2.7.2 DN100 (4") dia. up to DN300 (12") dia. - shall be bronze eccentric plug valve, 1,379kPa (200 psi) non-shock cold water or oil, with handwheel gear, and grooved, flanged or screwed ends, as appropriate for piping system.

- DeZurik PEC Series

2.3 VALVES FOR MEDIUM TO HIGH PRESSURE SERVICE

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- 2.3.1 This section applies to valves used in domestic cold water and domestic hot water systems up to 3,440 kPa (500 psi) system operating pressure.
- 2.3.2 Gate Valves
- 2.3.2.1 50mm (2") dia. or less - shall be Class 300, stainless steel body and trim, OS&Y, PTFE packing and gasket.
Threaded ends - Kitz AK300UMM
- 2.3.2.2 65mm (2-½") dia. and over - shall be Class 300, stainless steel body and trim, OS&Y, PTFE packing and gasket.
Flanged ends - Kitz 300UMHAM
- 2.3.3 Globe Valves
- 2.3.3.1 50mm (2") dia. or less - shall be Class 300, stainless steel body and trim, OS&Y, PTFE packing and gasket.
Threaded ends - Kitz AK300UPM
- 2.3.3.2 65mm (2-½") dia. and over - shall be Class 300, stainless steel body and trim, OS&Y, PTFE packing and gasket.
Flanged ends - Kitz 300UPAM
- 2.3.4 Butterfly Valves (up to 1,724 kPa / 250 psi operating pressure)
- 2.3.4.1 65mm (2-½") dia. and over - shall be Class 150, cast brass or stainless steel body with aluminum bronze or stainless steel disk, stainless steel stems, Teflon seat, lead-free (NSF-372), with a 2,068 kPa (300 psi) single flange shut off rating (dead end service) and 121°C (250°F) temperature rating.
- 2.3.4.2 Valves 65mm (2-½") dia. and up to 100mm (4") dia. shall have a 10-position lever. Valves 150mm (6") dia. and above shall have hand wheel gear activator.
Grooved ends - Victaulic Series 608N (for copper piping)
- Victaulic Series 861 Vic-300 (for SS piping)
- 2.3.5 Check Valves
- 2.3.5.1 50mm (2") dia. or less - shall be Class 300, stainless steel body, PTFE or fluoroelastomer gasket, swing type check.

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- Threaded ends - Kitz AK300UOM
 - Grooved ends - Victaulic Series 816
- 2.3.5.2 65mm (2-½") dia. and over - shall be Class 300, stainless steel body and bolted cover, PTFE gasket, swing type check.
 - Flanged ends - Kitz 300UOAM
- 2.3.5.3 Wafer Check Valves – stainless steel body, shaft, disc and spring.
 - Single Flap - Moygro W30A-666
 - Double Door - Mueller 74-HHH-H-H
- Powell 3070YMO
- 2.3.5.4 Silent Check Valves – carbon steel or stainless steel body, stainless steel trim, spring loaded center guided disc, stainless steel spring and shaft.
 - Flanged ends - Mueller 103MHT (wafer)
- Mueller 109MHT (globe style)
- 2.3.6 Ball Valves
 - 2.3.6.1 100mm (4") dia. or less - shall be rated for 1034kPa (150 psi) steam, 4137kPa (600 psi) non-shock cold water or oil, with full or standard port brass or bronze body, lead-free (NSF-61) brass or stainless steel ball, PTFE seats and packing.
 - Threaded ends - Kitz 858
- Toyo 5044A-LF
- Apollo 70LF-100 series
- MAS B-3LF
 - Soldered ends - Kitz 859
- Toyo 5049A-LF
- Apollo 70LF-200 series
- MAS B-4LF
 - Note: Ball valves may be used in lieu of gate or globe valves for pipe sizes of 100mm (4") dia. or less.

3 EXECUTION

3.1 GENERAL

- 3.1.1 Valves shall be the same size as the line in which installed.

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- 3.1.2 Valves shall be located in such a manner that the top works, operators, and bonnets may be easily removed.
- 3.1.3 Seats and seals used in potable water systems shall be ANSI classified in accordance with NSF-61.
- 3.1.4 Stems of valves shall be positioned for maximum ease in use, but in no event in a manner causing a hazard, nor with stem down unless specifically shown as such.
- 3.1.5 Provide valves where shown on the Drawings, or on schematic diagrams, or in details, or as specified in the Contract Documents.
- 3.1.6 Provide drain valves at all low points. Drain valves shall be ball or gate valves, complete with cap and chain.
- 3.2 GATE VALVES
 - 3.2.1 Provide gate valves:
 - 3.2.1.1 Where indicated on the Drawings and in the Specification.
 - 3.2.1.2 On all branch lines.
 - 3.2.1.3 As isolation of each floor for all services.
 - 3.2.1.4 At the base of all risers.
- 3.3 GLOBE OR ECCENTRIC PLUG VALVES
 - 3.3.1 Provide globe and/or eccentric plug valves:
 - 3.3.1.1 Where indicated on the Drawings and in the Specification.
 - 3.3.1.2 On all bypass systems.
 - 3.3.1.3 Where required for throttling control.
 - 3.3.2 For balancing of domestic hot water recirculation system, provide thermostatic flow regulators in lieu of throttling valves. Refer to Section 22 11 19 – Domestic Water Piping Specialties.
- 3.4 BUTTERFLY VALVES
 - 3.4.1 Provide butterfly valves:
 - 3.4.1.1 Where indicated on Drawings and in the Specification.

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3.4.2 For pipe sizes DN65 (2-1/2") and larger, butterfly valves may be used in lieu of gate valves.

3.5 CHECK VALVES

3.5.1 Provide check valves:

3.5.1.1 Where indicated on the Drawings and in the Specification.

3.5.1.2 On the discharge of all pumps.

3.5.1.3 On the discharge of multiple equipment.

3.6 BALL VALVES

3.6.1 Install ball valves in the following locations:

3.6.1.1 Where indicated on the Drawings and in the Specification.

3.6.1.2 At each single plumbing fixture.

3.6.1.3 At each single item of equipment.

3.6.2 For pipe sizes DN100 (4") and smaller, ball valves may be used in lieu of gate and globe valves.

END OF SECTION

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3 EXECUTION

- 3.1 Pipe Freeze Protection
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1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 – General Requirements, shall apply to and govern this Section.

1.2 SCOPE OF WORK

1.2.1 Provide an electrical pipe tracing system as indicated on the Drawings and specified in this Section.

1.2.2 Connect heat trace power supply from disconnect switches provided by Division 26 - Electrical. Refer to Division 26 – Electrical drawings for exact locations. Co-ordinate power requirements with Division 26 – Electrical. Refer to Section 20 05 14 – Electrical Wiring for wiring requirements.

1.2.3 Provide electric tracing for the following services:

1.2.3.1 All domestic water piping (cold, hot, hot recirculation), including humidification make-up, cooling tower make-up, and irrigation supply in unheated areas or outside the building.

1.2.3.2 All sanitary and storm drain lines in unheated areas except parking drain sanitary system.

1.2.3.3 Humidifier drain lines, exposed on roof.

1.2.3.4 Trench drains exposed to freezing.

1.2.3.5 Roof gutters.

1.3 SHOP DRAWINGS

1.3.1 Provide shop drawings for:

- heat trace cables
- power connection, splice and tee kits
- temperature sensors, moisture sensors, control panel, and contactor modules
- accessories including tape, straps, banding, labels

1.4 ELECTRICAL EQUIPMENT AND WORK

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1.4.1 Read together with Division 26 – Electrical and adhere to its requirements. Supply and install all electrical apparatus, which is required and is not covered by Division 26 – Electrical.

1.4.2 The entire design and installation shall comply with the Ontario Electrical Safety Code and all applicable regulations. Heating cable circuits shall be protected by a ground-fault device for equipment protection. This requirement is in accordance with section 427-22 of the NEC-1996. Ground-fault protection is included with the control system specified for all applications.

2 **PRODUCTS**

2.1 GENERAL

2.1.1 Furnish and install a complete cUL Listed, CSA Certified, or FM approved system of heating cables, components, and controls to provide freeze protection of piping as indicated in the Contract Documents.

2.2 PIPE FREEZE PROTECTION CABLES

2.2.1 The self-regulating heating cable shall consist of two (2) 16 AWG nickel-copper bus wires embedded in parallel in a self-regulating polymer core that varies its power output to respond to temperature all along its length, allowing the heating cable to be cut to length in the field. The heating cable shall be covered by a radiation-crosslinked, modified polyolefin dielectric jacket. To provide a ground path and to enhance the heating cable's ruggedness, the heating cable shall have a braid of tinned copper and an outer jacket of modified polyolefin (-CR), as required per section 427-23 of the NEC-1996. For installation on plastic piping, the heating cable shall be applied using aluminum tape (AT-180). The heating cable shall be Tyco Thermal Controls, XL-Trace series, or approved equivalent.

2.2.2 In order to conserve energy and to prevent overheating, the heating cable shall have a self-regulating factor of at least 90 %. The self-regulation factor is defined as the percentage reduction, without thermostatic control, of the heating cable output going from 4.4°C (40°F) pipe temperature operation to 65.6°C (150°F) pipe temperature operation.

2.2.3 The heating cable shall operate on line voltage of 120 / 208 Volts without the use of transformers.

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- 2.2.4 The heating cable for metal-pipe freeze protection shall be sized according to the table below. The required heating cable output rating is in Watts per meter (foot) at 10°C (50°F). (Heating cable selection is based on 51mm (2 inch) fiberglass insulation on metal piping.)

Pipe size mm (inches)	Minimum Ambient Temperature	
	-17.8°C (0°F)	-28.9°C (-20°F)
100 (4") or less	16.4 (5) Watts	16.4 (5) Watts
150 (6")	16.4 (5) Watts	26.2 (8) Watts
200 (8")	16.4 (5) Watts	26.2 (8) Watts
250 (10") or more	16.4 (5) Watts	2 strips of 16.4 (5) Watts

- 2.2.5 Power connection, end seal, splice, and tee kit components shall be cUL Listed, CSA Certified, or FM Approved for use as part of the system to provide pipe freeze protection. Component enclosures shall be rated NEMA 4X to prevent water ingress and corrosion. Installation shall not require the installing Subcontractor to cut into the heating-cable core to expose the bus wires. All components that make an electrical connection shall be re-enterable for servicing. Installation of power-connection kits shall be under Division 22 - Plumbing.

- 2.2.6 No component shall use silicone to seal the electrical connections. An exception will be made in areas where a conduit transition is required.

2.3 TEMPERATURE AND MOISTURE SENSORS

- 2.3.1 Drainage piping shall have one sensor per "zone", mounted to the ceiling in unheated space and shall operate on Proportional Ambient Sensing Control. Trench Drain and Canopy Gutter De-icing cables shall be energized upon the detection of precipitation at low temperatures, and remain energized until runoff is clear.

- 2.3.2 Temperature sensors shall be 100-ohm platinum RTD (Resistance Temperature Devices), with 3m tails mechanically protected by a corrugated steel sheath and ½" gland fitting for connection to the

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junction box. Digit race RTD10CS or approved equivalent. Temperature sensors shall be connected to the control system terminals as indicated on heat-tracing schedules. Coordinate conduit and low-voltage signal wiring with Division 26 - Electrical. RTD wiring shall be shielded 3-conductor, 22AWG + drain, Belden type 8771 or approved equivalent.

2.3.3 Aerial Snow-Sensors shall detect precipitation occurring below 38°F (4°C) and close an internal contact to send a demand signal to the control system. Snow Sensors shall operate at 120V. Digit race LCD-7A or approved equivalent.

2.3.4 Gutter Moisture Sensors shall be mounted horizontally in the gutter as indicated on construction drawings, and shall detect the presence of moisture (i.e. runoff water) below 38°F (4°C) to send a demand signal to the control system. The intent of this device is to hold associated circuits on until all melt water is clear of the drainage system. Digit race type GIT-3A or approved equivalent. This Subcontractor is responsible for providing auxiliary relays to prevent line voltage reaching low-voltage control terminals.

2.4 CONTROL SYSTEM

2.4.1 (Option 1) Manual Control

2.4.1.1 The system shall be controlled by a switch, either directly or through an appropriate contactor.

2.4.2 (Option 2) Thermostatic Control – Ambient Sensing

2.4.2.1 The system shall be controlled by an ambient sensing thermostat (AMC-F5) set at 4.4°C (40°F) either directly or through an appropriate contactor.

2.4.3 (Option 3) Thermostatic Control – Line Sensing

2.4.3.1 The system shall be controlled by a line sensing thermostat (AMC-F5) set at 4.4°C (40°F) either directly or through an appropriate contactor.

2.4.4 (Option 4) DDC Control System

2.4.4.1 All sensors shall communicate with a DDC system, Digit race ACCS-30 or approved equivalent. This approach serves to minimize the number of sensing devices required for efficient system operation and also to eliminate field-location of control

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devices and thus reduce the risk of tampering.

- 2.4.4.2 The Heating Cable manufacturer shall provide a DDC system with pre-programmed parameters to concurrently control and monitor heating cable circuits fire-protection pipe freeze protection. All system programming shall be through a CSA-listed central User Interface Terminal, Tyco Thermal Controls type ACCS-UIT2 or approved equivalent.
- 2.4.4.3 Heating Cable circuits and sensor signals (refer to Subsection 2.5 above) shall be connected to cUL-listed remote Power Control Modules, Tyco Thermal Controls type ACCS-PCM2-5 or approved equivalent. The Power Control Modules shall each house five two-pole contactors rated to 30A/277V, and five sensor inputs. Power Control Modules shall also include ground-fault sensing devices for each heating cable circuit, the status of which shall be monitored by the control system.
- 2.4.4.4 Power Control Modules and User Interface Terminal shall be interconnected using RS-485 communication series. Coordinate communication conduit requirements with Division 26 - Electrical.
- 2.4.4.5 The Control System shall be capable of communicating ground fault, temperature alarms, and status alarms through programmable alarm contacts. Coordinate with Division 26 - Electrical.
- 2.4.4.6 The Control System shall be capable of communicating operating status, power consumption, and alarms to the Building Automation System in BACnet protocol.
- 2.4.5 No heat tracing circuit shall extend more than 600mm (24") beyond a point where such junctions permit optional flow paths. In such cases, separately controlled tracers shall be used.
- 2.4.6 Separately controlled heating circuits shall be provided on dead end legs and closed bypasses.
- 2.4.7 Where the rating of the thermostat would be exceeded, it shall be used in conjunction with a relay or contactor.

3 **EXECUTION**

3.1 PIPE FREEZE PROTECTION

- 3.1.1 Hydrostatically test all piping prior to installation of tracing cables.

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- 3.1.2 Heating Cable Installation shall comply with manufacturer's recommendations.
- 3.1.3 The cable shall be fastened to metallic piping at intervals no more than 300mm (12") using heat-resistant fiberglass tape, type GT-66 or approved equivalent. Metallic tie-wraps shall not be acceptable as they may puncture the heating cable jacket. When installing on polymer-based piping, aluminum heat-transfer tape shall be installed along the entire length of heating cable to improve performance.
- 3.1.4 Extra cable shall be used at points such as valves and flanges to compensate for increased heat loss.
- 3.1.5 All terminations shall be protected from the weather and from physical damage.
- 3.1.6 Any field alternations or deviations shall proceed only after authority via signed change order has been issued by the Consultant. All changes shall be accurately recorded by the Contractor and shall be turned over to the Consultant upon completion of the work.
- 3.1.7 Junction boxes, thermostats, and the like shall not be attached to the insulation, but shall be mounted on brackets fabricated of galvanized angle, channel or other material of sufficient strength to support equipment mounted on them.
- 3.1.8 Apply "Electric Traced" labels to the outside of the thermal insulation, on alternating sides at 3m intervals.
- 3.2 **SENSORS**
- 3.2.1 Install all sensing devices in accordance with manufacturer's recommendations. Refer to notes in Subsection 2.5 above.
- 3.2.2 Temperature sensors installed on piping (for Line-Sensing) shall be located opposite the heating cable so as to sense the coldest temperature on the segment of pipe.
- 3.2.3 Temperature sensors installed in air (for Ambient-Sensing) shall be strapped to the ceiling in a location such that the temperature is representative of the exposure temperature of any associated heat-tracing. Ambient temperature sensors shall not be installed adjacent to exhaust vents.

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3.2.4 Aerial Snow-Sensors shall be installed in a location such that they are exposed to precipitation from all directions and not subject to heating or exhaust vents. They shall be wired such that line voltage is not introduced to the signal run.

3.2.5 Gutter Snow-Sensors shall be installed between runs of heating cable with sensor grid pointed “upstream”, i.e. toward the flow of melt-water. They shall be wired such that line voltage is not introduced to the signal run.

3.3 CONTROL SYSTEM

3.3.1 Install all control components in accordance with manufacturer’s recommendations.

3.3.2 Sensor signal wiring shall be connected to the appropriate terminal within the appropriate power control module.

3.3.3 Control system components shall all be connected in series, using RS-485 twisted pair communication wiring. Coordinate necessary communication conduit runs with Division 26 – Electrical Subcontractor.

3.4 TESTING, COMMISSIONING AND REPORTING

3.4.1 All Self-Regulating Cables (for pipe tracing and gutter tracing) shall be tested for insulation resistance using a megohmmeter at 500, 1000, and 2500VDC and results shall exceed 1000MΩ to be acceptable. Self-Regulating cables shall also be tested for capacitance to verify continuous circuit lengths, with results recorded in nF and in approximate corresponding length. Refer to manufacturer’s installation guides for nF/ft conversion rates for each type of cable.

3.4.2 All Mineral-Insulated Cables (for trench drain de-icing) shall be tested for insulation resistance using a megohmmeter at 500VDC and results shall consistently exceed 100 MΩ to be acceptable. Cables shall also be tested for continuity, with results recorded in resistance (Ω) and approximate corresponding length.

3.4.3 Sensors and Control System shall be concurrently tested and commissioned with the assistance of the manufacturer. Temperature sensors may be tested by observing readings and comparing with actual temperature. Moisture sensors shall be tested by simulating activation criteria (low temperature and moisture) and observing contact engagement.

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3.4.4 The Division 22 - Plumbing Subcontractor is responsible for carrying testing, programming and commissioning costs as part of this Contract.

END OF SECTION

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- 3.1 Motor Starters

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Section Name: **Motor Starters and MCCs**
Section No.: **22 05 36**
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1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 - General Requirements, shall apply to and govern this Section.

1.2 SCOPE OF WORK

1.2.1 Provide all labour, materials, tools equipment, training commissioning and certification required to complete the work as shown on the Drawings and specified in this Section, including:

1.2.1.1 All motor starters for mechanical equipment.

1.2.1.2 All motor control centres for mechanical equipment.

1.2.2 Division 26 – Electrical shall provide all Motor Control Centres (MCC's) and loose motor starters.

1.2.3 Provide Division 26 – Electrical with a complete motor list, including nominal power, voltage, phase, application, starter type and control interlocks.

1.3 SUBMITTALS

1.3.1 Provide shop drawings for:

1.3.1.1 All motor starters.

1.3.1.2 All motor control centres.

1.4 ELECTRICAL EQUIPMENT AND WORK

1.4.1 Read together with Division 26 – Electrical and adhere to its requirements. Supply and install all electrical apparatus, which is required and is not covered by Division 26 – Electrical.

2 **PRODUCTS**

2.1 MOTOR STARTERS

2.1.1 Provide where indicated, shown the Motor Starter Schedules and as specified in this Section separate motor starters not forming part of a motor control centre for all mechanical equipment (except those equipped with packaged starters).

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- 2.1.2 Motor starters shall be supplied by the manufacturer of the motor control centres specified, and shall meet the requirements therein complete with disconnect switch, fuses, control transformer, and all auxiliary devices.
- 2.1.3 Provide combination type with non-fused disconnect switch for individual motor starters equal to CGE CR 208, where overcurrent protection has been provided at motor control centre or distribution source.
- 2.1.4 Provide combination type with fusible disconnect switches equal to CGE CR 208 for grouped motor starters supplied from a common feeder or splitter. Include all interconnection power wiring.
- 2.1.5 Manual starters for single phase fractional horsepower motors unless otherwise indicated shall be equal to CGE CR 1061 with pilot light in cover. In finished areas, provide flush mounted units with stainless steel covers and pilot lights.
- 2.1.6 Where starters are grouped, provide a common backboard, interlocking and control wiring indicated on the Motor Control Schedules and engraved nameplates indicating source of control supply if separate from the starter.
- 2.1.7 Short circuit interrupting capacity for all starters shall be minimum of _____ kA for all starters, or higher to meet co-ordination study. Support all bus work to suit rating.

3 **EXECUTION**

3.1 MOTOR STARTERS

- 3.1.1 Provide lamacoid plastic plates identifying all starters. Provide warning label for motors under remote control. Adhere to Section 20 05 53 – Identification colour scheme for tags.

END OF SECTION

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- 3.1 Cleanouts and Cleanout Access Covers

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1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 - General Requirements, shall apply to and govern this Section.

1.2 SHOP DRAWINGS

1.2.1 Submit shop drawings for the following equipment:

1.2.1.1 Cleanouts

2 **PRODUCTS**

2.1 CLEANOUTS AND CLEANOUT ACCESS COVERS

2.1.1 Provide cleanouts where shown on Contract Drawings on all drainage and waste systems, and as required by the Local Plumbing Code, including the following:

2.1.1.1 Where there is a change of direction of 45 degrees or more.

2.1.1.2 Not more than 15m (50'-0") apart on straight runs for DN100 (4") and less; 30m (100'-0") for DN150 (6") and greater.

2.1.1.3 On sanitary drain stacks serving kitchen sinks, at every second floor.

2.1.1.4 At the base of every stack and rainwater leader.

2.1.1.5 Where drains leave the building.

2.1.1.6 On footing drains where shown on the Drawings.

2.1.2 Bring cleanouts below floor up to finished floor with a 'Y' and 1/8th bend. Locate all cleanouts for easy access and in areas of least traffic, as directed by Consultant.

2.1.3 Make cleanouts full size of drain up to and including 100mm (4") drains. For drains larger than 100mm (4"), use 100mm (4") cleanouts.

2.1.4 Cleanouts in floor – cast iron body, removable positive gasket seal closure, 150mm (6") adjustable round cover. J.R.Smith Series 4000; Zurn ZN1400 Series; Mifab C1100-R Series, Watts CO-200 Series.

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- 2.1.4.1 Finished areas with nickel bronze top. J.R.Smith 4020; Zurn ZN1400-NH; Mifab C1100-R-1, Watts CO-200-R-1.
- 2.1.4.2 Tiled areas with nickel bronze top. J.R.Smith 4140; Zurn ZN1400-NH-X; Mifab C1100-T-1, Watts CO-200-T-1.
- 2.1.4.3 Terrazzo areas with nickel bronze top. J.R.Smith 4180; Zurn ZN1400-NH-Z; Mifab C1100-UR-1, Watts CO-200-U-1.
- 2.1.4.4 Concrete areas with extra heavy cast iron top. J.R.Smith 4220; Zurn Z1400-NH; Mifab C1100-XR-4, Watts CO-200-RX-4.
- 2.1.5 Cleanouts in walls.
- 2.1.5.1 Face-of-wall access cover for openings in tile, masonry and plaster walls with round C.P. bronze frame and secured cover. J.R.Smith 4720, Watts CO-300 Series.
- 2.1.5.2 Flush-with-wall access cover for plaster and wet wall constructions with round C.P. bronze frame and secured cover. J.R.Smith 4725; Zurn Z1463; Mifab C1440-R6, Watts CO-300 Series.
- 2.1.5.3 Access doors in tile, masonry and plaster walls, and in acoustic tile: refer to Section 15050 – Basic Materials and Methods.
- 2.1.5.4 Urinal cleanout – wall access cleanout with bronze plug, S.S. bolt and wingnut, and 100mm (4") polished S.S. secured cover. J.R.Smith SQ4-1819; Zurn Z1666-1; Mifab C1440-RD-3, Watts WUCO.
- 2.1.6 Cleanouts at the base of each stack and rainwater leader – cast iron cleanout tee and countersunk iron plug with gasket seal, less cover. J.R.Smith 4510; Zurn Z1445-HBXSP; Mifab C1460, Watts CO-460.
- 2.1.7 Cleanouts for concealed cast iron stacks – cast iron cleanout tee and countersunk iron plug with gasket seal, S.S. round cover and screw. J.R.Smith 4530; Zurn Z1446-HBXSP; Mifab C1460-RD-3, Watts CO-460-RD.
- 2.1.8 Cleanouts for exposed and concealed copper stacks to be by pipe manufacturer.

3 **EXECUTION**

3.1 CLEANOUTS AND CLEANOUT ACCESS COVERS

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- 3.1.1 Cleanouts on drains outside building shall be brought up to grade with a DN100 (4") 'Y' and 1/8th bend in medium weight soil pipe with solid brass recess plug-in top. Provide necessary support for soil pipe and set cleanout flush with grade in a 300mm by 300mm by 150mm (12" x 12" x 6") concrete pad.
- 3.1.2 In all areas with seamless flooring and plastic terrazzo finishes provide special flanges. These flanges shall be 100mm (4") larger in diameter than the drain or cleanout top of sleeve diameter, and located approximately 5mm ($\frac{3}{16}$ ") below the top flanges to be of the same material as the drain or cleanout finish.
- 3.1.3 Provide special flanges for cleanouts as described above.

END OF SECTION

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1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 - General Requirements, shall apply to and govern this Section.

1.2 SCOPE OF WORK

1.2.1 Provide all labour, materials, tools, equipment, training, commissioning and certification required to complete the work as shown on the Drawings and specified in this Section, including:

1.2.1.1 Domestic cold water piping, including connections to all fixtures and equipment, capped connections, and connections to municipal water supply.

1.2.1.2 Domestic hot water piping, including connections to all fixtures and equipment and capped connections.

1.2.1.3 PEX tubing for potable water distribution system.

1.3 REGULATORY REQUIREMENTS

1.3.1 Standards listed by reference, including revisions by issuing authority, form part of this Specification Section to extent indicated. Standards listed are identified by issuing authority, authority abbreviation, designation number, title, or other designation established by issuing authority. Standards subsequently referenced in this Section are referred to by issuing authority abbreviation and standard designation.

1.3.2 In addition to specific requirements for pipe fittings as further specified in this document and where applicable, the equipment shall comply with the Boiler and Pressure Vessels Act (the "Act") and CSA Standard B51.

1.3.3 In compliance with the Act and relevant Codes, all fittings shall be registered by the manufacturer, and shall be identified by the appropriate Canadian registration number.

1.3.4 Where fittings are provided without the appropriate Canadian registration number, the Contractor shall obtain a copy of the manufacturer's Statutory Declaration as provided to the authorities having jurisdiction.

1.3.5 All welding and fabrication shall be to the requirements of the

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ANSI/ASME B31.9 code for pressure piping and CSA standard B51 code for the Construction and Inspection of Boilers and Pressure Vessels.

- 1.3.6 All copper piping shall be certified to ASTM Standard B42 for Seamless Copper Pipe or ASTM Standard B88 for Seamless Copper Water Tube.
- 1.3.7 All stainless steel piping shall be certified to ASNI/AWWA C220-98.
- 1.3.7.1 ASTM F876 Standard Specification for Cross-Linked Polyethylene (PEX) Tubing.
- 1.3.7.2 ASTM F877 Standard Specification for Cross-Linked Polyethylene (PEX) Plastic Hot and Cold Water Distribution Systems.
- 1.3.7.3 ASTM F1960 Standard Specification for Cold Expansion Fittings with PEX Reinforcing Rings for use with Cross-Linked Polyethylene (PEX) Tubing.
- 1.3.7.4 CAN/CSA B137.5 Cross-Linked Polyethylene (PEX) Tubing Systems for Pressure Applications.
- 1.3.7.5 CAN/ULC-S101-M89 Standard Methods of Fire Endurance Tests of Building Construction and Materials.
- 1.3.7.6 CAN/ULC-S115-M95 Standard Method of Fire Tests of Firestop Systems.
- 1.3.7.7 CAN/ULC-S102.2-M88 Standard for Surface Burning Characteristics of Flooring, Floor Covering and Miscellaneous Materials and Assemblies.
- 1.3.8 Plastic Pipes Institute (PPI):
 - 1.3.8.1 PPI Technical Report TR-4/00.
- 1.3.9 Wirsbo, AQUAPEX *Installation Handbook*, current edition.
- 1.4 **SUBMITTALS**
 - 1.4.1 Provide shop drawings for all specified Products, including:
 - 1.4.1.1 Piping material and fittings.
 - 1.4.1.2 Joining material (flux, solder, filler metal, coupling)

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- 1.4.1.3 Submit verification of Standard Grade hydrostatic pressure ratings from Plastic Pipe Institute in accordance with TR-4/00. The following three (3) standard grade ratings are required: 93°C (200°F) at 551 kPa (80 psi); 82°C (180°F) at 689 kPa (100 psi) and 23°C (73.4°F) at 1,102 kPa (160 psi).
- 1.4.1.4 Submit Product Submittal sheets for tubing, manifolds, stand-up brackets, connection system, and fittings.
- 1.4.2 Submit appropriate ULC or Warnock Hersey and CSA listings as proof of compliance with provincial building and plumbing codes.
 - 1.4.2.1 Submit listings that indicate that the PEX tubing system has been listed to CAN/ULC-S101 when the PEX tubing is incorporated in and traverses a CAN/ULC-S101 floor/ceiling assembly. The listing must be appropriate to assemblies on site.
 - 1.4.2.2 Submit listings that indicate that the PEX tubing firestop system has been listed to CAN/ULC-S115 when the PEX tubing penetrates a fire separation. The listing must be appropriate to assemblies on site.
 - 1.4.2.3 Submit listings that indicate that the PEX tubing system has been listed to CAN/ULC-S102.2 for maximum 25 flame spread and maximum 50 smoke developed.
 - 1.4.2.4 Submit listings that indicate that the PEX tubing system has been listed to CAN/CSA-B137.5.
- 1.4.3 Submit the following:
 - 1.4.3.1 Copy of manufacturer's letter indicating that the installer has been recognized by the manufacturer as a "Trained Installer" trained in the use of its PEX tubing potable water distribution system.
 - 1.4.3.2 Manufacturer's installation instructions.
 - 1.4.3.3 Installer shall provide in writing to the Owner that the PEX tubing and components furnished under this specification conforms to the material and mechanical requirements specified herein.
- 1.4.4 Include the following in the closeout documentation:
 - 1.4.4.1 Warranty documents specified in the Contract Documents.
 - 1.4.4.2 Manufacturer's field reports specified in this Section.

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1.4.4.3 Project record documents for installed materials in accordance with Section 20 00 00 - General Requirements.

1.4.5 Division 22 - Plumbing Subcontractor to prepare and submit an alternative compliance application under the OBC if stainless steel piping is used for domestic water service.

1.5 QUALITY ASSURANCE

1.5.1 Qualifications:

1.5.1.1 Installer experienced in performing work of this Section who has specialized in installation of work similar to that required for this project.

1.5.1.2 Installation must be by skilled tradesmen holding a trade qualification license or apprentices under the supervision of a licensed tradesperson.

1.5.2 Pre-installation Meetings:

1.5.2.1 Conduct pre-installation meeting to verify project requirements, manufacturer's installation instructions and manufacturer's warranty requirements.

1.6 DELIVERY, STORAGE AND HANDLING

1.6.1 Comply with manufacturer's ordering instructions and lead-time requirements to avoid construction delays.

1.6.2 Deliver materials to job site in manufacturer's original, unopened, undamaged containers with identification labels intact.

1.6.3 Store materials protected from exposure to harmful weather and job site conditions.

1.6.4 Store PEX tubing in cartons or under cover to avoid dirt or foreign material from being introduced into the tubing.

1.6.5 Do not expose PEX tubing to direct sunlight for more than 30 days. If construction delays are encountered, installer is responsible for providing cover to portions of tubing exposed to direct sunlight.

1.7 WARRANTY

1.7.1 Refer to the Articles of Agreement, General Conditions and Section 20 00 00 - General Requirements for project warranty provisions.

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- 1.7.2 PEX manufacturer's warranty shall conform to the following:
 - 1.7.2.1 PEX tubing and fittings shall carry a twenty-five (25) year non-prorated warranty against failure due to defect in material or workmanship.
 - 1.7.2.2 All tubing manufacturer's valves and stops shall carry a one (1) year non-prorated warranty against failure due to defect in material or workmanship.
 - 1.7.2.3 The assembly of manufacturer's tubing and fittings shall carry a twenty-five (25) year non-prorated warranty on maintaining a leak-proof seal.
 - 1.7.2.4 Warranty shall provide for repair or replacement of any tube, fittings, or connection, which are proven to be defective and pay for consequential damages.
 - 1.7.2.5 Warranty shall be transferable to subsequent owners.
 - 1.7.2.6 Effective Warranty: Current manufacturer's warranty at time of installation.
 - 1.7.2.7 Warranty shall commence on Date of Substantial Completion.

2 **PRODUCTS**

2.1 PIPES AND FITTINGS

- 2.1.1 For 860 kPa (125 psi) or less operating pressure use 860 kPa (125 psi) rated fittings. For 860 kPa to 1,730 kPa (125 psi to 250 psi) operating pressure use 1,730 kPa (250 psi) rated fittings.
- 2.1.2 Buried water lines:
 - 2.1.2.1 Piping shall be IPEX "Blue Brute" PVC, 100mm – 300mm (4" – 12"), to Standards AWWA C900, CAN/CSA B137.3, ULC Cex448, UNI-B-3-80.
 - 2.1.2.2 Fittings for 100, 150 and 200mm (4", 6" & 8") PVC pipe shall be injection moulded, colour coded blue with push-on gasketed joints conforming to AWWA C907 (latest revision), be ULC listed, FM approved and be certified by the Canadian Standards Association to CAN/CSA B 137.2. Injection moulded fittings shall be produced from 4000 psi HDB compound.
 - 2.1.2.3 Gaskets shall be made of SBR. Gaskets must be removable from

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the pipe gasket race, in order to aid cleaning the bell and spigot should it be necessary prior to assembly.

- 2.1.2.4 Service connections to PVC mains shall be effected by using PVC moulded tapped couplings 100mm, 150mm & 200mm (4", 6" & 8") conform to AWWA C907 and be certified by the Canadian Standards Association to CAN/CSA B137.2.
- 2.1.2.5 Service saddles shall be stainless steel 304 and be a minimum 18-gauge (1.3mm) construction and shall have AWWA taper (CC) outlet thread. Service saddles shall be used for taps on pipe sizes larger than 200mm (8"), where tapped couplings cannot be used.
- 2.1.2.6 Mechanical joint restraints shall conform to ASTM F1674 and manufacturer's specifications. Restraining collars shall be attached to the fitting bell behind the gasket face. Tie-rods shall run from the collar behind the bell to a suitable collar on the connecting pipe. Tie-rods to be Denso wrapped.
- 2.1.2.7 Concrete thrust blocks shall conform to Ontario Provincial Standards Specification (OPSS) 1350 with nominal minimum 28-day compression strength of 20 MPa (2,900 psi). Thrust blocks as per UNI-B-3-92 and shall be constructed as per Ontario Provincial Standards Drawing (OPSD) 1103.01 and OPSD 1103.02.
- 2.1.2.8 Tracer wire shall be 12-gauge Thermoplastic Water Resistant insulated wire, Nylon jacketed (TWN) multi-strand copper and shall be installed along all PVC watermain at the 12 o'clock position and as close to the pipe as possible. The tracer wire shall be brought to the surface at all fire hydrants, looped twice around the hydrant barrel 100mm (4") below finished grade and fastened by means of a washer to a breakaway flange bolt.
- 2.1.3 Domestic cold water, hot water, and hot water recirculation piping shall be type 'L' hard copper with wrought copper or cast brass fittings and 95/5 solder joints or brazed joints using phosphorus based filler metal, up to 1,380 kPa (200 psi) operating pressure.
- 2.1.3.1 Alternatively, for domestic cold water and hot water piping, 100mm (4") dia. and larger, stainless steel piping, Schedule 10 (up to 250 psi) / Schedule 40 (for operating pressure above 250 psi), conforming to AWWA Standard C220 with roll-grooved joints can be used.
- 2.1.4 Mechanical couplings (e.g. Victaulic) shall be permitted for domestic cold water, hot water and hot water recirculation systems,

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provided:

- 2.1.4.1 The couplings are located in accessible locations unless otherwise approved by the engineer.
- 2.1.4.2 All couplings are by one manufacturer, suitable for pressure and temperature of respective system.
- 2.1.4.3 Rigid (Victaulic Style 107H Quick-Vic) couplings with offsetting angle bolt pads are used in mechanical rooms for Schedule 40 piping.
- 2.1.4.3.1 Flexible (Victaulic Style 177) couplings may be used in equipment drops in lieu of flexible-connectors and where vibration attenuation and stress relief are required.
- 2.1.4.4 Couplings for stainless steel roll-grooved plumbing piping to be manufactured from ductile iron conforming to ASTM-A536 and be complete with a Grade 'E' EPDM gasket, suitable for water service to 110°C (230°F) Couplings to be UL classified in accordance with ANSI/NSF-61 for potable water service.
- 2.1.4.5 Couplings for copper grooved piping in size 50mm (2") and above to be designed to copper-tube dimensions with offsetting angle bolt pads to provide a rigid joint, (Victaulic Style 607) complete with EPDM flush-seal gasket suitable for temperatures from -34° (-30°F) to 110°C (230°F). Couplings to be UL classified in accordance with ANSI/NSF-61 for potable water service.
- 2.1.4.6 Fittings for copper piping shall be full flow copper fittings per ASTM B-75, or B-152, conform to ANSI B16.18 (cast copper alloy) or ANSI B16.22 (wrought copper), manufactured to copper-tube dimensions.
- 2.1.4.7 Couplings for stainless steel roll-grooved piping shall be with EPDM gaskets conforming to ANSI/NSF-61.
- 2.2 **PEX POTABLE WATER DISTRIBUTION SYSTEM**
- 2.2.1 Plumbing tubing system to be Wirsbo AQUAPEX Professional Plumbing System as manufactured by Uponor Canada Inc.
- 2.2.2 Tube shall be cross-linked polyethylene (PEX) manufactured by PEX-A or peroxide method.
- 2.2.2.1 PEX tubing shall be manufactured in accordance with ASTM F876, ASTM F877 and CAN/CSA-B137.5. The tube shall be listed to

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ASTM by an independent third party agency.

- 2.2.2.2 PEX tubing shall have Standard Grade hydrostatic design and pressure ratings of 93°C (200°F) at 551 kPa (80 psi); 82°C (180°F) at 689 kPa (100 psi) and 23°C (73.4°F) at 1,102 kPa (160 psi). Temperature and pressure ratings shall be issued by the Plastic Pipe Institute (PPI), a division of the Society of the Plastic Industry (SPI).
- 2.2.2.3 Minimum bend radius for cold bending of the PEX tubing shall not be less than six (6) times the outside diameter. Bends with a radius less than stated shall require the use of a bend support as supplied by tube manufacturer.
- 2.2.2.4 PEX tube dimension shall be 12mm (½") up to and including 40mm (1-½") nominal inside diameter in accordance with ASTM F876 and ASTM F877 and as indicated on the Contract Drawings.
- 2.2.3 Manifolds to be either:
 - 2.2.3.1 Wirsbo Quick & Easy AQUACENTER
 - 2.2.3.2 Wirsbo Quick & Easy PLS Manifold
 - 2.2.3.3 Wirsbo Quick & Easy Type "L" Copper Manifold
- 2.2.4 Fittings shall be Wirsbo Quick & Easy, manufactured of polysulfone or brass. Fittings shall be PEX-A cold expansion type fitting.
 - 2.2.4.1 Fittings shall be supplied by the PEX tubing manufacturer.
 - 2.2.4.2 PEX-A cold expansion type fitting shall be an assembly consisting of insert and PEX-A cold expansion ring.
- 2.2.5 Ice maker and washing machine outlet boxes shall be supplied by the PEX tubing manufacturer.
- 2.2.6 Fixture shut-offs shall be supplied by the PEX tubing manufacturer.
- 2.2.7 Wall penetration brackets, drop ear bend support type, designed for wall membrane penetrations shall be supplied by PEX tubing manufacturer.
- 2.2.8 Concrete tube support brackets "Stand-Up" to hold PEX tubing in place in structural concrete slabs shall be of rigid PVC construction and be designed for that purpose.

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3 EXECUTION

3.1 GENERAL

- 3.1.1 Comply with manufacturer's product data, including Product technical bulletins, installation instructions, and Product carton instructions for installation.
- 3.1.2 Ream all piping and keep plugged to prevent entry of dirt. Use pipes, which conform to CSA and ASTM standards.
- 3.1.3 Install piping in a professional manner and in accordance with the practices of the trade.
- 3.1.4 Consider the piping shown on the Drawings as diagrammatic, for clearness in indicating the general runs and connections and that the piping may, or may not, in all parts be shown in the true position. This does not relieve the responsibility for the proper erection of the systems of piping in every respect suitable for the work intended.
- 3.1.5 Ensure that fabrication, welded or otherwise, meets the requirements of the ASA B31.9 Code for Pressure Piping, the CSA B51 Code for Boiler, Pressure Vessel, and Pressure Piping, and all requirements of the Boilers and Pressure Vessels Act of the Province of Ontario.
- 3.1.6 Use only fittings, or other materials to be incorporated in the work, which are approved by TSSA's Boiler and Pressure Vessels Safety Program, for the class of work for which they are used.
- 3.1.7 Thoroughly clean the inside of fittings and outside of pipe with steel wool and coat with flux, before soldering or brazing any copper pipe work joint. Remove the working parts of valves before soldering or brazing commences, and replace after soldering or brazing is complete.
- 3.1.8 Provide swing joints in runouts to units, off horizontal mains.
- 3.1.9 In Victaulic grooved piping systems, install swing joints consisting of flexible couplings, pipe nipples and elbows that provide simultaneous movement in all directions. Refer to Victaulic design submittal #26.12.
- 3.1.10 Use di-electric connections for cathodic protection wherever pipes of dissimilar material are connected together. When connecting

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grooved end steel to copper piping, use Victaulic dielectric waterway, Style 647-GG.

- 3.1.11 All traps and fittings shall be of same material or equal in quality and thickness to the pipe to which they are connected.
- 3.1.12 Provide unions or flanges at all connections to equipment or fixtures requiring servicing or replacement.
- 3.1.12.1 Unions or flanges for servicing are not required in installations using Victaulic couplings. (The couplings shall serve as disconnect points.)
- 3.1.13 In copper pipes, provide wrought copper unions with soldered joints for pipe up to and including 50mm (2"), and 1,035 kPa (150 psi) cast brass flanges for pipes 65mm (2-1/2") or larger.
- 3.1.14 Install all grooved end components as per manufacturers latest recommendation. All grooved products shall be of one manufacturer. The grooved coupling manufacturer's factory trained representative shall provide on-site training for contractor's field personnel in the use of grooving tools and installation of grooved joint products.
- 3.1.15 Provide thrust restraints on mechanical pipe joints where required to accommodate axial thrust. Scope of bracing shall include but not be limited to all joints at the base of all vertical storm drains, including cleanouts, and all joints in horizontal piping at the lowest level which drains by gravity to the street services.
- 3.2 EXAMINATION
- 3.2.1 Verify conditions, which have been previously installed under other sections, are acceptable for PEX tubing system installation in accordance with manufacturer's instructions.
- 3.3 EQUIPMENT CONNECTIONS
- 3.3.1 Install piping connection to equipment, to prevent any strain on pipe and equipment and to facilitate removal equipment without disconnecting more than the minimum of pipework or shutting down any other piece of equipment.
- 3.3.2 Install equipment and apparatus requiring servicing and/or replacing with unions or flanges.
- 3.3.3 Install valves, and automatic valve assemblies prefabricated and in

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uniform arrangement.

3.3.4 Install piping, automatic control valves, thermostat wells, orifice plates, etc., and any other appurtenances, supplied under the work of other Specification Sections or by the Owner for insertion in piping and equipment.

3.3.5 Provide di-electric fittings between dissimilar metals where corrosion may occur.

3.4 CONNECTIONS FOR OTHER TRADES

3.4.1 Provide valved hot and/or cold water to all equipment supplied by others, requiring same and connect.

3.4.2 Provide quick fill valved connections for chilled water, hot water, and condenser water systems.

3.4.3 Provide valve bypass arrangement for water differential pressure transmitters. Coordinate exact quantity and location with the Division 25 - Integrated Automation Subcontractor.

3.5 PEX INSTALLATION

3.5.1 Install PEX tubing in accordance with tubing manufacturer's recommendations and as indicated on Contract Drawings.

3.5.2 Manifolds shall be isolated with potable water ball valves.

3.5.3 PEX tubing shall not be exposed to direct sunlight for more than 30 days.

3.5.4 Insulation must cover the PEX tubing when exposed to a direct UV light source such as fluorescent light bulbs.

3.5.5 Ensure that no glues, solvents, sealants, or chemicals come in contact with the tubing without prior permission from the tube manufacturer.

3.5.6 PEX tubing passing through structural concrete slabs shall be sleeved with utility grade polyethylene tubing one (1) pipe diameter larger than the PEX tubing.

3.5.7 PEX tubing passing through metal studs shall be use grommets or sleeves at the penetration.

3.5.8 Protect PEX tubing with sleeves where abrasion may occur.

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- 3.5.9 Use strike protectors where PEX tubing has the potential for being struck with a screw or nail.
- 3.5.10 Manufacturer's bend supports shall be used where bends are less than six (6) times outside pipe diameter.
- 3.5.11 Manufacturer's concrete tube support bracket shall be used in structural concrete applications at all fixture and manifold locations.
- 3.5.12 Manufacturer's wall penetration brackets shall be used at all wall membrane penetrations.
- 3.5.13 Pressure test PEX potable water distribution system with air or potable water in accordance with applicable codes or, in the absence of applicable codes, to a pressure of 173 kPa (25 psi) above normal working pressure of the system. The pressure test shall last a minimum of 30 minutes. As the piping expands, restore pressure first at 10 minutes into the test, and again at 20 minutes. The test pressure must not fall more than 34kPa (5 psi) after 30 minutes. No leakage should be detected.
- 3.5.14 Comply with safety precautions when pressure testing, including use of compressed air, where applicable. Water shall not be used to pressurize the system if ambient air temperature has the possibility of dropping below 0°C (32°F).
- 3.6 **TESTING**
- 3.6.1 After all pipes have been placed in position and all branches installed, but before fixtures have been set or connected, test the tightness of all joints and the soundness of all pipes.
- 3.6.2 Make all tests before piping is furred in.
- 3.6.3 Notify the Consultant at least 48 hours before commencing with test, and give the Consultant a written certificate confirming these tests.
- 3.6.4 Test all water lines hydrostatically at 1-1/2 times the working pressure but at not less than 1,380 kPa (200 psi), for a period of not less than four (4) hours without any drop in pressure. Do testing before piping is buried or furred in and before pressure sensitive devices are installed in the pipework. Correct all defects disclosed by tests. Retest until all results are acceptable.
- 3.6.5 If any leaks are discovered by the above tests, remove and replace

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the faulty portions of the systems and repeat the test. Repeat this procedure until the system is accepted by the Consultant's representative on the Site. Do not caulk threaded joints.

- 3.6.6 Check horizontal pipe with an accurate level for any alterations in pitch. Inspect laterals, cross arms, and eliminate pockets. Correct any cases of water hammer.

3.7 FIELD QUALITY CONTROL

- 3.7.1 Provide PEX manufacturer's field service consisting of produce use recommendations and periodic site visit for inspection of product installation in accordance with manufacturer's instructions.

- 3.7.2 Manufacturer shall visit the site on a monthly basis during the installation of the PEX piping system. Each visit shall be documented with a report issued to the Consultant.

3.8 FLUSHING AND CLEANING

- 3.8.1 Inspect the systems, and remove any heavy debris and excessive oil and dirt.

- 3.8.2 Flush all completed systems with clear water at the highest obtainable pressure and velocity.

- 3.8.3 During flushing and cleaning, maintain all isolating and control valves in the open position.

- 3.8.4 Sterilize domestic hot and cold water piping. Provide chemical and bacteriological test data to prove that sterilization has been carried out.

- 3.8.5 Flush, chlorinate and reflush all outside water mains in accordance with AWWA C651-05 Specifications.

3.9 STREET SERVICES

- 3.9.1 Connect building cold water services, fire water, main storm and sanitary sewers to street mains where shown, and make all necessary arrangements with authorities and utilities involved. Pay for all permits and inspections and for all work to be done by the local authorities and utility companies.

- 3.9.2 Check and verify all invert elevations before proceeding with any of the work of this Section.

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3.10 COMPLETION

3.10.1 Provide a declaration, signed by a responsible officer of the Division 22 – Plumbing Subcontractor indicating that the following procedures and tests have been performed in accordance with the Drawings and Specifications. Provide two (2) copies of the signed declaration to the Consultant.

3.10.1.1 Water pressure test performed and leak free.

3.10.1.2 Plumbing inspections made and issue necessary certificates.

END OF SECTION

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1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 - General Requirements, shall apply to and govern this Section.

1.2 SHOP DRAWINGS

1.2.1 Submit shop drawings for the following equipment:

1.2.1.1 Hose bibs

1.2.1.2 Water meter

1.2.1.3 Thermostatic mixing valves

1.2.1.4 Backflow preventers

1.2.1.5 Pressure reducing valves

1.2.1.6 Shock absorbers

1.2.1.7 Domestic hot water storage tanks

2 **PRODUCTS**

2.1 SHOCK ABSORBERS

2.1.1 Shock absorbers shall be P.P.P. Inc 'SS' Series.

2.2 HOSE BIBS

2.2.1 Outside wall hydrants ('N.F.W.H.') shall be non-freeze flush type with stainless steel box, polished nickel bronze hinged locking cover and key and integral vacuum breaker. J.R.Smith 5509-QTNB; Zurn Z-1300-SS; Mifab MHY-20-3; Watts HY-725-SS.

2.2.2 Non-freeze wall hydrants ('N.F.W.H.') shall be ¼ turn non-drip, ceramic cartridge, 19mm (¾") non-freeze wall type with bronze face, adjustable wall-flange operating key, and self-draining integral vacuum breaker. Length to suit wall thickness. J.R.Smith 5609-QT; Zurn Z-1310; Mifab MHY-16; Watts HY-420.

2.2.3 Inside hose bibs (H.B.) shall be with rough chrome plated, heavy duty, angled body, 12mm (½") with 19mm (¾") hose end vacuum breaker. Acorn 'Neptune' 8121CR.

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2.2.4 Inside combination cold and hot water hose bibs 'HB-2' in mechanical rooms and garbage rooms shall be DN15 (1/2") with DN20 (3/4") hose end vacuum breaker.

2.3 WATER METER

2.3.1 Water meter shall be 'Neptune' Trident, style 3 disc meter with standard register.

2.3.2 Provide 3-valve by-pass around meter and drain valve.

2.3.3 Provide remote reading totalizer complete with wiring and plastic conduit.

2.4 BACKFLOW PREVENTERS

2.4.1 Provide backflow preventers in accordance with CAN/CSA-B64.10-11.

2.4.2 Acceptable Products for non-potable applications are as follows:

2.4.2.1 B64.4 Reduced Pressure Principle Type (RP) – Conbraco Series 40-200, Watts 009/909, Wilkins 975XL/975, Febco 825YA/YD, Hersey Grinnell FRP-2, Ames 4000.

2.4.2.2 B64.5 Double Check Valve Type (DCVA) – Conbraco Series 40-100, Watts 007/757, Wilkins 950XL/950, Febco 805/850, Hersey Grinnell FDC/HDC, Ames 2000/3000.

2.4.3 Acceptable Products for potable applications are as follows:

2.4.3.1 B64.4 Reduced Pressure Principle Type (RP) – Apollo Valves Series 40-200, Watts 009/909, Wilkins 375XL, Febco 825YA/YD, Ames 4000B (or 4000SS).

2.4.3.2 B64.5 Double Check Valve Type (DCVA) – Conbraco Series 40-100, Watts 007/757, Wilkins 950XL/950, Febco 805/850, Ames 2000/3000.

2.4.4 Use screwed connections to DN50 (2") size, flanged connections for larger sized valves, bronze or cast iron body, bronze trim, and stainless steel pilot trim.

2.4.5 Backflow preventers shall have a minimum working pressure of 1,724 kPa (250 psi).

2.5 HOT WATER MIXING VALVES

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- 2.5.1 Provide master thermostatic valves conforming to requirements of CSA B.125 to control valve discharge water temperature to 49°C (120°F). Select valves to provide the required maximum flow rate at a maximum pressure drop of 69 kPa (10 psi).
- 2.5.2 Thermostatic Valves shall be listed to ASSE 1017 – Temperature Actuated Mixing Valves For Hot Water Distribution Systems. Valves should also have Uniform Plumbing Code Canadian (cUPC) listing.
- 2.5.3 Valve body to cast bronze to ASTM B 584. Bronze internal components to ASTM B 139.
- 2.5.4 Valve shall have Manufacturer's name, as well as ASSE 1017 and cUPC logos, clearly displayed for conformance to standard.
- 2.5.5 Provide factory assembled and tested large TYPE TM thermostatic water mixing valve, small TYPE TM valve, DURA-trol® solid bi-metal thermostat (directly linked to valve porting to control the intake of hot and cold water and compensate for supply temperature or pressure fluctuations) with Seven Year Limited Warranty, color coded dials (HOT-COLD with directional indicators), locking temperature regulator handles, adjustable limit stops set for 49°C (120°F), integral hot and cold supply check stops.
- 2.5.6 Provide outlet ball valve shutoffs, color-coded dial thermometer, and inlet piping manifold.
- 2.5.7 Factory preassembled and hydrostatically tested to ASSE 1017 requirements, rough bronze finished system shall provide full time standby service should one mixing valve require maintenance.
- 2.5.8 Valves shall be piped strictly in accordance to Manufacturer's required piping method and be factory assembled and shipped to site for installation.
- 2.6 THERMOSTATIC FLOW REGULATOR
- 2.6.1 Flow regulator shall be Circuit Solver as manufactured by Therm-Omega-Tech, Inc., or equivalent, NSF-61 certified for use in all domestic water systems.
- 2.6.2 Circuit Solver shall regulate the flow of recirculated domestic hot water based on water temperature entering the regulator regardless of system operating pressure.

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- 2.6.3 Even when fully closed the Circuit Solver shall bypass a small amount hot water to maintain dynamic control of the recirculating loop.
- 2.6.4 Circuit Solver shall be factory adjustable as required by project conditions.
- 2.6.5 Circuit Solver shall be available in sizes ranging from DN15 (½ inch) NPT to DN50 (2") NPT, with standard tapered female pipe thread connection, rated to 1,378 kPa (200 psi) maximum operating pressure and to 148.9°C (300°F) maximum working temperature.
- 2.6.6 Body and all internal components shall be constructed of stainless steel with major components constructed of type 303 stainless steel.
- 2.6.7 Thermal actuator shall be spring loaded and self cleaning, delivering closing thrust sufficient to keep orifice opening free of scale deposits.

3 EXECUTION

3.1 UNIONS, FLANGES, DI-ELECTRIC COUPLINGS

- 3.1.1 Provide unions or flanges at all connections to equipment of fixtures requiring servicing or replacing.
- 3.1.2 In copper pipes, provide wrought copper unions with soldered joints for pipes up to and including DN50 (2") sizes and 1,034 kPa (150 psi) cast brass flanges for pipes DN100 (4") or larger.
- 3.1.3 Install approved dielectric isolation in following specified systems:
 - 3.1.3.1 Domestic cold water systems
 - 3.1.3.2 Make-up water systems
 - 3.1.3.3 Expansion pipes where make-up is connecting to the expansion tank
 - 3.1.3.4 In all other locations where specifically noted or shown on the Drawings
- 3.1.4 Install approved dielectric isolation at the transition between noble materials such as copper, brass bronze, high alloy castings, or stainless steel and low alloy ferrous materials such as black iron,

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galvanized iron, or cast iron. These dielectric isolators must be installed in such a way that they are not shorted out by accidental contacts to process equipment, building steel, instrumentation tubing, or electrical neutrals. Ensure that dielectric unions are constructed of materials that are compatible galvanically with the systems to which they are connected, e.g. a dielectric union for installation between copper and iron must be constructed with a body of iron and a tailpiece of copper or brass.

3.2 SHOCK ABSORBERS

- 3.2.1 Provide shock absorbers on both hot and cold water systems. Install in an upright position at all quick closing valves, solenoids, groups of plumbing fixtures and isolated fixtures. Locate and size as required and in accordance with the Plumbing and Drainage Institute Standard No. WH201 P.D.I. and as per manufacturer's instruction.

3.3 BACKFLOW PREVENTERS

- 3.3.1 Provide backflow preventers for all potential cross connections, including domestic water connections to all heating, cooling and refrigeration equipment, to irrigation system, where shown on drawings, and as required by the Ontario Plumbing Code and local authority having jurisdiction. As a minimum standard, installation shall be in conformance with CAN/CSA-B64.10-11.
- 3.3.2 Provide bronze body, spring loaded, soft seated, silent check valve upstream of backflow preventers. Up to and including DN50 (2"): Watts Series 600, Conbraco 61-500, Wilkins Model 40. DN65 (2-½") and above: Apco Series 300, Mueller.
- 3.3.3 Installation of silent check valve upstream of double check valves servicing main domestic water line is not required.

3.4 KITCHEN, AND OTHER OWNER'S EQUIPMENT

- 3.4.1 Provide complete roughing-in and final connections for kitchen, laboratory, and other Owner's equipment as shown on the drawings and as further delineated by the kitchen, laboratory, and other Owner's equipment drawings provided by the Owner and/or by other Specialist Consultants. This Subcontractor shall prepare complete 1:50 scale drawing with all services shown as required for approval by the Consultant.
- 3.4.2 No roughing-in shall be started and no final connections made to

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equipment until complete roughing-in and connection drawings have been provided by the Owner.

- 3.4.3 Provide valved and capped connections to equipment supplied by others.
- 3.4.4 When the equipment has been installed, do all final connections to equipment.
- 3.4.5 Provide vacuum breaker on each domestic water connection serving each laboratory fixture. Conbraco Series 38-502, Watts 9D/N-LF9, Wilkins 750A/760, Febco 815, Hersey Grinnell BCP.
- 3.5 THERMOSTATIC FLOW REGULATOR
- 3.5.1 Install thermostatic flow regulator in each domestic hot water recirculation riser/branch beyond the last hot water device in that branch. Provide suitable line size isolation valves and access panel as required in non-accessible ceilings and walls.

END OF SECTION

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1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 - General Requirements, shall apply to and govern this Section.

1.2 SCOPE OF WORK

1.2.1 Provide all labour, materials, tools, equipment, training, commissioning and certification required to complete the work as shown on the Drawings and specified in this Section, including:

1.2.1.1 Sanitary system, including drains, and vents.

1.2.1.2 Floor drains and fittings.

1.3 REGULATORY REQUIREMENTS

1.3.1 In addition to specific requirements for pipe fittings as further specified in this document and where applicable, the equipment shall comply with the Boiler and Pressure Vessels Act (the "Act") and CSA Standard B51.

1.3.2 In compliance with the Act and relevant Codes, all fittings shall be registered by the manufacturer, and shall be identified by the appropriate Canadian registration number.

1.3.3 Where fittings are provided without the appropriate Canadian registration number, the Contractor shall obtain a copy of the manufacturer's Statutory Declaration as provided to the authorities having jurisdiction.

1.3.4 All welding and fabrication shall be to the requirements of the ANSI/ASME B31.9 code for pressure piping and CSA standard B51 code for the Construction and Inspection of Boilers and Pressure Vessels.

1.3.5 All copper piping shall be certified to ASTM Standard B88 for Seamless Copper Water Tube.

1.4 REFERENCES

1.4.1 ASTM D1784 – Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.

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1.4.2 CAN/CSA B181.2 – PVC Drain, Waste and Vent Pipe and Pipe Fittings.

1.4.3 CAN/CSA B182.1 – Plastic Drain and Sewer Pipe and Pipe Fittings.

1.4.4 CAN/CSA B602 – Mechanical Couplings for Drain, Waste, and Vent Pipe and Sewer Pipe.

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

1.4.6 CAN/ULC-S115 – Standard Method of Fire Tests of Firestop Systems

1.4.7 National Plumbing Code of Canada (NPC)

1.4.8 Ontario Building Code (OBC)

1.5 QUALITY ASSURANCE

1.5.1 Source Limitations: Obtain plastic piping and fittings from a single manufacturer.

2 **PRODUCTS**

2.1 PIPES AND FITTINGS

2.1.1 Buried sanitary drains:

2.1.1.1 Piping shall be IPEX “PVC BDS Solvent Weld” DR-35 100mm - 150mm (4” - 6”) CAN/CSA B182.1, or IPEX “Ring-Tite” PVC DR-35 100mm - 375mm (4” – 15”) CAN/CSA B182.2, to ASTM Standard D3034.

2.1.1.2 Fittings for 100, 125, 150, 200, 300, and 375-mm (4”, 5”, 6”, 8”, 10”, 12”, & 15”) PVC DR 35 pipe shall be injection-moulded or fabricated fittings, certified by the Canadian Standards Association to CAN/CSA B182.1 and B182.2. Pipe and fittings to be constructed by the same manufacturer to ensure compatibility.

2.1.1.3 Gaskets shall be factory installed and made of elastomer, EPDM. Nitrile gaskets shall be used, as determined by the Consultant, where contaminated soils or special chemical or temperature resistance is encountered or required.

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- 2.1.1.4 PVC injection-moulded or fabricated tees shall be used for all service connections on new sewer main construction, including sewer mains for new subdivisions prior to assumption.
- 2.1.1.5 The pipe shall be jointed in accordance with the manufacturer's specifications.
- 2.1.1.6 Tracer wire shall be installed with all PVC pipe.
- 2.1.2 Sanitary piping cast into raft footings shall be ABS DWV.
- 2.1.3 Unburied sanitary drains, 75mm (3") dia. and under shall be copper drainage tube (DWV), cast brass fittings and 50/50 solder joints. Drains 100mm (4") dia. and over shall be standard weight cast iron pipe and fittings with mechanical joints.
 - 2.1.3.1 Alternatively, PVC-DWV pipe and fittings may be used in accordance with the following:
 - 2.1.3.1.1 For above-ground DWV applications, IPEX System 15 DWV certified to CAN/CSA B181.2 and having a Flame Spread Rating not more than 25.
 - 2.1.3.1.2 For above-ground DWV applications within air plenums (including entry and exit from plenum), and in High Buildings, IPEX System XFR DWV certified to CAN/CSA B181.2 and having a Flame Spread Rating not more than 25 and Smoke Developed Classification not more than 50.
 - 2.1.3.2 PVC pipe joints shall be solvent weld as follows:
 - 2.1.3.2.1 IPEX System 15/System XFR One-Step PVC Cement certified to CSA B181.2.
 - 2.1.3.2.2 IPEX System 15/System XFR Two-Step PVC Cement certified to CSA B181.2.
 - 2.1.3.2.3 IPEX System 15/System XFR PVC Primer certified to CSA B181.2.
 - 2.1.3.2.4 Sizes 1-1/2 inch to 6 inch: One-Step PVC Cement.
 - 2.1.3.2.5 Sizes 8 inch and above: Two-Step PVC Cement with PVC Primer.
 - 2.1.3.3 Sanitary drain lines serving waterless urinals and pool main drains up to 150mm (6") diameter shall be IPEX System 15 DWV certified to CAN/CSA B181.2 and having a Flame Spread Rating not more than 25. If drain lines are located within air plenums (including

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entry and exit from plenum), or in High Buildings, piping shall be IPEX System XFR DWV certified to CAN/CSA B181.2 and having a Flame Spread Rating not more than 25 and Smoke Developed Classification not more than 50. Run PVC piping in full length up to the connection to buried service unless otherwise indicated on plans.

- 2.1.4 Pumped sanitary drains shall be Schedule 40 galvanized steel pipe; stretch reduced continuous weld, ASTM A53, with screwed fittings.
- 2.1.4.1 In lieu of the above specified piping, DWV piping with cast brass fittings and 50/50 solder joints may be used.
- 2.1.4.2 In lieu of the above specified piping, IPEX "Xirtec CPVC" S40 for use in an air plenum or High Building, or IPEX "Xirtec PVC" S40 otherwise, may be used.
- 2.1.4.3 Mechanical couplings (e.g. Victaulic) shall be permitted for pumped sanitary drain system, provided:
 - 2.1.4.3.1 The couplings are located in accessible locations.
 - 2.1.4.3.2 All couplings are by one manufacturer, suitable for pressure and temperature of respective system.
 - 2.1.4.3.3 Rigid (zero-flex or equivalent) couplings with angle bolt pads are used in mechanical rooms.
 - 2.1.4.3.4 Couplings for Schedule 40 piping to be manufactured from ductile iron conforming to ASTM-A536 and be complete with a Grade 'E' EPDM gasket, suitable for water service to 110°C (230°F).
 - 2.1.4.3.5 Couplings for copper grooved piping in size 50mm (2") and above to be designed with angle bolt pads to provide a rigid joint, complete with EPDM flush-seal gasket suitable for temperatures from -34° (-30°F) to 110°C (230°F).
 - 2.1.4.3.6 Fittings for Schedule 40 piping shall be manufactured from ductile iron conforming to ASTM-A536 or segmentally welded steel, with grooves designed to accept grooved end couplings.
- 2.1.5 Vents 50mm (2") dia. and less shall be type DWV copper, 65mm (2-1/2") and over galvanized.
- 2.1.5.1 In lieu of the above specified piping, IPEX System XFR for use in in air plenums and High Buildings, and IPEX System 15 otherwise,

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may be used.

- 2.1.6 Fitting restraints for cast iron piping shall be HoldRite #117 series or approved equal. Field-devised methods and materials shall not be used to accomplish this application solution.

3 **EXECUTION**

3.1 GENERAL

- 3.1.1 Install in accordance with requirements of the Ontario Building Code or the local plumbing Authority Having Jurisdiction.
- 3.1.2 Ream all piping and keep plugged to prevent entry of dirt. Use pipes, which conform to CSA and ASTM standards.
- 3.1.3 Connect vent lines into the soil stack above highest fixture or extend separately through roof to a height of 600mm (24") above roofline and 3.6m (12 ft) away from any opening into building and flash properly.
- 3.1.4 Do not use double hubs, straight crosses, double T's or double TY's on any soil or waste pipe.
- 3.1.5 Install piping in a workmanlike manner and in accordance with current plumbing industry practices.
- 3.1.6 Consider the piping shown on the Drawings as diagrammatic, for clearness in indicating the general runs and connections and that the piping may, or may not, in all parts be shown in the true position. This does not relieve the responsibility for the proper erection of the systems of piping in every respect suitable for the work intended.
- 3.1.7 Cleanouts and other service items must be accessible.
- 3.1.8 Penetrations through structure shall be such that structural loads are not transferred to pipes.
- 3.1.9 On screwed piping, make up joints, metal to metal with red or white lead and oil applied to the thread. No hemp wick or packing will be permitted in making up screwed joints.
- 3.1.10 Thoroughly clean the inside of fittings and outside of pipe with steel wool and coat with flux, before soldering any copper pipe work joint. Remove the working parts of valves before soldering commences, and replace after soldering is complete.

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- 3.1.11 Use di-electric connections for cathodic protection wherever pipes of dissimilar material are connected together. When connecting grooved end steel to copper piping, use Victaulic dielectric waterway, Style 647-GG.
- 3.1.12 All traps and fittings shall be of same material or equal in quality and thickness to the pipe to which they are connected.
- 3.1.13 Provide unions or flanges at all connections to equipment or fixtures requiring servicing or replacement.
- 3.1.14 In copper pipes, provide wrought copper unions with soldered joints for pipe up to and including 50mm (2"), and 1,035 kPa (150 psi) cast brass flanges for pipes 65mm (2-1/2") or larger.
- 3.1.15 Install all grooved end components as per manufacturers latest recommendation. All grooved products shall be of one manufacturer.
- 3.1.16 Provide fitting restraints on mechanical pipe joints where required to accommodate axial thrust. Fitting restraints shall include but not be limited to all fittings over 75mm (3") in size, at the base of all vertical sanitary drains serving more than 10 storeys, including cleanouts, and all joints in horizontal piping at the lowest level which drains by gravity to the street services.
- 3.1.17 Provide fire-stop systems for all piping, at all penetrations through fire-rated separations tested and listed in accordance with CAN/ULC-S115.
- 3.2 PVC PIPE DRAIN INSTALLATION
- 3.2.1 In addition to the foregoing instructions (where applicable):
 - 3.2.1.1 Plastic piping installed in a building classified as a "High Building" or installed within a ceiling space used as an air plenum shall have a Flame Spread Rating less not more than 25 and Smoke Developed Classification not more than 50.
 - 3.2.1.2 Installation by a qualified installer.
 - 3.2.1.3 This Subcontractor to meet with PVC pipe manufacturer prior to construction to review the procedures concerning all aspects of installation described herein (solvent welding, supports, expansion/contraction and testing). The Contractor shall provide the Engineer with a written record of the meeting.

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- 3.2.1.4 Pipe must be cut squarely. Burrs and other loose materials shall be removed by chamfering of the pipe-end.. When required, PVC purple primer, Xirtec 07, shall first be generously applied to the pipe-end and inside the fitting hub. Next, CSA certified PVC solvent cement shall be applied to the pipe-end and inside the fitting hub while these areas are still moist. The pipe-end shall next be inserted to the full depth of the fitting hub and given a one-quarter turn. The pipe-end shall then be held in position until the solvent cement cures to the point of initial set. Pipe and fitting solvent weld joints shall be allowed to fully cure prior to pressure testing (follow the pipe manufacturers' recommended cure times).
- 3.2.1.5 For pumped discharge piping, ensure piping is braced to structure to avoid excessive movement.
- 3.2.1.6 This Subcontractor to accommodate all effects of thermal expansion and contraction movement by the use of line offsets or mechanical joint rubber couplings at sufficient intervals. As a general guideline, for piping installed in a controlled climate, straight pipe runs of less than 30m (100 ft) shall not require any expansion/contraction measures; for piping exposed to external weather elements, only runs of 15m (50 ft) or less shall not require expansion/contraction accommodation.
- 3.2.1.7 CSA certified mechanical joint couplings shall be installed at every second floor of the building. Rigidly support the stack pipe on alternating floors to minimize potential movement.
- 3.2.1.8 Provide fire-stop systems for all piping, at all penetrations through fire-rated separations tested and listed in accordance with CAN/ULC-S115.
- 3.3 TESTING
- 3.3.1 After all pipes have been placed in position and all branches installed, but before fixtures have been set or connected, test the tightness of all joints and the soundness of all pipes.
- 3.3.2 Make all tests before piping is furred in.
- 3.3.3 Notify the Consultant at least 48 hours before commencing with test, and give the Consultant a written certificate confirming these tests.
- 3.3.4 Sanitary, Waste, and Vent Piping: Securely close all openings in pipe ends throughout the work by means of approved plugs and fill

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the entire piping system, including stacks, branches to fixtures and all horizontal runs with water, up to highest opening and let this water stand at this level for not less than two (2) hours. Perform another test after the fixtures are set, connected, and connections are made to all equipment. Test by running water into all pipes, fixtures, traps, and apparatus in order to detect any imperfect material or workmanship. Where it is impossible to test the whole system at one time, divide into parts. Perform a smoke or ball test or any other test required by authorities having jurisdiction.

- 3.3.5 Test all pumped drain lines hydrostatically at 1-1/2 times the working pressure but at not less than 1,380 kPa (200 psi), for a period of not less than four (4) hours without any drop in pressure. Do testing before piping is buried or furred in and before pressure sensitive devices are installed in the pipework. Correct all defects disclosed by tests. Retest until all results are acceptable.
- 3.3.6 If any leaks are discovered by the above tests, remove and replace the faulty portions of the systems and repeat the test. Repeat this procedure until the system is accepted by the Consultant's representative on the site. Do not caulk threaded joints.
- 3.3.7 Check horizontal pipe with an accurate level for any alterations in pitch. Inspect laterals, cross arms, and eliminate pockets.
- 3.3.8 For PVC piping:
 - 3.3.8.1 Testing to be conducted after all solvent weld joints have cured.
 - 3.3.8.2 Perform hydrostatic pressure test prior to the piping system being commissioned.
 - 3.3.8.3 Pressure test underground piping systems before backfilling in accordance with requirements of the Ontario Building Code or the local plumbing Authority Having Jurisdiction.
 - 3.3.8.4 Pressure test above-ground piping systems in accordance with requirements of the Ontario Building Code or the local plumbing Authority Having Jurisdiction.
 - 3.3.8.5 As per manufacturer's instructions.
 - 3.3.8.6 The system should be slowly filled with water and all air bled from the highest and farthest points in the installation.
 - 3.3.8.7 Once the system has reached the desired test pressure, it should

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remain at this pressure for one hour.

3.3.8.8 During this time, visually inspect all joints for leaks.

3.3.8.9 If any leaks are discovered, remove and replace the faulty portion(s) of the system and allow to cure fully before re-testing.

3.3.8.10 Follow proper safety precautions and use protective equipment during testing.

3.3.8.11 Prepare test and inspection reports.

3.4 DRAIN PIPES IN RAFT FOOTINGS

3.4.1 Firmly restrain piping by tying off to adjacent rebars for entire horizontal length.

3.4.2 After leak test, leave water in pipe during concrete pour.

3.4.3 Notify Consultant at least 48 hours before pour.

3.5 FLUSHING AND CLEANING

3.5.1 General

3.5.1.1 Inspect the systems, and remove any heavy debris and excessive oil and dirt.

3.5.1.2 Flush all completed systems with clear water at the highest obtainable pressure and velocity.

3.6 STREET SERVICES

3.6.1 Connect building main and sanitary sewer to street main where shown, and make all necessary arrangements with authorities and utilities involved. Pay for all permits and inspections and for all work to be done by the local authorities and utility companies.

3.6.2 Check and verify all invert elevations before proceeding with any of this Work.

3.7 COMPLETION

3.7.1 Provide a declaration, signed by a responsible officer of the Division 22 – Plumbing Subcontractor indicating that the following procedures and tests have been performed in accordance with the Drawings and Specifications. Provide two (2) copies of the signed

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declaration to the Consultant.

3.7.1.1 Pressure test performed and leak free.

3.7.1.2 Plumbing inspections made and issue necessary certificates.

END OF SECTION

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1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 - General Requirements, shall apply to and govern this Section.

1.2 SHOP DRAWINGS

1.2.1 Submit shop drawings for the following equipment:

1.2.1.1 Floor drains

1.2.1.2 Trap primers

1.2.1.3 Grease interceptors

1.2.1.4 Catch basins

2 **PRODUCTS**

2.1 FLOOR DRAINS

2.1.1 Finished Areas – ‘FD-1’

2.1.1.1 Cast iron body floor drain, reversible flashing clamp with weep holes, adjustable top and 125mm (5") diameter, nickel bronze, 6mm (1/4") thick secured strainer, full 100mm (4") throat opening. J.R.Smith 2005A; Zurn ZN415-B; Mifab F1100C-1, Watts FD-100-C-A5-1. For quarry or mosaic tiled areas provide 125mm x 125mm (5" x 5") square nickel bronze strainer. J.R.Smith 2005B; Zurn ZN415-Y; Mifab F1100C-S, Watts FD-100-C-L5-1.

2.2 HUB DRAINS

2.2.1 Unfinished Areas – ‘HD-1’

2.2.1.1 Cast iron body drain, reversible flashing clamp with weep holes and cast iron hub adaptor. J.R.Smith 2005-2645; Zurn Z415-1030; Mifab F1100C-DD-50, Watts FD-100-C-DD-50.

2.2.2 Finished Areas – ‘HD-2’

2.2.2.1 Cast iron body drain, reversible flashing clamp with weep holes and nickel bronze hub adaptor. J.R.Smith 2005-2645NB; Zurn ZN415-1030; Mifab F1100C-DD-1, Watts FD-100-C-DD-1.

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2.3 FUNNEL FLOOR DRAINS

2.3.1 Unfinished Areas – ‘FFD-1’

2.3.1.1 Cast iron body combination funnel and floor drain, reversible flashing clamp with weep holes, adjustable top, 200mm (8") diameter, heavy duty, cast iron grate 13mm (1/2") thick strainer with 89mm x 229mm (3-1/2" x 9") cast iron funnel. J.R.Smith 2320-3591-CI; Zurn Z556 with Z414-1; Mifab F1320C-G-50, Watts FD-320-G-50.

2.3.2 Finished Areas – ‘FFD-2’

2.3.2.1 Cast iron body combination funnel and floor drain, reversible flashing clamp with weep holes, adjustable top, 125mm (5") diameter, nickel bronze, 6mm (1/4") thick secured strainer with 100mm (4") diameter nickel bronze funnel. J.R.Smith 2005A-3580NB; Zurn ZN415-B with ZN414; Mifab F1100C-F4-1, Watts FD-100-C-EF-1.

2.4 TRAP PRIMERS

2.4.1 One to Four Drain

2.4.1.1 Provide P.P.P MP-500 complete with adjustable timer trap seal primer. Tap size to be 15mm (1/2") with integral stainless steel screen. Electrical components shall include circuit breaker, test switch, timer solenoid valve (UL listed) and 120V/1Ph/60Hz connection.

2.4.2 More than Four Drain

2.4.2.1 Provide P.P.P. PT complete with adjustable timer trap seal primer. Primer shall be activated by a 20mm (3/4") normally closed solenoid valve. Manifold shall be prefabricated type "L" copper tubing. Electrical components shall include circuit breaker, switch, timer, solenoid valve (UL Listed). Electronic assembly tested and certified to UL73. Electrical connection shall be 120V/1Ph/60Hz. Cabinet shall be 356mm x 406mm x 86mm made from 16 GA steel and galvanized. Access door shall be prime coated steel complete with screw driver latch.

2.5 GREASE INTERCEPTOR

2.5.1 Provide a grease interceptor of the capacity as indicated on the Drawings.

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- 2.5.2 The grease interceptor shall be epoxy coated steel construction with removable baffles, gasketed aluminum cover, flow-control device, and deep seal trap with cleanout.
- 2.5.3 Provide the following accessories:
- 2.5.3.1 - Floor extension to suit invert of pipe.
 - 2.5.3.2 - Enzyme opening.
 - 2.5.3.3 - 'LR' for low profile installation.
 - 2.5.3.4 - 'S' for suspension with waterproofing flange and adequately
 - 2.5.3.5 - supported from structure.
- 2.5.4 If installed in fill provide stainless steel interceptor.
- 2.5.5 Provide electronic monitoring device with control panel, step down transformer and all control wiring (monitoring device required for all projects located in Scarborough).

3 **EXECUTION**

3.1 TRAPS

- 3.1.1 Provide every fixture and floor drain with traps in accordance with local regulations. Provide each trap with its own brass plug and ferrule cleanout.
- 3.1.2 For traps located in ceilings, provide access doors.
- 3.1.3 For drains in apparatus casings or air plenums, provide deep seal trap. For drains in outside air plenums, provide running trap located as far as possible from drains.
- 3.1.4 All traps for floor and hub drains shall be protected with trap primers. For electronic trap primers, run line voltage wiring to the nearest electrical panel with spare circuit.
- 3.1.5 Division 22 contractor must coordinate with electrical trade for circuit locations during scope drawing stage, otherwise Division 22 trade will be responsible for all costs associated with circuit wiring.
- 3.1.6 Trap seal primers must be installed above finished floor. Piping must have a minimum of 300mm (12") from bottom of outlet before 90 degree elbow can be used. Furthest distance from primer to

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floor drain is 6m. Trap primer make up line must have a continuous slope to the floor drain.

- 3.1.7 If required by authorities having jurisdiction, provide building traps complete with cleanout and fresh air inlet with special grilles to meet the Consultant's approval.

3.2 DRAINS

- 3.2.1 In all areas with seamless flooring and plastic terrazzo finishes provide special flanges. These flanges shall be 100mm (4") larger in diameter than the drain top or sleeve diameter, and located approximately 5mm ($\frac{3}{16}$ ") below the top flanges to be of the same material as the drain finish.

- 3.2.2 Provide special flanges for the following items as described above:

- 3.2.2.1 Floor drains

- 3.2.2.2 Hub drains

- 3.2.2.3 Combination drains

- 3.2.2.4 Area drains

3.3 UNIONS, FLANGES, DI-ELECTRIC COUPLINGS

- 3.3.1 Provide unions or flanges at all connections to equipment of fixtures requiring servicing or replacing.

- 3.3.2 In copper pipes, provide wrought copper unions with soldered joints for pipes up to and including DN50 (2") sizes and 1,034 kPa (150 psi) cast brass flanges for pipes DN100 (4") or larger.

- 3.3.3 Install approved dielectric isolation in following specified systems:

- 3.3.3.1 In all locations where specifically noted or shown

- 3.3.4 Install approved dielectric isolation at the transition between noble materials such as copper, brass bronze, high alloy castings, or stainless steel and low alloy ferrous materials such as black iron, galvanized iron, or cast iron. These dielectric isolators must be installed in such a way that they are not shorted out by accidental contacts to process equipment, building steel, instrumentation tubing, or electrical neutrals. Ensure that dielectric unions are constructed of materials that are compatible galvanically with the systems to which they are connected, e.g. a dielectric union for

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installation between copper and iron must be constructed with a body of iron and a tailpiece of copper or brass.

3.4 KITCHEN AND OTHER OWNER'S EQUIPMENT

- 3.4.1 Provide complete roughing-in and final connections for kitchen, and other Owner's equipment as shown on the Drawings and as further delineated by the kitchen, and other Owner's equipment drawings provided by the Owner. Contractor shall prepare complete 1:50 scale drawing with all services shown as required for approval by the Consultant.
- 3.4.2 No roughing-in shall be started and no final connections made to equipment until complete roughing-in and connection drawings have been provided by the Owner.
- 3.4.3 Provide a complete venting system as part of the roughing-in. Venting shall be acceptable to the local plumbing inspector.
- 3.4.4 Provide capped connections to equipment supplied by others.
- 3.4.5 When the equipment has been installed, do all final connections to equipment.

END OF SECTION

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1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 - General Requirements, shall apply to and govern this Section.

1.2 SHOP DRAWINGS

1.2.1 Submit shop drawings for the following equipment:

1.2.1.1 Plumbing fixtures and brass.

1.2.1.2 Fixture carriers and other appurtenances.

2 **PRODUCTS**

2.1 FIXTURES

2.1.1 Refer to Appendix A for plumbing fixtures.

3 **EXECUTION**

3.1 TRAPS

3.1.1 Provide every fixture with traps in accordance with local regulations. Provide each trap with its own brass plug and ferrule cleanout.

3.1.2 For traps located in ceilings, provide access doors.

3.2 UNIONS, FLANGES

3.2.1 Provide unions or flanges at all connections to fixtures requiring servicing or replacing.

3.2.2 In copper pipes, provide wrought copper unions with soldered joints for pipes up to and including DN50 (2") sizes and 1,034 kPa (150 psi) cast brass flanges for pipes DN100 (4") or larger.

3.3 FIXTURES

3.3.1 Supply and install all hangers, supports, brackets, reinforcement, steel back-up plates, etc. for the proper installation of fixtures and supply fittings.

3.3.2 Install all components in strict accordance with manufacturer's

Project Name: CITY OF TORONTO - DAYCARE CENTRE (METRO HALL)
Project No.: 2021-0245
Section Name: **Plumbing Fixtures**
Section No.: **22 40 00**
Date: October 1, 2024

recommendations.

- 3.3.3 Where plumbing fixtures contact wall, and/or floors, seal joints with Dow Corning #781, building sealant, make watertight and bead smooth in a neat professional manner.
- 3.3.4 Exposed trim, supplies, traps, fittings, etc. shall be brass, heavily chrome plated unless noted otherwise.
- 3.3.5 Provide a trap for each fixture.
- 3.3.6 Vent fixtures in accordance with Section 22 13 16 – Sanitary Waste and Vent Piping.
- 3.3.7 Install chrome plated angle on straightaway type screwdriver compression stops, as required, on all hot and cold water service connections to all fixtures.
- 3.3.8 Install escutcheon plates where all service connections to fixtures pass through walls or floors. Plates shall be cast brass, heavy chrome plated. Same internal diameter as external diameter of pipe.

END OF SECTION

PRODUCT SPECIFICATION INFORMATION

PROJECT NAME

211018 - Metro Hall // Plumbing Fixtures

PROJECT LOCATION

**Toronto, Ontario
Canada**

DATE

2024/06/25

PREPARED BY

Head Office

American
Standard

WC-1

Toilet - Wall-hung

AFWALL® MILLENNIUM™ FloWise®

To be specified

Centoco - Seat



☒ **500STSCFE-001** FAST-N-LOCK, For elongated bowl, Open front, Heavy-duty, For commercial applications, Polypropylene, Toilet seat, Less seat cover, Plastic commercial check hinges, and Stainless steel hinge pin, Specified in White finish,

FAST-N-LOCK mounting system takes the guess work out when tightening the hardware. The specially designed fasteners in click" when the appropriate torque is reached. The bolt and nut material shall be stainless steel,

Dimensions: 25 mm (1") high, 473 mm (18-5/8") long, 371 mm (14-5/8") wide

American Standard- Toilet

☒ **3351101.020**



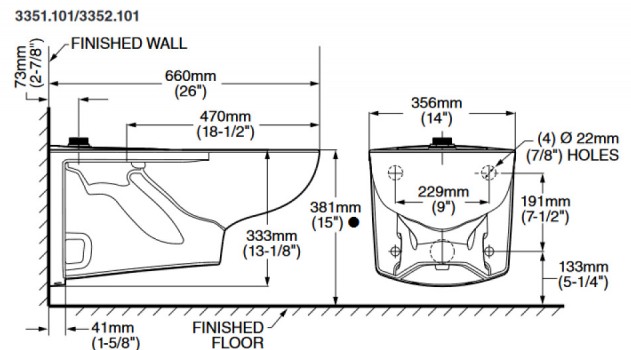
Toilet, Wall-hung with wall outlet, Toilet operates in the range of 4.2 to 6.0 LPF (1.1 - 1.6 GPF), White finish Vitreous china, EverClean® antimicrobial surface, Elongated bowl, Concealed trapway design, Direct-fed siphon jet flush action, 38 mm (1-1/2") top spud, Flush valve by others, Fully-glazed 54 mm (2-1/8") trapway, Static load rating of 454 kg (1000 lb), this product is not recommended for bariatric use, Condensation channel, Toilet seat not included, Consisting of:
Overall Dimensions: 356 mm (14") wide, 660 mm (26") from finished wall, Water Surface: 254 x 305 mm (10" x 12") water surface area
Map Score: >=1000 MaP® flush score (when use with proper flush valve)
Compliances: ASME A112.19.2 compliant, CSA B45.1 compliant.

Sloan - Flush Valve



☒ **SL-ROYAL 111-1.28-ESS** ROYAL® Automatic no-touch Exposed Water closet flushometer, 38 mm (1-1/2") spud coupling For top spud toilet, Hardwired, constructed from Semi-red brass, Polished chrome finish, High Efficiency 4.8 LPF (1.28 GPF), Chloramine resistant PERMEX® synthetic rubber diaphragm, OPTIMA® EL-1500 self-adaptive infrared sensor, Sensor located on die cast sensor plate with no visible fasteners (for 2-gang electrical box), Courtesy Flush® electrical override button, Flush tube for 292 mm (11-1/2") rough-in, Adjustable tailpiece, 25 mm (1") I.P.S. screwdriver Bak-Chek® angle control stop with free spinning vandal-resistant stop cap, Dual-filtered fixed bypass, Sweat solder adapter kit with cover tube, High back pressure vacuum breaker, 25 mm (1") supply pipe, Cast wall flange with set screw, Non-hold-open, no external volume adjustment, fixed volume accuracy is controlled by CID™ technology, 24 VAC input/output, With indicator light, Requires transformers 0345154 or 0345999, Pressure Range: 103 - 552 kPa (15 - 80 PSI) operating water pressure
Compliances: cUPC compliant.

Refer to the product specification sheet for complete information



Note:

Spec Reference: 123702

Product Reference: 222296; 7039973; 7308524;
7030565; 7041732; 7303925

Sloan - Faucet and Flush Valve Power Kit



☒ **SL-EL-154** For flush valve

Watts - Carrier



☒ **ISCA-101-L/R-M11** Industry Standard single Horizontal adjustable Closet Carrier, Adjustable for standard and wheelchair height, 102 mm (4") no hub waste, 51 mm (2") no hub vent connections, patented compression seal faceplate assembly, epoxy coated cast iron, with incremental measurements embossed onto legs to easily adjust height of carrier to most commonly used fixture requirements, epoxy coated cast iron foot support, neoprene bowl gasket, epoxy coated cast iron, integral test cap, chrome cap nuts, Plated hardware, Adjustable ABS nipple, Tiling frame,

Codes and Compliances: Carrier complies with requirements of ASME A112.6.1M up to a 500 lb (227 kg) static load.

Champion - Coupling



☒ **MI-XHUB** Connects to Type 300 stainless steel shield painted red for easy identification, Neoprene gasket,

Compliances and certifications:

Note:

Spec Reference: 123702
Product Reference: 222296; 7039973; 7308524;
7030565; 7041732; 7303925

To be specified

Centoco - Seat



☒ **AM2300STSCC-001** For baby seat, Open front, Heavy-duty, For commercial applications, Polypropylene, Toilet seat, Less seat cover, Self-sustaining plastic commercial check hinges, and Stainless steel hinge pin, Specified in White finish, and Antimicrobial additive inhibits the growth of stain and odor causing bacteria, Includes stainless steel hardware,

Dimensions: 25 mm (1") high, 387 mm (15-1/4") long, 362 mm (14-1/4") wide

Sloan - Flush Valve



☒ **ROYAL 111-YO-1.28** ROYAL® Manual Exposed Water closet flushometer, 38 mm (1-1/2") spud coupling For top spud toilet, constructed from Semi-red brass, Polished chrome finish, High Efficiency 4.8 LPF (1.28 GPF), Chloramine resistant PERMEX® synthetic rubber diaphragm, Metal oscillating handle with triple seal handle packing, Flush tube for 292 mm (11-1/2") rough-in, Adjustable tailpiece, 25 mm (1") I.P.S. screwdriver Bak-Chek® angle control stop with free spinning vandal-resistant stop cap, Dual-filtered fixed bypass, Sweat solder adapter kit with cover tube, High back pressure vacuum breaker, Inlet located right of valve, 25 mm (1") supply pipe, Cast wall flange with set screw, Non-hold-open, no external volume adjustment, fixed volume accuracy is controlled by CID™ technology, Angle back check stop seat bumper for seats without covers, Pressure Range: 103 - 552 kPa (15 - 80 PSI) operating water pressure Complies: Requires less than 5 pounds of force to activate (push button), cUPC compliant.

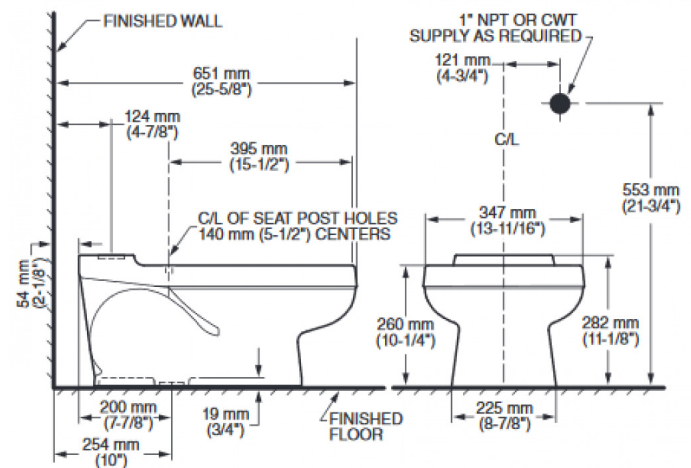
American Standard- Toilet

☒ **2282001.020**



Toilet, Floor mounted with floor outlet, Toilet operates in the range of 4.8 to 6.0 LPF (1.28 - 1.6 GPF), White finish Vitreous china, Junior bowl, 260 mm (10-1/4") rim height for toddlers, Minimum 254 mm (10") rough-in from wall to the center of waste outlet, Siphon jet flush action, 38 mm (1-1/2") top spud, Flush valve by others, Fully-glazed trapway, Toilet seat not included, Two (2) colour-matched bolt caps with retainers (481310-100), Consisting of:
Overall Dimensions: 348 mm (13-11/16") wide, 651 mm (25-5/8") from finished wall, 283 mm (11-1/8") high
Water Surface:
Map Score: 800 g MaP® flush score
Compliances: ASME A112.19.2 compliant, CSA B45.1 compliant.

Refer to the product specification sheet for complete information



Note:

Spec Reference: 123702

Product Reference: 222294; 7132857; 7307938



S-1 (Adult Handwash)

Type 304 Stainless steel

Single compartment,
Counter mounted,
Undermount
Kitchen sink

To be specified

Chicago Faucets - Faucet



☒ **430-ABCP** Counter mounted, Manual, Single handle, Sink faucet, Polished chrome finish, Single hole centerset, Lead Free ANSI/NSF 61 compliant, ECAST® brass construction, Ceramic cartridge with volume control, 5.7 LPM (1.5 GPM) maximum flowrate, Pressure compensating Econo-Flo™ non-aerated laminar spray outlet, Tubular cast brass spout, 229 mm (9") spout reach, 146 mm (5-3/4") high, 108 mm (4-1/4") lever handle, 13 mm (1/2") NPSM supply inlet, Includes hot limit safety stop.

Lawler - Mixing Valve



☒ **570-86820** Point of Use and Master controlled fixtures, Thermostatic master water mixing control valve, Lead free brass body construction, Nickel plated finish, Lead free brass body construction, 1.9 - 30 LPM (0.5 - 8 GPM) range for flowrate , To adjust the mixed outlet temperature of the valve, remove the cap to gain access to the adjusting spindle. The spindle should be rotated-clockwise to reduce the temperature, counter-clockwise to increase the temperature until the desired set point is reached, 11 LPM (3 GPM) tempered flowrate @ 5 PSI pressure drop, The temperature is adjusted with the help of Spindle, 4-7/8" (124 mm) Height, The temperature is adjusted with the help of Spindle, 3/8" MNPT (9.5 mm) inlet, 3/8" MNPT (9.5 mm) inlet, 95-115 °F outlet water temperature range, 3/8" MNPT (9.5 mm) outlet, 3/8" MNPT (9.5 mm) outlet, internal checks, Thermostatic master water mixing control valve, Nickel plated finish, Point of Use and Master controlled fixtures, ASSE 1070 approved Certified to CSA B125.3 for ASSE 1070 applications, 95-115 °F outlet water temperature range, Offers choice of temperature settings from 95° through 115 °F., 125 PSI max hydrostatic pressure, 125 PSI max hydrostatic pressure, ±20% pressure variation, ±20% pressure variation, 11 LPM (3 GPM) tempered flowrate @ 5 PSI pressure drop, To adjust the mixed outlet temperature of the valve, remove the cap to gain access to the adjusting spindle. The spindle should be rotated-clockwise to reduce the temperature, counter-clockwise to increase the temperature until the desired set point is reached, 40-80 °F, 10 °F, 180 °F max, 7 GPM flowrate @ 45 PSI, Offers choice of temperature settings from 95° through 115 °F., ±5 °F, Protects against scalding and chilling

Franke Commercial- Sink

☒ **UCS6808P-1**



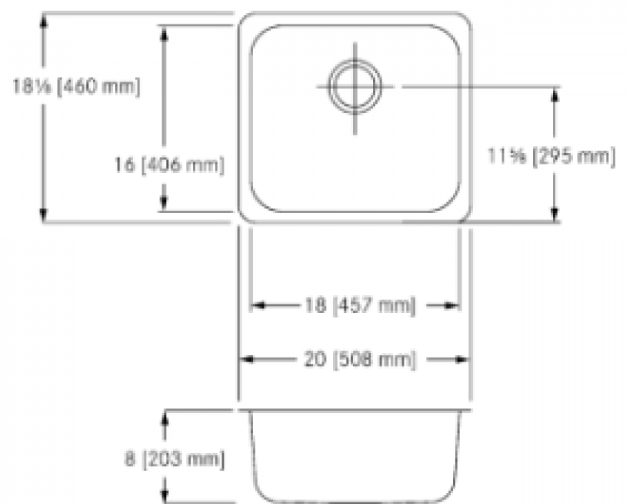
Without faucet ledge, 18 gauge Type 304 Stainless steel Polished to #4 satin finish, Center back waste location, 38 mm (1-1/2") (DN38) brass tailpiece, 89 mm (3-1/2") crumb cup strainer, waste fitting included, Undercoated to reduce condensation and resonance,

Codes and Compliances: ASME A112.19.3 compliant, CSA B45.4 compliant,

Bowl Dimension: Left bowl is 457mm (18") long and right bowl is 305mm (12") long, 406 mm (16") wide, 203 mm (8") deep,

Overall Dimension: 508 mm (20") long, 460 mm (18-1/8") wide, 203 mm (8") high.

Refer to the product specification sheet for complete information



Note:

Spec Reference: 123702
Product Reference: 7018175; 7018429;
7018383; 7047032; 7017077



S-1 (Adult Handwash)

Type 304 Stainless steel

Single compartment,
Counter mounted,
Undermount
Kitchen sink

McGuire - Supply



☒ **LFCK165LK** Lead Free, with Chrome-plated finish, Pipe to compression connection, 3/8" I.P.S x 3/8" O.D connection, Shallow wall flange, Loose key handle, Full turn brass stem, 305 mm (12") chrome-plated risers, Purple EPDM peroxide cured washers,

Codes and compliances: NSF/ANSI 61 & 372, UPC

McGuire - P-Trap



☒ **8912CB** Heavy cast brass, Adjustable p-trap, 292 mm (11-1/2") length, With cleanout plug, Steel box flange, Neoprene gasket, Seamless tubular brass bend, Slipnuts

Note:

Spec Reference: 123702
Product Reference: 7018175; 7018429;
7018383; 7047032; 7017077



S-2

Type 304 Stainless steel

Double compartment,
Counter mounted,
Undermount
Kitchen sink

To be specified

Chicago Faucets - Faucet



☒ **434-ABBN** Counter mounted, Manual, Single handle, Sink faucet, Brushed nickel finish, Single hole centerset, Lead Free ANSI/NSF 61 compliant, ECAST® brass construction, With supply, Ceramic cartridge with volume control, 5.7 LPM (1.5 GPM) maximum flowrate, Gooseneck spout, Pull down, 210 mm (8-1/4") spout reach, 432 mm (17") high, Lever handle, 13 mm (1/2") NPSM supply inlet for 10 mm (3/8") or 13 mm (1/2") flexible riser, Includes hot limit safety stop.

Lawler - Mixing Valve



☒ **570-86820** Point of Use and Master controlled fixtures, Thermostatic master water mixing control valve, Lead free brass body construction, Nickel plated finish, Lead free brass body construction, 1.9 - 30 LPM (0.5 - 8 GPM) range for flowrate , To adjust the mixed outlet temperature of the valve, remove the cap to gain access to the adjusting spindle. The spindle should be rotated-clockwise to reduce the temperature, counter-clockwise to increase the temperature until the desired set point is reached, 11 LPM (3 GPM) tempered flowrate @ 5 PSI pressure drop, The temperature is adjusted with the help of Spindle, 4-7/8" (124 mm) Height, The temperature is adjusted with the help of Spindle, 3/8" MNPT (9.5 mm) inlet, 3/8" MNPT (9.5 mm) inlet, 95-115 °F outlet water temperature range, 3/8" MNPT (9.5 mm) outlet, 3/8" MNPT (9.5 mm) outlet, internal checks, Thermostatic master water mixing control valve, Nickel plated finish, Point of Use and Master controlled fixtures, ASSE 1070 approved Certified to CSA B125.3 for ASSE 1070 applications, 95-115 °F outlet water temperature range, Offers choice of temperature settings from 95° through 115 °F., 125 PSI max hydrostatic pressure, 125 PSI max hydrostatic pressure, ±20% pressure variation, ±20% pressure variation, 11 LPM (3 GPM) tempered flowrate @ 5 PSI pressure drop, To adjust the mixed outlet temperature of the valve, remove the cap to gain access to the adjusting spindle. The spindle should be rotated-clockwise to reduce the temperature, counter-clockwise to increase the temperature until the desired set point is reached, 40-80 °F, 10 °F, 180 °F max, 7 GPM flowrate @ 45 PSI, Offers choice of temperature settings from 95° through 115 °F., ±5 °F, Protects against scalding and chilling

Franke Commercial- Sink

☒ **UCD6408P-1**



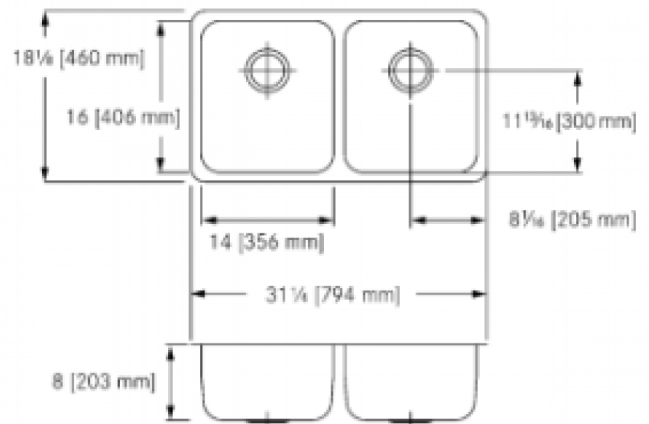
Without faucet ledge, 18 gauge Type 304 Stainless steel Polished to #4 satin finish, Center back waste location, 38 mm (1-1/2") (DN38) brass tailpiece, 89 mm (3-1/2") crumb cup strainer, waste fitting included, Undercoated to reduce condensation and resonance,

Codes and Compliances: ASME A112.19.3 compliant, CSA B45.4 compliant,

Bowl Dimension: Left bowl is 356 mm (14") long and right bowl is 356 mm (14") long, Left bowl is 406 mm (16") wide and right bowl is 406 mm (16") wide, Left bowl is 203 mm (8") deep and right bowl is 203 mm (8") deep,

Overall Dimension: 794 mm (31-1/4") long, 460 mm (18-1/8") wide, 203 mm (8") high.

Refer to the product specification sheet for complete information



Note:

Spec Reference: 123702
Product Reference: 7018168; 13820278;
7018383; 7017080; 7017077



S-2

Type 304 Stainless steel

Double compartment,
Counter mounted,
Undermount
Kitchen sink

McGuire - Supply



☒ **LFBV170** Lead Free, with Chrome-plated finish, Convertible loose key handle.

McGuire - P-Trap



☒ **8912CB** Heavy cast brass, Adjustable p-trap, 292 mm (11-1/2") length, With cleanout plug, Steel box flange, Neoprene gasket, Seamless tubular brass bend, Slipnuts

Note:

Spec Reference: 123702
Product Reference: 7018168; 13820278;
7018383; 7017080; 7017077



S-3

Type 304 Stainless steel

Triple compartment,
Counter mounted, Drop-in
Commercial sinks

To be specified

McGuire - P-Trap



☒ **8912CB** Heavy cast brass, Adjustable p-trap, 292 mm (11-1/2") length, With cleanout plug, Steel box flange, Neoprene gasket, Seamless tubular brass bend, Slipnuts

Franke Commercial- Sink

☒ **LBT6410PCB-1-1**



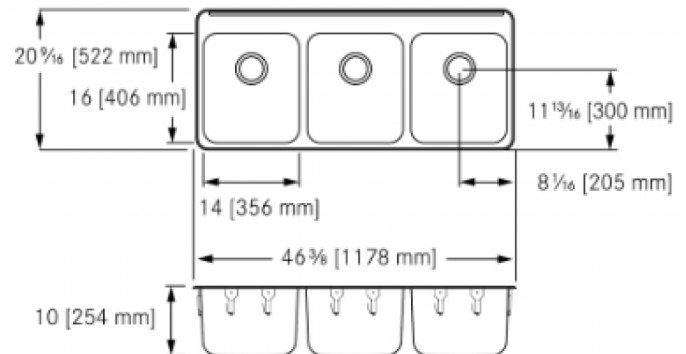
Single hole centerset, With faucet ledge, 18 gauge Type 304 Stainless steel Polished to #4 satin finish, Factory installed EZ TORQUE™ fasteners, Factory applied rim seal, Center back waste location, 38 mm (1-1/2") (DN38) brass tailpiece, 89 mm (3-1/2") crumb cup strainer, waste fitting included, Undercoated to reduce condensation and resonance,

Codes and Compliances: ASME A112.19.3 compliant, CSA B45.4 compliant,

Bowl Dimension: Left bowl is 356 mm (14") long, middle bowl is 356 mm (14") long and right bowl is 356 mm (14") long, Left bowl is 406 mm (16") wide, middle bowl is 406 mm (16") wide and right bowl is 406 mm (16") wide, Left bowl is 254 mm (10") deep, middle bowl is 254 mm (10") deep and right bowl is 254 mm (10") deep,

Overall Dimension: 1178 mm (46-3/8") long, 522 mm (20-9/16") wide, 254 mm (10") high.

Refer to the product specification sheet for complete information



Note:

Spec Reference: 123702
Product Reference: 7032621; 7017077

To be specified

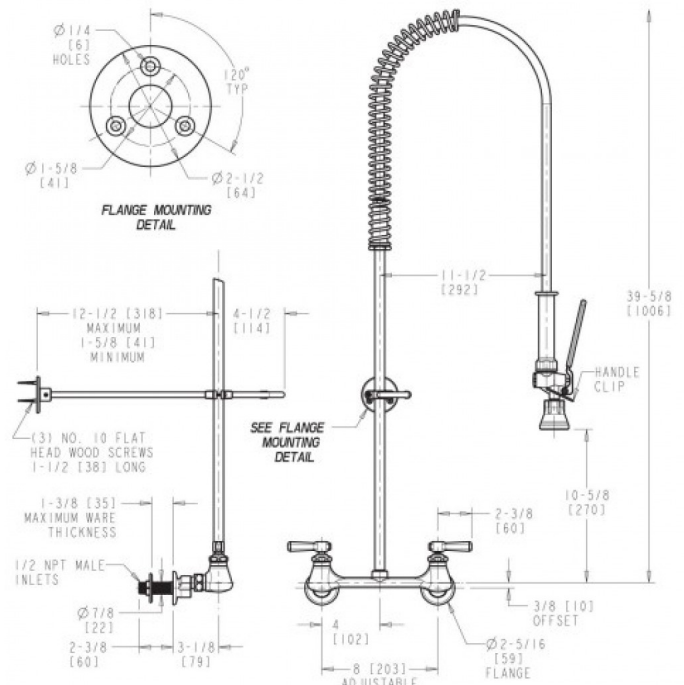
Chicago Faucets- Faucet

☒ **510-GWSLXKCAB**







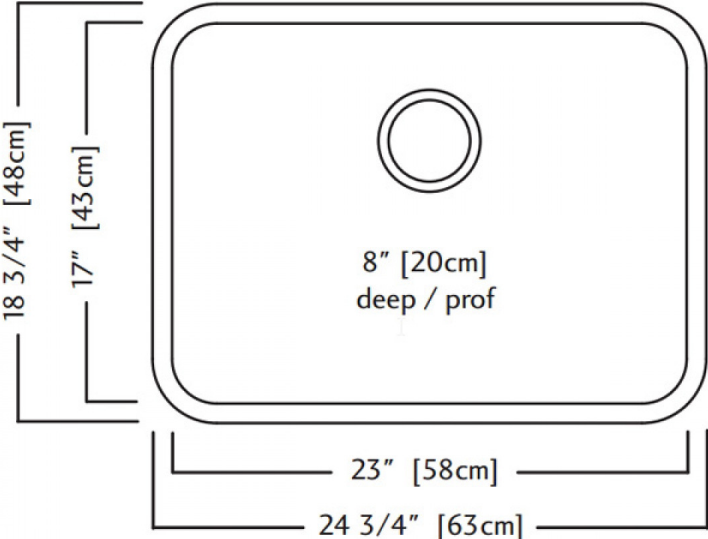
Wall-hung, Manual, Two handles, Pre-rinse fitting, Chrome plated finish, 184 - 222 mm (7-1/4" - 8-3/4") adjustable centerset, Lead Free ANSI/NSF 61 and ANSI/NSF 372 compliant, ECAST® brass construction, 1/4 turn ceramic cartridge with integrated check valve, 3.8 LPM (1.0 GPM) flow rate @60psi pre-rinse spray valve, Spray outlet, Pre-rinse spout, Pull down, 292 mm (11-1/2") spout reach, 1006 mm (39-5/8") high, Pre-rinse spout and valve consisting of 584 mm (23") riser with spring guide, 1118 mm (44") flexible stainless steel hose with insulated handle, pipe strap and hook assembly, Vandal-resistant 60 mm (2-3/8") lever handle with indexed buttons, 13 mm (1/2") NPT female thread inlet.

Refer to the product specification sheet for complete information



Note:

Spec Reference: 123702
Product Reference: 13831535

	<div>S-4</div> <div>Grade 18-8 Type 304 Stainless steel</div>	<div>Single compartment, Counter mounted, Undermount Kitchen sink</div>
<div>To be specified</div> <div>Chicago Faucets - Faucet</div>  <div> <input checked="" type="checkbox"/> 434-ABBN Counter mounted, Manual, Single handle, Sink faucet, Brushed nickel finish, Single hole centerset, Lead Free ANSI/NSF 61 compliant, ECAST® brass construction, With supply, Ceramic cartridge with volume control, 5.7 LPM (1.5 GPM) maximum flowrate, Gooseneck spout, Pull down, 210 mm (8-1/4") spout reach, 432 mm (17") high, Lever handle, 13 mm (1/2") NPSM supply inlet for 10 mm (3/8") or 13 mm (1/2") flexible riser, Includes hot limit safety stop. </div>	<div>Kindred- Sink</div> <div><input checked="" type="checkbox"/> QSU1925-8</div>  <div> Without faucet ledge,Grade 18-8 20 gauge Type 304 Stainless steel Polished to satin finish, Silk finish, Installation kit are included, Center back waste location, 89 mm (3-1/2") basket strainer waste fittings included, Sink is fully undercoated, Bowl Dimension: Left bowl is 584mm (23") long and right bowl is 381mm (15") long, Left bowl is 432 mm (17") wide and right bowl is 432 mm (17") wide, 203 mm (8") deep, Overall Dimension: 629 mm (24-3/4") long, 476 mm (18-3/4") wide, 203 mm (8") high. </div> <div>Refer to the product specification sheet for complete information</div>	
<div>Lawler - Mixing Valve</div>  <div> <input checked="" type="checkbox"/> 570-86820 Point of Use and Master controlled fixtures, Thermostatic master water mixing control valve, Lead free brass body construction, Nickel plated finish, Lead free brass body construction, 1.9 - 30 LPM (0.5 - 8 GPM) range for flowrate , To adjust the mixed outlet temperature of the valve, remove the cap to gain access to the adjusting spindle. The spindle should be rotated-clockwise to reduce the temperature, counter-clockwise to increase the temperature until the desired set point is reached, 11 LPM (3 GPM) tempered flowrate @ 5 PSI pressure drop, The temperature is adjusted with the help of Spindle, 4-7/8" (124 mm) Height, The temperature is adjusted with the help of Spindle, 3/8" MNPT (9.5 mm) inlet, 3/8" MNPT (9.5 mm) inlet, 95-115 °F outlet water temperature range, 3/8" MNPT (9.5 mm) outlet, 3/8" MNPT (9.5 mm) outlet, internal checks, Thermostatic master water mixing control valve, Nickel plated finish, Point of Use and Master controlled fixtures, ASSE 1070 approved Certified to CSA B125.3 for ASSE 1070 applications, 95-115 °F outlet water temperature range, Offers choice of temperature settings from 95° through 115 °F., 125 PSI max hydrostatic pressure, 125 PSI max hydrostatic pressure, ±20% pressure variation, ±20% pressure variation, 11 LPM (3 GPM) tempered flowrate @ 5 PSI pressure drop, To adjust the mixed outlet temperature of the valve, remove the cap to gain access to the adjusting spindle. The spindle should be rotated-clockwise to reduce the temperature, counter-clockwise to increase the temperature until the desired set point is reached, 40-80 °F, 10 °F, 180 °F max, 7 GPM flowrate @ 45 PSI, Offers choice of temperature settings from 95° through 115 °F., ±5 °F, Protects against scalding and chilling </div>	 <div> <div>18 3/4" [48cm]</div> <div>17" [43cm]</div> <div>8" [20cm] deep / prof</div> <div>23" [58cm]</div> <div>24 3/4" [63cm]</div> </div>	
<div>Note:</div>	<div>Spec Reference: 123702</div> <div>Product Reference: 15110099; 13820278; 7018383; 7047032; 7017077</div>	



S-4

Grade 18-8 Type 304 Stainless steel

Single compartment,
Counter mounted,
Undermount
Kitchen sink

McGuire - Supply



☒ **LFCK165LK** Lead Free, with Chrome-plated finish, Pipe to compression connection, 3/8" I.P.S x 3/8" O.D connection, Shallow wall flange, Loose key handle, Full turn brass stem, 305 mm (12") chrome-plated risers, Purple EPDM peroxide cured washers,

Codes and compliances: NSF/ANSI 61 & 372, UPC

McGuire - P-Trap



☒ **8912CB** Heavy cast brass, Adjustable p-trap, 292 mm (11-1/2") length, With cleanout plug, Steel box flange, Neoprene gasket, Seamless tubular brass bend, Slipnuts

Note:

Spec Reference: 123702
Product Reference: 15110099; 13820278;
7018383; 7047032; 7017077



S-5 (Kids Handwash)

Type 304 Stainless steel

Single compartment,
Counter mounted,
Undermount
Kitchen sink

To be specified

Sloan - Faucet



☒ **EA7-700-HLT-CP-1.0GPM-LAM-IR-IQ-FCT** OPTIMA®, Counter mounted, Automatic no-touch, Hardwired (specify transformer separately), Sink/lavatory faucet, Polished chrome finish, Single hole centerset, Brass spout, Flexible high pressure hose, 3.8 LPM (1.0 GPM) maximum flowrate, Laminar flow outlet, Gooseneck spout, 147 mm (5-7/8") spout reach, 355 mm (13-31/32") high, Double infrared sensors with automatic setting feature and microprocessor, Bi-stable magnetic solenoid valve, Above deck control access, Mixing valve ordered separately, Sloan transformer recommended, 12/24 hour hygienic rinse line purge function (field settable).

Lawler - Mixing Valve



☒ **570-86820** Point of Use and Master controlled fixtures, Thermostatic master water mixing control valve, Lead free brass body construction, Nickel plated finish, Lead free brass body construction, 1.9 - 30 LPM (0.5 - 8 GPM) range for flowrate , To adjust the mixed outlet temperature of the valve, remove the cap to gain access to the adjusting spindle. The spindle should be rotated-clockwise to reduce the temperature, counter-clockwise to increase the temperature until the desired set point is reached, 11 LPM (3 GPM) tempered flowrate @ 5 PSI pressure drop, The temperature is adjusted with the help of Spindle, 4-7/8" (124 mm) Height, The temperature is adjusted with the help of Spindle, 3/8" MNPT (9.5 mm) inlet, 3/8" MNPT (9.5 mm) inlet, 95-115 °F outlet water temperature range, 3/8" MNPT (9.5 mm) outlet, 3/8" MNPT (9.5 mm) outlet, internal checks, Thermostatic master water mixing control valve, Nickel plated finish, Point of Use and Master controlled fixtures, ASSE 1070 approved Certified to CSA B125.3 for ASSE 1070 applications, 95-115 °F outlet water temperature range, Offers choice of temperature settings from 95° through 115 °F., 125 PSI max hydrostatic pressure, 125 PSI max hydrostatic pressure, ±20% pressure variation, ±20% pressure variation, 11 LPM (3 GPM) tempered flowrate @ 5 PSI pressure drop, To adjust the mixed outlet temperature of the valve, remove the cap to gain access to the adjusting spindle. The spindle should be rotated-clockwise to reduce the temperature, counter-clockwise to increase the temperature until the desired set point is reached, 40-80 °F, 10 °F, 180 °F max, 7 GPM flowrate @ 45 PSI, Offers choice of temperature settings from 95° through 115 °F., ±5 °F, Protects against scalding and chilling

Franke Commercial- Sink

☒ **UCS6808P-1**



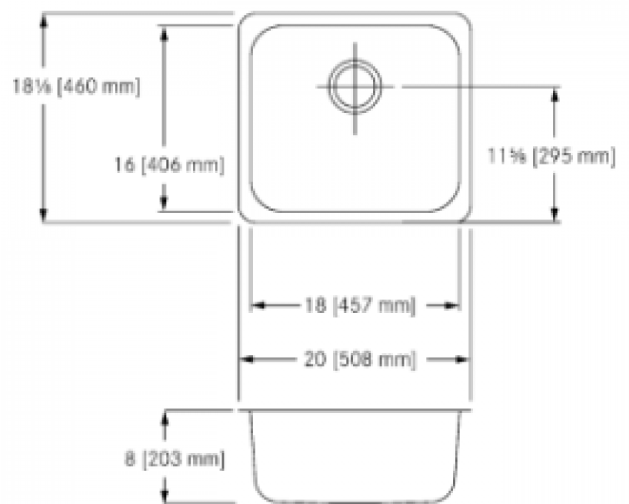
Without faucet ledge, 18 gauge Type 304 Stainless steel Polished to #4 satin finish, Center back waste location, 38 mm (1-1/2") (DN38) brass tailpiece, 89 mm (3-1/2") crumb cup strainer, waste fitting included, Undercoated to reduce condensation and resonance,

Codes and Compliances: ASME A112.19.3 compliant, CSA B45.4 compliant,

Bowl Dimension: Left bowl is 457mm (18") long and right bowl is 305mm (12") long, 406 mm (16") wide, 203 mm (8") deep,

Overall Dimension: 508 mm (20") long, 460 mm (18-1/8") wide, 203 mm (8") high.

Refer to the product specification sheet for complete information



Note:

Spec Reference: 123702

Product Reference: 7018175; 19596481;
7018383; 7047032; 7017077; 7030567



S-5 (Kids Handwash)

Type 304 Stainless steel

**Single compartment,
Counter mounted,
Undermount
Kitchen sink**

McGuire - Supply



☒ **LFCK165LK** Lead Free, with Chrome-plated finish, Pipe to compression connection, 3/8" I.P.S x 3/8" O.D connection, Shallow wall flange, Loose key handle, Full turn brass stem, 305 mm (12") chrome-plated risers, Purple EPDM peroxide cured washers,

Codes and compliances: NSF/ANSI 61 & 372, UPC

McGuire - P-Trap



☒ **8912CB** Heavy cast brass, Adjustable p-trap, 292 mm (11-1/2") length, With cleanout plug, Steel box flange, Neoprene gasket, Seamless tubular brass bend, Slipnuts

Sloan - Faucet and Flush Valve Power Kit



☒ **SL-ETF-416** For faucet

Note:

Spec Reference: 123702
Product Reference: 7018175; 19596481;
7018383; 7047032; 7017077; 7030567



LAV-1 (Revised)

OVALYN

**Undermount Lavatory
Vitreous china**

To be specified

Sloan - Faucet

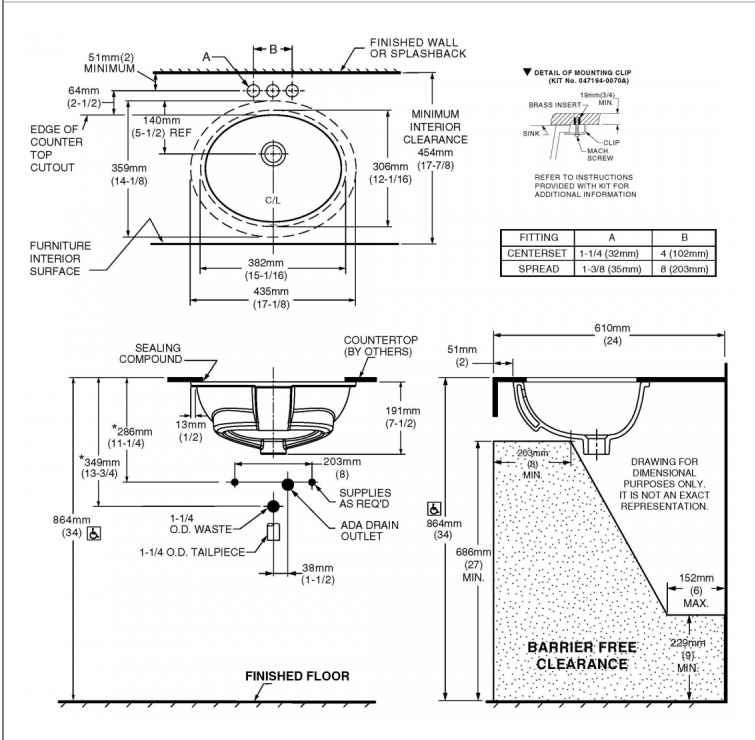


☒ **SF-2400-PLG-CP-0.35GPM-MLM-IR-FC** SLOAN®, Counter mounted, Automatic no-touch, Plug-in, Lavatory faucet, Polished chrome finish, Single hole centerset, Brass construction, 610 mm (24") flexible hose, 1.3 LPM (0.35 GPM) maximum flowrate, Multi-laminar spray outlet, 0.25 GPC (0.95 LPC) factory default, Integrated pedestal spout, 114 mm (4-1/2") spout reach, 152 mm (6") high, Infrared sensor with adjustable range, Filtered solenoid valve with serviceable strainer filter, Four (4) AA-size battery back-up power source, Mixing valve ordered separately, Sloan transformer recommended.



Undermount Lavatory, Vitreous china, White finish, Front overflow, Glazed underside, Mounting kit supplied (047194-0070A),

Overall Dimensions: 435 mm (17-1/8") long, 359 mm (14-1/8") wide, 191 mm (7-1/2") high
Bowl Dimensions: 383 mm (15-1/16") long, 306 mm (12-1/16") wide, 140 mm (5-1/2") deep
Weight:



Note:

Spec Reference: 123702
Product Reference: 7010604; 7314470;
7030567; 7018383; 7028883

Lawler - Mixing Valve



☒ **570-86820** Point of Use and Master controlled fixtures, Thermostatic master water mixing control valve, Lead free brass body construction, Nickel plated finish, Lead free brass body construction, 1.9 - 30 LPM (0.5 - 8 GPM) range for flowrate , To adjust the mixed outlet temperature of the valve, remove the cap to gain access to the adjusting spindle. The spindle should be rotated-clockwise to reduce the temperature, counter-clockwise to increase the temperature until the desired set point is reached, 11 LPM (3 GPM) tempered flowrate @ 5 PSI pressure drop, The temperature is adjusted with the help of Spindle, 4-7/8" (124 mm) Height, The temperature is adjusted with the help of Spindle, 3/8" MNPT (9.5 mm) inlet, 3/8" MNPT (9.5 mm) inlet, 95-115 °F outlet water temperature range, 3/8" MNPT (9.5 mm) outlet, 3/8" MNPT (9.5 mm) outlet, internal checks, Thermostatic master water mixing control valve, Nickel plated finish, Point of Use and Master controlled fixtures, ASSE 1070 approved Certified to CSA B125.3 for ASSE 1070 applications, 95-115 °F outlet water temperature range, Offers choice of temperature settings from 95° through 115 °F., 125 PSI max hydrostatic pressure, 125 PSI max hydrostatic pressure, ±20% pressure variation, ±20% pressure variation, 11 LPM (3 GPM) tempered flowrate @ 5 PSI pressure drop, To adjust the mixed outlet temperature of the valve, remove the cap to gain access to the adjusting spindle. The spindle should be rotated-clockwise to reduce the temperature, counter-clockwise to increase the temperature until the desired set point is reached, 40-80 °F, 10 °F, 180 °F max, 7 GPM flowrate @ 45 PSI, Offers choice of temperature settings from 95° through 115 °F., ±5 °F, Protects against scalding and chilling

American Standard - Fixture Drain



☒ **2411.015.002** Grid drain, For sinks, Brass construction, Chrome finish, 6-3/8" (162 mm) height, With overflow, 32 mm (1-1/4") tailpiece

Note:

Spec Reference: 123702
Product Reference: 7010604; 7314470;
7030567; 7018383; 7028883

*American
Standard*


LAV-3

MURRO

**Wall-hung Lavatory
Vitreous china**

To be specified

Sloan - Faucet



☒ **EBF-650-BAT-TEE-BN-0.35GPM-MLM-IR-FCT** OPTIMA®, Counter mounted, Automatic no-touch, Optional hardwired power (battery as a back-up), 24 VAC power harness connector supplied, Lavatory faucet, Brushed nickel finish (may require a minimum order quantity - contact supplier), 102 mm (4") centerset, Brass spout, 1.3 LPM (0.35 GPM) maximum flowrate, Multi-laminar spray outlet, Fixed spout, 116 mm (4-9/16") spout reach, 92 mm (3-5/8") high, Self-adapting infrared sensor, Dual inlet filter assembly with 9.5 mm (3/8") compression brass cap for tempered water included, Wireless bluetooth status view, setting adjustment and diagnostic via Sloan Connect App?®, Integral water supply shut off.

Sloan - Faucet and Flush Valve Power Kit



A black and white photograph of a Sloan SL-EL-154 flush valve solenoid. The device is a rectangular unit with a black central body and silver-colored metal end caps. It is mounted on a square metal base plate with four mounting holes. Two electrical wires, one black and one white, extend from the bottom of the unit.

☒ **SL-EL-154** For flush valve

A white pedestal sink with a modern, angular design. The sink has a single-lever faucet and is mounted on a tall, rectangular pedestal. The background is a plain, light gray.



Overall Dimensions: 545 mm (21-7/16") long, 540 mm (21-1/4") wide, 152 mm (6") high
Bowl Dimensions: 343 mm (13-1/2") long, 394mm (15-1/2") wide, 127 mm (5") deep
Weight:

[illegible]

Note:

Spec Reference: 123702
Product Reference: 15581148; 19383243;
7030565; 7018383; 7028883; 7016922; 7017073;
17168699

*American
Standard*

LAV-3

Wall-hung Lavatory
Vitreous china

MURRO

Lawler - Mixing Valve



☒ **570-86820** Point of Use and Master controlled fixtures, Thermostatic master water mixing control valve, Lead free brass body construction, Nickel plated finish, Lead free brass body construction, 1.9 - 30 LPM (0.5 - 8 GPM) range for flowrate , To adjust the mixed outlet temperature of the valve, remove the cap to gain access to the adjusting spindle. The spindle should be rotated-clockwise to reduce the temperature, counter-clockwise to increase the temperature until the desired set point is reached, 11 LPM (3 GPM) tempered flowrate @ 5 PSI pressure drop, The temperature is adjusted with the help of Spindle, 4-7/8" (124 mm) Height, The temperature is adjusted with the help of Spindle, 3/8" MNPT (9.5 mm) inlet, 3/8" MNPT (9.5 mm) inlet, 95-115 °F outlet water temperature range, 3/8" MNPT (9.5 mm) outlet, 3/8" MNPT (9.5 mm) outlet, internal checks, Thermostatic master water mixing control valve, Nickel plated finish, Point of Use and Master controlled fixtures, ASSE 1070 approved Certified to CSA B125.3 for ASSE 1070 applications, 95-115 °F outlet water temperature range, Offers choice of temperature settings from 95° through 115 °F., 125 PSI max hydrostatic pressure, 125 PSI max hydrostatic pressure, ±20% pressure variation, ±20% pressure variation, 11 LPM (3 GPM) tempered flowrate @ 5 PSI pressure drop, To adjust the mixed outlet temperature of the valve, remove the cap to gain access to the adjusting spindle. The spindle should be rotated-clockwise to reduce the temperature, counter-clockwise to increase the temperature until the desired set point is reached, 40-80 °F, 10 °F, 180 °F max, 7 GPM flowrate @ 45 PSI, Offers choice of temperature settings from 95° through 115 °F., ±5 °F, Protects against scalding and chilling

American Standard - Fixture Drain



☒ **2411.015.002** Grid drain, For sinks, Brass construction, Chrome finish, 6-3/8" (162 mm) height, With overflow, 32 mm (1-1/4") tailpiece

Note:

Spec Reference: 123702
Product Reference: 15581148; 19383243;
7030565; 7018383; 7028883; 7016922; 7017073;
17168699

McGuire - Supply



☒ **LFBV2165** Lead Free, with Chrome-plated finish, Two 13 mm (1/2") I.P.S. x 10 mm (3/8") Ø brass ball valve connection, Two steel shallow flanges, Convertible loose key handle, 304 mm (12") copper flexible risers.

McGuire - P-Trap



☒ **8902CB** Cast brass body material, Chrome-plated finish, Professional line box flange, 292 mm (11-1/2") length, With cleanout plug, Steel box flange, Neoprene gasket, Slipnuts, 17 gauge seamless tubular wall bend

Watts - Carrier



☒ **WCA-411** WCA-411/WCA-411-WC, Single floor-mounted lavatory carrier with concealed arms, For concealed arm carrier, adjustable arms, epoxy coated cast iron, integral welded feet, upper tie rod, Heavy gauge steel offset uprights, basin locking device, Plated hardware, levelling screws.

Note:

Spec Reference: 123702
Product Reference: 15581148; 19383243;
7030565; 7018383; 7028883; 7016922; 7017073;
17168699



LB-1

Laundry Box

Metal Laundry Box (8-1/4" W x 6" H x 3-1/2" D)

To be specified

Material

- ☐ Plastic
☒ Metal construction

Connection Type

- ☒ 1/2" FEMALE SWEAT x 3/4" HOSE
☐ 1/2" PEX FITTING x 3/4" HOSE
☐ 1/2" ProPEX FITTING

Fire Rating

- ☒ No Fire Rating
☐ With Fire Rating

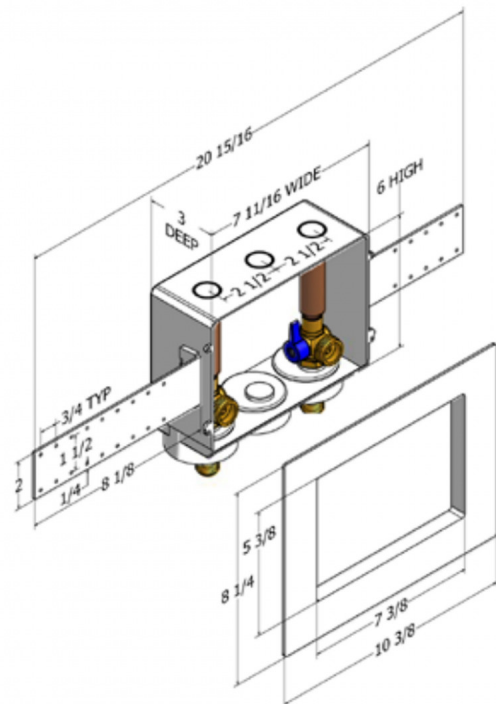
PPP- Laundry Box

☒ **MM-500 MLB**



Metal construction, Solenoid operated equipment can create destructive water hammer, by adding the Ice maker box assembly you are protecting your equipment as well as insuring against premature replacement

Refer to the product specification sheet for complete information



Note:

Spec Reference: 123702
Product Reference: 7304101



MS-1

Type 316 Stainless steel

Single compartment, Floor
mounted,
Mop service sinks

To be specified

American Standard - Faucet



☒ **8354112.002** Wall-hung, Manual, Two handles, Mop sink faucet, Polished chrome finish, 152 - 254 mm (6" - 10") adjustable centerset, Brass construction, Integral check valve, Ceramic disc cartridge, no flow restrictor, 37.8 LPM (10 GPM) @20 PSI, Threaded hose end, Cast brass spout with bucket hook, 248 mm (9-3/4") spout reach, Top brace, Vandal-resistant lever handles, 13 mm (1/2") female inlet.

Lawler - Mixing Valve



☒ **TMM-1070-87500** The point of use mechanical mixing valve with thermostatic limit stop, MECHANICAL MIXING VALVE, Lead free brass body construction, Lead free brass body construction, The temperature adjusting dial is located on the cold inlet. Turning the dial clockwise will lower the outlet temperature, turning the dial counter-clockwise will raise it. The valve cannot be adjusted above its shut-off temperature of 120F, 1.8 LPM (0.5 GPM) tempered flowrate @ 5 PSI pressure drop, Compression Fitting, 84 mm (3-5/16") high, Compression Fitting, 3/8" MNPT (9.5 mm) inlet, 3/8" MNPT (9.5 mm) inlet, 3/8" MNPT (9.5 mm) outlet, 3/8" MNPT (9.5 mm) outlet, integral rubber duck-bill backflow checks, MECHANICAL MIXING VALVE, The point of use mechanical mixing valve with thermostatic limit stop, ASSE 1070 approved ASSE lead free Certified for ASSE 1070 applications, High temperature limit stop, Automatically shuts down flow of water when temperature reaches 120 °F, 125 PSI max supply pressure, 5 PSI Minimum Operating pressure, 5 PSI Minimum Operating pressure, 125 PSI max supply pressure, 1.8 LPM (0.5 GPM) tempered flowrate @ 5 PSI pressure drop, The temperature adjusting dial is located on the cold inlet. Turning the dial clockwise will lower the outlet temperature, turning the dial counter-clockwise will raise it. The valve cannot be adjusted above its shut-off temperature of 120F, 140 °F max, 8 LPM (2.1 GPM) flowrate @ 45 PSI, Automatically shuts down flow of water when temperature reaches 120 °F, 118 °F ±3 °F, Protects against scalding and chilling

Franke Commercial- Sink

☒ **FSS222210-316-1**



Without faucet ledge, 16 gauge Type 316 Stainless steel Polished to #4 satin finish, With 305 mm (12") high backsplash and integral corner splashguard, Radius coved bowl corners, Includes one piece wall hangers, Center waste location, 51 mm (2") I.P.S. grid drain, Undercoated to reduce condensation and resonance,

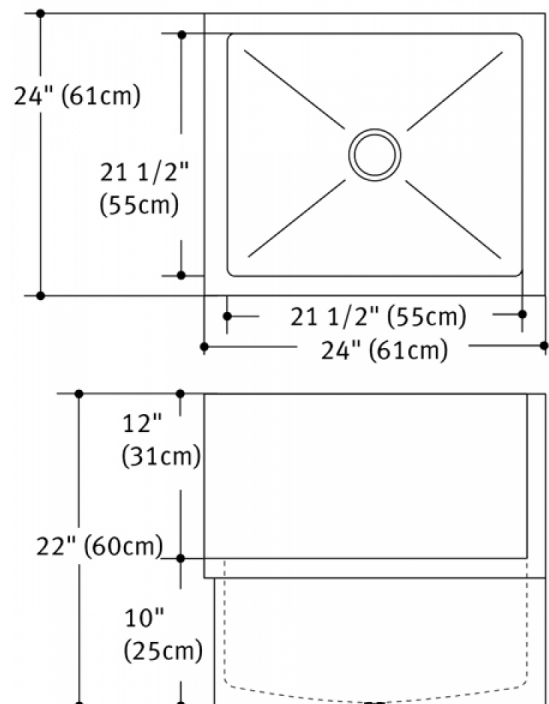
Codes and Compliances: ASME A112.19.3 compliant, CSA B45.4 compliant,

Bowl Dimension: 546 mm (21-1/2") long, 546 mm (21-1/2") wide, 254 mm (10") deep,

Overall Dimension: 610 mm (24") long, 610 mm (24") wide, 559 mm (22") high,

Notes: The sink can be installed in either left or right corners.

Refer to the product specification sheet for complete information



Note:

Spec Reference: 123702

Product Reference: 7018165; 38558; 7018151



HB-1

Type 304 Stainless steel

Single compartment, Wall-hung,
Wall trough sink

To be specified

Chicago Faucets - Faucet



☒ **897-RCF** Wall-hung, Manual, Two handles, Mop sink faucet, Rough chrome plated finish, 194 - 213 mm (7-5/8" to 8-3/8") adjustable centerset, Round wall escutcheons, Brass construction, Adjustable supply arms, 1/4 turn ceramic cartridge, No flow restrictor, Threaded hose end, Spout with pail hook, 146 mm (5-3/4") spout reach, 273 mm (10-3/4") high, Top brace, 60 mm (2-3/8") lever handle with indexed buttons, Atmospheric vacuum breaker is not intended for continuous pressure applications.

Lawler - Mixing Valve



☒ **570-86820** Point of Use and Master controlled fixtures, Thermostatic master water mixing control valve, Lead free brass body construction, Nickel plated finish, Lead free brass body construction, 1.9 - 30 LPM (0.5 - 8 GPM) range for flowrate, To adjust the mixed outlet temperature of the valve, remove the cap to gain access to the adjusting spindle. The spindle should be rotated-clockwise to reduce the temperature, counter-clockwise to increase the temperature until the desired set point is reached, 11 LPM (3 GPM) tempered flowrate @ 5 PSI pressure drop, The temperature is adjusted with the help of Spindle, 4-7/8" (124 mm) Height, The temperature is adjusted with the help of Spindle, 3/8" MNPT (9.5 mm) inlet, 3/8" MNPT (9.5 mm) inlet, 95-115 °F outlet water temperature range, 3/8" MNPT (9.5 mm) outlet, 3/8" MNPT (9.5 mm) outlet, internal checks, Thermostatic master water mixing control valve, Nickel plated finish, Point of Use and Master controlled fixtures, ASSE 1070 approved Certified to CSA B125.3 for ASSE 1070 applications, 95-115 °F outlet water temperature range, Offers choice of temperature settings from 95° through 115 °F., 125 PSI max hydrostatic pressure, 125 PSI max hydrostatic pressure, ±20% pressure variation, ±20% pressure variation, 11 LPM (3 GPM) tempered flowrate @ 5 PSI pressure drop, To adjust the mixed outlet temperature of the valve, remove the cap to gain access to the adjusting spindle. The spindle should be rotated-clockwise to reduce the temperature, counter-clockwise to increase the temperature until the desired set point is reached, 40-80 °F, 10 °F, 180 °F max, 7 GPM flowrate @ 45 PSI, Offers choice of temperature settings from 95° through 115 °F., ±5 °F, Protects against scalding and chilling

Franke Commercial- Sink

☒ **WTS2025-1-2**



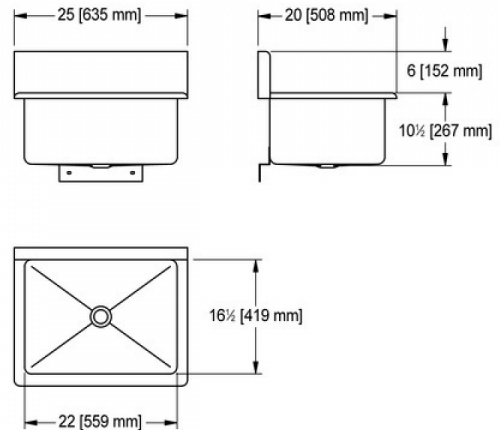
203 mm (8") centerset, 14 gauge Type 304 Stainless steel Polished to #4 satin finish, With 152 mm (6") high backsplash, Radius coved bowl corners and rolled radius rim, Center waste location, 38 mm (1-1/2") (DN38) brass tailpiece, 89 mm (3-1/2") crumb cup strainer,

Codes and Compliances: ASME A112.19.3 compliant, CSA B45.4 compliant,

Bowl Dimension: 559 mm (22") long, 419 mm (16-1/2") wide, 267 mm (10-1/2") deep,

Overall Dimension: 635 mm (25") long, 508 mm (20") wide, 419 mm (16-1/2") high.

Refer to the product specification sheet for complete information



Note:

Spec Reference: 123702
Product Reference: 7032789; 7018472;
7018383; 7017077



HB-1

Type 304 Stainless steel

Single compartment, Wall-
hung,
Wall trough sink

McGuire - P-Trap



☒ **8912CB** Heavy cast brass, Adjustable p-trap, 292 mm (11-1/2") length, With cleanout plug, Steel box flange, Neoprene gasket, Seamless tubular brass bend, Slipnuts

Note:

Spec Reference: 123702
Product Reference: 7032789; 7018472;
7018383; 7017077



DIVISION 23 – HVAC
SPECIFICATIONS
FOR THE
CITY OF TORONTO - DAYCARE CENTRE (METRO HALL)
55 JOHN STREET
TORONTO, ONTARIO

Prepared by:

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Suite 200
Toronto, ON M2H 3N5

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DISCIPLINES MECHANICAL
ELECTRICAL
PLUMBING
LIGHTING DESIGN
COMMUNICATIONS & AV
SECURITY & RISK
COMMISSIONING
ENERGY SERVICES

Our Project No. 2021-0245

Issued for Approval
Design Development

October 1, 2024



Project Name: CITY OF TORONTO - DAYCARE CENTRE (METRO HALL)
Project No.: 2021-0245
Section Name: **Table of Contents**
Section No.: **Division 23 - HVAC**
Date: October 1, 2024

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Section 23 05 36	Motor Starters and MCCs
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Project Name: CITY OF TORONTO - DAYCARE CENTRE (METRO HALL)
Project No.: 2021-0245
Section Name: **Hydronic Valves**
Section No.: **23 05 23**
Date: October 1, 2024

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- 3.6 Radiation Valves
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Project Name: CITY OF TORONTO - DAYCARE CENTRE (METRO HALL)
Project No.: 2021-0245
Section Name: **Hydronic Valves**
Section No.: **23 05 23**
Date: October 1, 2024

1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 - General Requirements, shall apply to and govern this Section.

1.2 SCOPE OF WORK

1.2.1 Provide valves for all hydronic piping systems, with the exception of control valves. Control valves shall be supplied under the work of the Division 25 – Integrated Automation Subcontractor, installed under this Section, and connected as part of the work of the Division 25 – Integrated Automation Subcontractor.

1.3 SHOP DRAWINGS

1.3.1 Provide Shop Drawings for:

1.3.1.1 All hydronic valves (except control valves)

2 **PRODUCTS**

2.1 GENERAL

2.1.1 All valves shall be of one manufacture unless otherwise noted in the Contract Documents and should have the manufacturer's name and pressure rating clearly marked on the body. Valves to conform to the current of ANSI, ASTM, ASME, and applicable Manufacturers' Standardization Society Specification (MSS).

2.1.2 Bronze valves up to and including 1034kPa (150 psi) steam pressure shall be manufactured to ASTM B62-93 standard. Bronze valves up to 1379kPa (200 psi) and 2068kPa (300 psi) steam pressure shall be manufactured to ASTM B61-93 standard. Bronze valves used in water systems may be cast bronze to ASTM B584-87 alloy CDA-836.

2.1.3 Iron body valves shall be ductile iron manufactured to ASTM A536-84 Grade 65-45-12 or cast iron ASTM A126-95 Class B standard where ductile iron is not available.

2.1.4 All valves shall have a CRN registration number.

2.1.5 Valve Materials

2.1.5.1 Bronze: to ASTM B62 or B61 as applicable

Project Name: CITY OF TORONTO - DAYCARE CENTRE (METRO HALL)
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- 2.1.5.2 Brass: to ASTM B283 C3770
- 2.1.5.3 Cast Iron: to ASTM A126, Class B
- 2.1.5.4 Forge Steel: to ASTM A105N
- 2.1.5.5 Cast Steel: to ASTM A216WCB
- 2.1.6 Valve Markings
 - 2.1.6.1 All pressure ratings, manufacturers' trademark and size to conform as per MSS-SP-25.
- 2.1.7 End Connections
 - 2.1.7.1 Threaded ends: to ASME B1.20.1
 - 2.1.7.2 Solder ends: to ASME B16.18
 - 2.1.7.3 Flanged ends: to ASME B16.1 (Class 125)
 - 2.1.7.4 Face To Face dimensions: to ASME B16.10
 - 2.1.7.5 Fanged ends: to ASME B16.5
 - 2.1.7.6 Butt Weld Ends: to ASME 16.25
 - 2.1.7.7 Socket Weld Ends: to ASME B.16.11
- 2.1.8 Testing & Design
 - 2.1.8.1 MSS-SP-80 - Bronze, Gate & Check Valves
 - 2.1.8.2 MSS-SP-110 - Ball Valves
 - 2.1.8.3 MSS –SP-70, 85, 71 - Cast Iron Gate, Globe & Check Valve
 - 2.1.8.4 MSS-SP-72 - American Valve
 - 2.1.8.5 MSS-SP-67 - Kitz, Apollo, Toyo, Demco & WKM E, Butterfly Valves
 - 2.1.8.6 API 602 - Forge Steel Valves (Design)
 - 2.1.8.7 API 598 - Cast Steel Valves, Forge Steel Valves (Testing)
 - 2.1.8.8 API 609 - WKM High Performance BFV

Project Name: CITY OF TORONTO - DAYCARE CENTRE (METRO HALL)
Project No.: 2021-0245
Section Name: **Hydronic Valves**
Section No.: **23 05 23**
Date: October 1, 2024

2.1.8.9 API 600 - Cast Steel Valves (Design)

2.2 VALVES FOR LOW PRESSURE SERVICE

2.2.1 This Subsection applies to valves used in heating and chilled water systems, condenser water systems, and chemical feed systems up to 1,034 kPa (150 psi) system operating pressure.

2.2.2 Gate Valves

2.2.2.1 50mm (2") dia. or less - shall be Class 125, all bronze, with solid wedge disc, rising stem.

Threaded ends - Toyo 293
- Kitz 24
- Crane 428

Soldered ends - Toyo 299
- Kitz 44
- Crane 1334

2.2.2.1.1 For application where non-rising stem is required.

Threaded ends - Toyo 280A
- Kitz 40
- Crane 438

Soldered ends - Toyo 281A
- Kitz 41
- Crane 1324

2.2.2.2 65mm (2-½") dia. and over - shall be Class 125, iron body/bronze mounted, with O.S. & Y., solid wedge design.

Flanged ends - Toyo 421
- Kitz 72
- Jenkins Fig. 454J
- Crane 465 ½

2.2.2.2.1 For application where non-rising stem is required.

Flanged ends - Toyo 415
- Kitz 75
- Jenkins Fig. 452J
- Crane 461

Project Name: CITY OF TORONTO - DAYCARE CENTRE (METRO HALL)
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2.2.3 Globe Valves

2.2.3.1 50mm (2") dia. or less - shall be Class 125, all bronze, with rising stem, fitted with PTFE disc.

Threaded ends - Toyo 220
- Kitz 03
- Crane 7TF

Soldered ends - Toyo 212
- Kitz 10
- Crane 1310

2.2.3.2 65mm (2-½") dia. and over - shall be Class 125, iron body/bronze mounted, O.S. & Y.

Flanged ends - Toyo 400A
- Kitz 76
- Crane 351

Alternative - Jenkins Fig. 2342J (renewable bronze seat and disc)

2.2.4 Check Valves

2.2.4.1 50mm (2") dia. or less - shall be Class 125, all bronze, Y pattern swing check.

Threaded ends - Toyo 236
- Kitz 22
- Crane 37

Soldered ends - Toyo 237
- Kitz 23
- Crane 1342

2.2.4.1.1 If lift check valve required.

Threaded ends - Kitz 36 (vertical)
- Jenkins Fig. 117ATJ (horizontal)
- Jenkins Fig. 119J (vertical)
- Crane 29 (vertical)
- Crane 27TF (horizontal)

2.2.4.2 65mm (2-½") dia. and over - shall be Class 125, iron body/bronze mounted or stainless steel, with bolted bonnet.

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- Flanged ends
 - Toyo 435A
 - Kitz 78
 - Jenkins Fig. 587J
 - Duo Check II (Wafer style)
 - Mueller 71 series
 - Crane 373
 - Check Rite CET (Wafer Style)
 - Moygro W12A-16V (Wafer Style)
- Grooved ends
 - Victaulic Series 712 (horizontal), 716 (vertical) or 779 with Venturi-taps

2.2.4.2.1 If silent check valve is required - cast iron body, bronze trim, EPDM seat, spring loaded center guided disc, stainless steel spring and shaft.

- Flanged ends
 - Apco or Smolenski
 - Mueller
- Grooved ends
 - Victaulic 716 - 65mm (2-½") to 300mm (12")
 - Victaulic AGS W715 - 350mm (14") to 750mm (30")

2.2.5 Ball Valves

2.2.5.1 50mm (2") dia. or less - shall be rated for 1034kPa (150 psi) steam, 4137kPa (600 psi) non-shock cold water or oil, with full or standard port brass or bronze body, brass chrome plated ball, Teflon seats and packing.

- Threaded ends
 - Toyo 5044A
 - Kitz 58
 - Apollo 77C-100
 - MAS B-3
 - Victaulic Series 722
- Soldered ends
 - Toyo 5049A
 - Kitz 59
 - Apollo 77C-200
 - MAS B-4

2.2.5.2 For hot water heating applications, stainless steel ball and stem.

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- Threaded ends
 - Toyo 5043-S
 - Kitz 58M/68AM-LL
 - Apollo 76F-100
- Soldered ends
 - Toyo 5041S
 - Kitz 59M/69AM-LL

2.2.6 Butterfly Valves

2.2.6.1 65mm (2-½") dia. and up to 300mm (12") dia. - shall be Class 125, cast or ductile iron full lug body with bronze disk, stainless steel stems, EPDM resilient seat, with a 1379kPa (200 psi) single flange shut off rating (dead end service) and 121°C (250°F) temperature rating.

2.2.6.2 Valves 50mm (2") dia. and up to 100mm (4") dia. shall have a 10-position lever. Valves 150mm (6") dia. and above shall have hand wheel gear activator.

- Lug Style
 - Newman Hattersley Fig. 45-31532x
 - Kitz 6122EL/G
 - Toyo 918BESL/G
 - Jenkins Fig. 2232ExJ
 - De Zurik BGM
 - Apollo 143-DBE-11/12
 - Crane 44BXZ
 - Centerline 200 series
 - MAS D-Series LD4AE

2.2.6.3 Grooved end butterfly valves:

2.2.6.3.1 DN50 – DN300 (2" – 12") shall be rated to 2,068 kPa (300 psi) and dead-end service capable to full rated pressure. Body material shall be ductile iron with blow-out proof stainless steel stem, electroless nickel coated ductile iron disc, pressure responsive EPDM seat for water service with temperature range of –34°C to +110°C (-30°F to 230°F). Stem shall be offset from the disc centerline to provide full 360-degree circumferential seating.

- Victaulic Vic-300 MasterSeal.

2.2.6.3.2 DN350 – DN750 (14" – 30") shall be rated to 2,068 kPa (300 psi) and dead-end service capable to full rated pressure. Body material shall be ductile iron with blow-out proof stainless steel stem, PPS (polyphenylene sulfide) coated ductile iron disc, and EPDM seal for water service with temperature range of –34°C to +110°C

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(-30°F to 230°F). Stem shall be offset from the disc centerline to provide full 360-degree circumferential seating.

- Victaulic AGS Series W706
(W709 for services to 1,270 kPa (175 psi))

2.2.7 Plug Valves

2.2.7.1 DN80 (3") dia. or less - shall be Class 125, bronze eccentric plug valve, with memory stop and drip cap, grooved, flanged or screwed ends, as appropriate for piping system.

- DeZurik PEC Series

2.2.7.2 DN100 (4") dia. up to DN300 (12") dia. - shall be Class 125, bronze eccentric plug valve, with handwheel gear, and grooved, flanged or screwed ends, as appropriate for piping system.

- DeZurik PEC Series

- Victaulic Series 377

(grooved ends, rated to 1,270 kPa (175 psi))

2.2.8 Each hydronic terminal unit shall be provided with a 'Dahl' radiator valve, series 121 with soldered connection, on the supply and return lines.

2.3 VALVES FOR MEDIUM PRESSURE SERVICE

2.3.1 This Subsection applies to valves used in heating and chilled water systems, condenser water systems, and chemical feed systems up to 1,724 kPa (250 psi) system operating pressure.

2.3.2 Gate Valves

2.3.2.1 50mm (2") dia. or less - shall be Class 150, all bronze, with solid wedge disc, rising stem.

Threaded ends - Toyo 298
 - Kitz 42
 - Crane 431UB

Soldered ends - Kitz 43
 - Crane 1334

2.3.2.1.1 For application where non-rising stem is required.

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Threaded ends - Toyo 204
 - Kitz 46
 - Crane 437

Soldered ends - Kitz 64
 - Crane 1324

2.3.2.2 65mm (2-½") dia. and over - shall be Class 150, cast carbon steel, with bolted bonnet, O.S. & Y., ½ Stellite trim, graphite packing.

Flanged ends - Bonney Forge 1-11-RF
 - Kitz 150 SCLS
 - Crane 47XUF
 - Beric 101-RF-AA08-H
 - Powell 1503-FC8G

2.3.3 Globe Valves

2.3.3.1 50mm (2") dia. or less - shall be Class 150, all bronze, with rising stem, fitted with PTFE disc.

Threaded ends - Toyo 221
 - Kitz 09
 - Crane 7TF

Soldered ends - Kitz 10
 - Crane 1310

2.3.3.2 65mm (2-½") dia. and over - shall be Class 150, cast carbon steel, with bolted bonnet, O.S. & Y., ½ Stellite trim, graphite packing.

Flanged ends - Bonney Forge 1-31-RF
 - Kitz 150 SCJS
 - Crane 143XU
 - Beric 201-RF-AA08-H
 - Powell 1531-FC8G

2.3.4 Check Valves

2.3.4.1 50mm (2") dia. or less - shall be Class 150, all bronze, Y pattern swing check.

Threaded ends - Toyo 238
 - Kitz 29
 - Crane 137

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Soldered ends - Kitz 30
 - Crane 1342

2.3.4.1.1 If lift check valve required.

Threaded ends - Kitz 36 (vertical)
 - Crane 27TF (horizontal)

2.3.4.2 65mm (2-½") dia. and over - shall be Class 150, cast carbon steel, with bolted cover, ½ Stellite trim, stainless steel inserted flexible graphite gasket. Valve shall be silent check.

Flanged ends - Bonney Forge 1-61-RF
 - Kitz 150 SCOS
 - Centreline 800 series
 - Duo Check II lug type
 - Mueller Series 72
 - Beric 301-RF-AAO8-X
 - Check Rite 210CET (Wafer Style)
 - Powell 1561-FC8G
 - Moygro (Wafer Style)

Grooved ends - Victaulic Series 712 (horizontal), 716 (vertical),
 W715 and 779 with Venturi taps

2.3.5 Ball Valves

2.3.5.1 50mm (2") dia. or less - shall be rated for 1034kPa (150 psi) steam, 4137kPa (600 psi) non-shock cold water or oil, full port brass or bronze body, brass chrome plated ball, Teflon seats and packing.

Threaded ends - Toyo 5044A
 - Kitz 58
 - Apollo 77C-100
 - MAS B3
 - Victaulic Series 722

Soldered ends - Toyo 5049A
 - Kitz 59
 - Apollo 77C-200
 - MAS B4

2.3.5.2 For hot water heating applications, stainless steel ball and stem.

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- Threaded ends
 - Toyo 5043-S
 - Kitz 58M/68AM-LL
 - Apollo 76F-100
- Soldered ends
 - Toyo 5041S
 - Kitz 59M/69AM-LL

2.3.6 Butterfly Valves

2.3.6.1 65mm (2-½") dia. and up to 300mm (12") dia. - shall be Class 150, carbon steel full lug body with stainless steel shaft and disk, RTFE packing and seat, and bi-directional bubble tight shut off to the full ASME rating.

2.3.6.2 Valves 65mm (2-½") dia. and up to 100mm (4") dia. shall have a 10-position lever. Valves 150mm (6") dia. and above shall have hand wheel gear activator.

- Lug Style
 - Flowseal 1LA-121-TTG
 - WKM B5113-02-S02-11-HL/G
 - Bray Series 41-466
 - Powell 1572-QCRTXXXGLV/GXX

2.3.6.3 Grooved end butterfly valves:

2.3.6.3.1 DN50 – DN300 (2" – 12") shall be rated to 2,068 kPa (300 psi) and dead-end service capable to full rated pressure. Body material shall be ductile iron with blow-out proof stainless steel stem, electroless nickel coated ductile iron disc, pressure responsive EPDM seat for water service with temperature range of –34°C to +110°C (-30°F to 230°F). Stem shall be offset from the disc centerline to provide full 360-degree circumferential seating.

- Victaulic Vic-300 MasterSeal.

2.3.6.3.2 DN350 – DN750 (14" – 30") shall be rated to 2,068 kPa (300 psi) and dead-end service capable to full rated pressure. Body material shall be ductile iron with blow-out proof stainless steel stem, PPS (polyphenylene sulfide) coated ductile iron disc, and EPDM seal for water service with temperature range of –34°C to +110°C (-30°F to 230°F). Stem shall be offset from the disc centerline to provide full 360-degree circumferential seating.

- Victaulic AGS Series W706.

2.4 VALVES FOR HIGH PRESSURE SERVICE

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2.4.1 This Subsection applies to valves used in heating and chilled water systems, condenser water systems, and chemical feed systems over 1,724 kPa (250 psi) system operating pressure.

2.4.2 Gate Valves

2.4.2.1 50mm (2") dia. or less - shall be Class 800, forge steel body, with O.S. & Y., bolted bonnet, ½ Stellite trim, graphite packing.

Threaded ends - Bonney Forge HL-11-T
 - Beric 501-TX8A08
 - Powell GA08TA58GB

2.4.2.2 65mm (2-½") dia. and over - shall be Class 300, cast carbon steel, with O.S. & Y., bolted bonnet, ½ Stellite trim, graphite packing.

Flanged ends - Bonney Forge 3-11-RF
 - Kitz 300 SCLS
 - Beric 103-RF-AA08-H
 - Powell 3003-FC8G

2.4.3 Globe Valves

2.4.3.1 50mm (2") dia. or less - shall be Class 800, forge steel body, O.S. & Y., bolted bonnet, ½ Stellite trim, graphite packing.

Threaded ends - Bonney Forge HL-31-T
 - Beric 502-TX8A08
 - Powell GL08TA58GB

2.4.3.2 65mm (2-½") dia. and over - shall be Class 300, cast carbon steel, with O.S. & Y., bolted bonnet, ½ Stellite trim, graphite packing.

Flanged ends - Bonney Forge 3-31-RF
 - Kitz 300 SCJS
 - Beric 203-RF-AA08-H
 - Powell 3031-FC8G

2.4.4 Check Valves

2.4.4.1 50mm (2") dia. or less - shall be swing type Class 800, forge steel body, with bolted bonnet, ½ Stellite trim, and graphite gasket.

Threaded ends - Bonney Forge HL-61-T
 - Beric 504-TX8A08
 - Powell SW08TA58GB

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2.4.4.2 65mm (2-½") dia. and over –shall be Class 300, cast carbon steel, with bolted cover, stainless steel inserted flexible graphite gasket.

Flanged ends - Bonney Forge 3-61-RF
 - Kitz 300 SCOS
 - Beric 303-RF-AA08-X
 - Check Rite Model 210 (Wafer Style)
 - Powell 3061-FC8G
 - Moygro (Wafer Style)

2.4.5 Ball Valves

2.4.5.1 50mm (2") dia. or less - shall be rated for 1034kPa (150 psi) steam, 4137kPa (600 psi) non-shock cold water or oil, full port brass or bronze body, brass chrome plated solid ball, Teflon seats and packing.

Threaded ends - Toyo 5044A
 - Kitz 58
 - Apollo 77C-100
 - MAS B3

Soldered ends - Toyo 5049A
 - Kitz 59
 - Apollo 77C-200
 - MAS B4

2.4.5.2 For hot water heating applications, stainless steel ball and stem.

Threaded ends - Toyo 5043-S
 - Kitz 58M/68AM-LL
 - Apollo 76F-100

Soldered ends - Toyo 5041S
 - Kitz 59M/69AM-LL

2.4.6 Butterfly Valves

2.4.6.1 65mm (2-½") dia. and up to 300mm (12") dia. - shall be Class 300, carbon steel full lug body with stainless steel shaft and disk, RTFE packing and seat, and bi-directional bubble tight shut off to the full ASME rating.

2.4.6.2 Valves 65mm (2-½") dia. and up to 100mm (4") dia. shall have a 10-position lever. Valves 150mm (6") dia. and above shall have hand wheel gear activator.

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Lug Style - WKM B5313-02-S02-11-HL/G
- Bray Series 43-466
- Powell 3072-QCRTXXXGLV/GXX

2.4.6.3 Grooved end butterfly valves:

2.4.6.3.1 DN50 – DN300 (2" – 12") shall be rated to 2,068 kPa (300 psi) and dead-end service capable to full rated pressure. Body material shall be ductile iron with blow-out proof stainless steel stem, electroless nickel coated ductile iron disc, pressure responsive EPDM seat for water service with temperature range of –34°C to +110°C (-30°F to 230°F). Stem shall be offset from the disc centerline to provide full 360-degree circumferential seating.

- Victaulic Vic-300 MasterSeal.

2.4.6.3.2 DN350 – DN750 (14" – 30") shall be rated to 2,068 kPa (300 psi) and dead-end service capable to full rated pressure. Body material shall be ductile iron with blow-out proof stainless steel stem, PPS (polyphenylene sulfide) coated ductile iron disc, and EPDM seal for water service with temperature range of –34°C to +110°C (-30°F to 230°F). Stem shall be offset from the disc centerline to provide full 360-degree circumferential seating.

- Victaulic AGS Series W706.

2.5 CIRCUIT BALANCING VALVES

2.5.1 Valve body shall be ductile iron with grooved, flanged, or screwed ends, as appropriate for piping system.

2.5.2 Valves shall have metering ports incorporating EPT check valves on both sides of the seat.

2.5.3 Valves shall be "Y" pattern modified equal percentage globe. Each valve shall be capable of precise flow measurement and positive shut-off.

2.5.4 Valves shall have minimum of four full 360° adjustment turns of the handwheel with a micrometer type indicator and a tamper-resistant memory.

2.5.5 Valve components shall be suitable for intended application.

2.5.6 Provide a computerized digital flow meter for future use by the Owner. Meter shall be preprogrammed with circuit setter

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calibration curves, and be capable of:

- 2.5.6.1 Direct flow readout
- 2.5.6.2 Proportional balancing
- 2.5.6.3 Computing required valve setting
- 2.5.6.4 Differential pressure measurement
- 2.5.6.5 Temperature measurement
- 2.5.6.6 Airflow measurement
- 2.5.6.7 Leak testing
- 2.5.7 The flow meter shall have automatic calibration and air purging, and be complete with hard lockable case, hoses, fittings, temperature probe, 0 – 18m w.g. (0 – 60 ft w.g.) transducer, and quick connect connections.
- 2.5.8 Select circuit balancing valve size to give a pressure drop at 100% open between 3.0 kPa (0.43 psi) and 21 kPa (3.0 psi). Select valves located remote from the pumps in the circuit near minimum pressure drop, and those located near the pumps at higher pressure drop.
- 2.5.9 Provide preformed rigid insulation for valves.
- 2.5.10 DN50 (2") and smaller: Victaulic / TA Hydronics Series 786 STAS or 787 STAD, RWV 9517 (NPT) / 9519 (soldered)
- 2.5.11 DN 65 (2-1/2") and larger: Victaulic / TA Hydronics Series 788 STAF or 789 STAG, RWV 9574P
- 2.5.12 Terminal Unit Coil Connection Kits
- 2.5.12.1 At Contractor's option and as detailed in schematics, terminal unit coil kits may be used in lieu of traditional coil installation. Victaulic Series 799 / 79V Koil-Kit Coil Pack shall include the following components: 78Y strainer / ball valve combination (or 78T where strainer is not required), two optional coil hoses, Series 78U union port and a balancing valve (series 78K or TA series 786/787) sized to flow rate.

3 EXECUTION

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3.1 GENERAL

- 3.1.1 Valves shall be the same size as the line in which installed.
- 3.1.2 Valves shall be located in such a manner that the top works, operators, and bonnets may be easily removed.
- 3.1.3 Stems of valves shall be positioned for maximum ease in use, but in no event in a manner causing a hazard, or with stem down unless specifically shown as such.
- 3.1.4 Provide valves where shown on the Drawings, or on schematic diagrams, or in details, or as specified in the Contract Documents.
- 3.1.5 Provide drain valves at all low points of system. Drain valves shall be ball or gate valve with cap and chain.
- 3.1.6 Provide chain wheel operators and operating chain for all valves located more than 2.1m (7 ft) above floor or walkway. Provide chain of sufficient length to extend to within 2.1m (7 ft) of operating platform or floor for free hanging chains, or to within 1.5m (5 ft) of floor in locations where chain can be secured to a wall or column. Provide wall hook as required for securing chain to wall or column.

3.2 GATE AND BUTTERFLY VALVES

- 3.2.1 Provide gate and/or butterfly valves:
 - 3.2.1.1 Where indicated on the Drawings and in the Specification.
 - 3.2.1.2 Entering and leaving all equipment and terminal units.
 - 3.2.1.3 On all branches.
 - 3.2.1.4 As isolation of each floor for all services.
 - 3.2.1.5 At the base of all risers.

3.3 GLOBE VALVES

- 3.3.1 Provide globe valves:
 - 3.3.1.1 Where indicated on the Drawings and in the Specification.
 - 3.3.1.2 On all bypass systems.
 - 3.3.1.3 Where required for throttling control.

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3.4 BALL VALVES

3.4.1 Provide ball valves where indicated on the Drawings and in the Specification.

3.4.2 For pipe sizes DN50 (2") and smaller, ball valves may be substituted for gate and globe valves.

3.5 CHECK VALVES

3.5.1 Provide check valves:

3.5.1.1 Where indicated on the Drawings and in the Specification.

3.5.1.2 On the discharge of all pumps (silent check).

3.5.1.3 On the discharge of multiple equipment.

3.6 RADIATION VALVES

3.6.1 Provide radiation valves on the supply and return lines at each radiation heating element.

3.7 DRAIN VALVES

3.7.1 Install 20mm ($\frac{3}{4}$ ") dia. drain valves at all down-fed terminal heating and/or cooling units.

3.7.2 Install 40mm (1- $\frac{1}{2}$ ") dia. or line size valves at low points and other drain points on system.

3.7.3 Install 40mm (1- $\frac{1}{2}$ ") dia. valves for flushing purposes.

3.8 CIRCUIT BALANCING VALVES

3.8.1 Provide ball, globe, or eccentric plug valves for throttling or controlling flow where indicated on the Drawings and in the Specification except where circuit balancing valves are specified.

3.8.1.1 Provide ball, globe, or eccentric plug valves in return piping connections to radiators, forced flow heaters, unit heaters, and wallfin heaters.

3.8.2 Provide circuit balancing valves as follows:

3.8.2.1 Where indicated on the Drawings and in the Specification.

3.8.2.2 In return branch mains and branch connections to return mains.

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- 3.8.2.3 In each return riser.
- 3.8.2.4 In return piping connections to air handling unit heating and cooling coils, fan coil units, heat pump units, reheat coils in air terminal control units, and any other equipment not listed under Paragraph 3.8.1.1.
- 3.8.3 Do not locate handwheel or measuring ports facing downward (to prevent build-up of sedimentation).
- 3.8.4 Position handwheel scale and ports for easy access.
- 3.8.5 Locate balancing valves a minimum of five pipe diameters downstream of any piping, and a minimum of ten pipe diameters from any pump. Maintain two pipe diameters downstream of any balancing valves free of any fitting.
- 3.8.6 Insulate balancing valves with preformed insulation provided by valve manufacturer.
- 3.8.7 Calibrated balancing valves and automatic flow-control valves shall not be used on equipment where pressure independent control valves are installed.

END OF SECTION

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Section Name: **Motor Starters and MCCs**
Section No.: **23 05 36**
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Project No.: 2021-0245
Section Name: **Motor Starters and MCCs**
Section No.: **23 05 36**
Date: October 1, 2024

1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 - General Requirements, shall apply to and govern this Section.

1.2 SCOPE OF WORK

1.2.1 Provide all labour, materials, tools equipment, training commissioning and certification required to complete the work as shown on the Drawings and specified in this Section, including:

1.2.1.1 All motor starters for mechanical equipment.

1.2.1.2 All motor control centres for mechanical equipment.

1.2.2 Division 26 – Electrical shall provide all Motor Control Centres (MCC's) and loose motor starters.

1.2.3 Provide Division 26 – Electrical with a complete motor list, including nominal power, voltage, phase, application, starter type and control interlocks.

1.3 SUBMITTALS

1.3.1 Provide shop drawings for:

1.3.1.1 All motor starters.

1.3.1.2 All motor control centres.

1.4 ELECTRICAL EQUIPMENT AND WORK

1.4.1 Read together with Division 26 – Electrical and adhere to its requirements. Supply and install all electrical apparatus, which is required and is not covered by Division 26 – Electrical.

2 **PRODUCTS**

2.1 MOTOR CONTROL CENTRES

2.1.1 Not Used.

2.2 MOTOR STARTERS

2.2.1 Provide where indicated, shown on the Motor Starter Schedules

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and as specified in this Section separate motor starters not forming part of a motor control centre for all mechanical equipment (except those equipped with packaged starters).

- 2.2.2 Motor starters shall be supplied by the manufacturer of the motor control centres specified, and shall meet the requirements therein complete with disconnect switch, fuses, control transformer, and all auxiliary devices.
- 2.2.3 Provide combination type with non-fused disconnect switch for individual motor starters equal to CGE CR 208, where overcurrent protection has been provided at motor control centre or distribution source.
- 2.2.4 Provide combination type with fusible disconnect switches equal to CGE CR 208 for grouped motor starters supplied from a common feeder or splitter. Include all interconnection power wiring.
- 2.2.5 Manual starters for single phase fractional horsepower motors unless otherwise indicated shall be equal to CGE CR 1061 with pilot light in cover. In finished areas, provide flush mounted units with stainless steel covers and pilot lights.
- 2.2.6 Where starters are grouped, provide a common backboard, interlocking and control wiring indicated on the Motor Starter Schedules and engraved nameplates indicating source of control supply if separate from the starter.

3 **EXECUTION**

3.1 MOTOR CONTROL CENTRES

- 3.1.1 Not Used.

3.2 MOTOR STARTERS

- 3.2.1 Provide lamacoid plastic plates identifying all starters. Provide warning label for motors under remote control. Adhere to Section 20 05 53 – Identification colour scheme for tags.

END OF SECTION

Project Name: CITY OF TORONTO - DAYCARE CENTRE (METRO HALL)
Project No.: 2021-0245
Section Name: **Hydronic Piping**
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1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 - General Requirements, shall apply to and govern this Section.

1.2 SCOPE OF WORK

1.2.1 Provide all labour, materials, tools equipment, training commissioning and certification required to complete the work as shown on the Drawings and specified in this Section, including:

1.2.1.1 Chilled water piping system.

1.2.1.2 Space heating hot water piping system.

1.2.1.3 Chilled glycol piping system.

1.2.1.4 Heating glycol piping system.

1.2.1.5 Condenser water piping system.

1.2.1.6 Condensate drainage system.

1.2.1.7 Chemical feed system.

1.2.2 Refer to Section 20 25 00 – Water Treatment for flushing, cleaning and chemical treatment.

1.2.3 Refer to Section 22 11 19 – Domestic Water Piping Specialties for backflow preventers.

1.3 REGULATORY REQUIREMENTS

1.3.1 In addition to specific requirements for pipe fittings as further specified in this document and where applicable, the equipment shall comply with the Boiler and Pressure Vessels Act (the “Act”) and CSA Standard B51.

1.3.2 In compliance with the Act and relevant Codes, all fittings shall be registered by the manufacturer, and shall be identified by the appropriate Canadian registration number.

1.3.3 Where fittings are provided without the appropriate Canadian registration number, the Contractor shall obtain a copy of the manufacturer's Statutory Declaration as provided to the authorities

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having jurisdiction.

1.3.4 All welding and fabrication shall be to the requirements of the ANSI/ASME B31.9 code for pressure piping and CSA standard B51 code for the Construction and Inspection of Boilers and Pressure Vessels.

1.3.5 All copper piping shall be certified to ASTM Standard B88 for Seamless Copper Water Tube.

2 **PRODUCTS**

2.1 PIPE AND FITTINGS

2.1.1 For 860 kPa (125 psi) or lower operating pressure use Class 125 fittings. For 860 kPa to 1,172 kPa (125 psi to 170 psi) operating pressure use Class 150 fittings. For 1,172 kPa to 3,034 kPa (170 psi to 440 psi) operating pressure use Class 300 fittings.

2.1.2 Heating water, chilled water, condenser water, and glycol piping shall be Schedule 40 black steel pipe; stretch reduced continuous weld, ASTM A53.

2.1.3 Condensate drain piping shall be type DWV copper drainage tube with cast brass fittings and 50/50 solder joints. Provide screwed cleanout tees and crosses at all changes in direction.

2.1.4 Mechanical couplings (e.g. Victaulic) shall be permitted for heating, chilled and condenser water, and glycol systems, provided:

2.1.4.1 The couplings are located in accessible locations, unless otherwise approved by the engineer.

2.1.4.2 All couplings and fittings are by one manufacturer, suitable for pressure and temperature of respective system.

2.1.4.3 Rigid (Victaulic Style 107H Quick-Vic) couplings with offsetting angle bolt pads and AGS rigid couplings (Victaulic Style W07) are used in mechanical rooms.

2.1.4.4 Flexible (Victaulic Style 177 or AGS Style W77) couplings may be used in equipment drops in lieu of flexible connectors and where vibration attenuation and stress relief are required.

2.1.4.5 Couplings for Schedule 40 piping to be manufactured from two (2) ductile iron housings conforming to ASTM-A536 and be complete with a Grade 'EHP' EPDM gasket, suitable for water service to

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121°C (250°F). Flange adapters for sizes DN50 (2") to DN300 (12") to be ductile iron ASTM-A536, Victaulic Style 741. Flange adapters for sizes DN350 (14") to DN750 (30") shall be Victaulic W741 or W45R flanged adapter nipple with AGS grooved end.

- 2.1.4.6 Fittings for Schedule 40 piping shall be manufactured from ductile iron conforming to ASTM-A536, wrought steel conforming to ASTM-A234, or segmentally welded from steel pipe conforming to ASTM-A53, with grooves designed to accept grooved end couplings.

3 **EXECUTION**

3.1 GENERAL

- 3.1.1 Ream all piping and keep plugged to prevent entry of dirt. Use pipes, which conform to CSA and ASTM standards.
- 3.1.2 Cut true and thoroughly ream all pipe before installation.
- 3.1.3 Install all piping in the best professional manner and in accordance with the best practices of the trade.
- 3.1.4 Install piping so that there is no interference with the installation of equipment, other piping, systems, ducts or the work of other Subcontractors.
- 3.1.5 Consider the piping shown on the Drawings as diagrammatic, for clearness in indicating the general runs and connections and that the piping may, or may not, in all parts be shown in the true position. This does not relieve the Contractor's responsibility for the proper erection of the systems of piping in every respect suitable for the work intended.
- 3.1.6 Install piping in designated spaces, shafts, and chases. Space and arrange piping to best utilize available space. Arrange grouped valves in equally spaced steps or in straight rows.
- 3.1.7 Layout and install piping, valves, fittings and cleanouts to facilitate easy maintenance. Install valves and control devices in locations where they can be reached from the floor, platform, or an 2.4m (8 ft) high stepladder. The maximum reach allowed to operate and to service any device shall be 600mm (24"). Do not locate any valves, couplings, or flanged/union connections directly above electrical panels, motor starters or MCCs.

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- 3.1.8 Install control valves with stems in vertical position with adequate clearance for removal of actuators.
- 3.1.9 Install eccentric reducers in all reductions of piping size. Maintain level on the top of pipes for water services and on bottom of pipe for steam. Provide proper venting and drainage.
- 3.1.10 Traps and fittings shall be of the same material, quality, and thickness as the piping to which they are attached.
- 3.1.11 Ensure that welding is performed, using either gas or electric welding equipment. Thoroughly clean pipe surfaces and level the ends of each pipe and fitting before welding. Securely align and space piping so that the width of circumferential welds is two and one-half times the pipe wall thickness. Ensure that the deposited metal forms a gradual increase in thickness from the outside surface to the centre of the weld.
- 3.1.12 Ensure that the pipe welding is done by a welder holding a certificate from TSSA or from the Canadian Welding Bureau (CWB) for the class of piping to be welded.
- 3.1.13 When welding or cutting with a torch, take every precaution to prevent fire. Ensure that welding or torch cutting operators have a fully charged 4.5kg (10 lb.) carbon dioxide fire extinguisher with them, when welding or cutting in building, or tunnels. Protect wooden structures with asbestos blanket.
- 3.1.14 Ensure that fabrication, welded or otherwise, meets the requirements of the ASA B31.9 Code for Pressure Piping, the CSA B51 Code for Boiler, Pressure Vessel, and Pressure Piping, and all requirements of the Boilers and Pressure Vessels Act of the Province of Ontario.
- 3.1.15 Use only fittings, or other materials to be incorporated in the work, which are approved by TSSA's Boiler and Pressure Vessels Safety Program, for the class of work for which they are used.
- 3.1.16 Thoroughly clean the inside of fittings and outside of pipe with steel wool and coat with flux, before soldering any copper pipe work joint. Remove the working parts of valves before soldering commences, and replace after soldering is complete.
- 3.1.17 Provide swing joints in runouts to units, off horizontal mains.
- 3.1.18 Maintain minimum 25mm (1") space between adjacent flanges or

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pipe insulation (whichever has the largest diameter).

- 3.1.19 All buried steel piping shall be protected with Insul-mastic Eastern Ltd. coal tar epoxy and wrapped with Polyken tape. Overlap joints and seams 50mm (2") and double cover at elbows and fittings.
- 3.1.20 Provide full size flushing ports with valves of DN40 (1-1/2") size at the lowest point in each system with a vent at the high point. Grade piping and/or add additional valved and capped drain points to permit complete drainage of entire system.
- 3.1.21 Provide unions or flanges at all connections to equipment or fixtures requiring servicing or replacement. Provide Van Stone style flanges where applicable.
- 3.1.21.1 Unions or flanges for servicing are not required in installations using Victaulic couplings. (The couplings shall serve as disconnect points.)
- 3.1.22 All capped connections for piping DN65 (2-1/2") or larger shall be terminated with flange and blind flange.
- 3.2 **PIPE AND FITTINGS**
- 3.2.1 Piping DN65 (2-1/2") dia. and larger shall be welded using 'Weld-O-Lets', Victaulic Mechanical-T, or factory manufactured tees. Piping DN50 (2") dia. and smaller shall be screwed with cast iron fittings. Long radius forged welding elbows shall be used at all turns unless approved by the engineer.
- 3.2.2 Branch piping two sizes smaller than the main may be cut directly into the main and welded or hole-cut with Victaulic Mechanical-T fittings.
- 3.2.3 Provide screwed clean-out tees and crosses at all changes in direction of condensate drain piping.
- 3.2.4 Provide di-electric connections for cathodic protection wherever pipes of dissimilar material are connected together (Victaulic Style 47 Di-electric Waterway).
- 3.2.5 In copper pipes, provide wrought copper unions with soldered joints for pipe up to and including DN50 (2"), and 1,035 kPa (150 psi) cast brass flanges for pipes DN65 (2-1/2") or larger.
- 3.2.6 Install all grooved end components as per manufacturers' latest recommendation. All grooved products shall be of one

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manufacturer. Grooved joints shall be installed in accordance with the manufacturer's latest published installation instructions. Grooved ends shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove. Gaskets shall be of an elastomer grade suitable for the intended service, and shall be molded and produced by the coupling manufacturer. The grooved coupling manufacturer's factory trained representative shall provide on-site training for contractor's field personnel in the use of grooving tools and installation of grooved joint products.

- 3.2.7 Provide valve bypass arrangement for water differential pressure transmitters. Coordinate exact quantity and location with the Subcontractor responsible for the work of Division 25 – Integrated Automation.

3.3 VENTING

- 3.3.1 On all up-feed coils, radiation, etc. provide a screwdriver operated manual air vent at the high point.
- 3.3.2 At all high points of the piping system provide a valved automatic float air vent. Pipe discharge to floor drains or to janitor sink with DN15 (1/2") dia. tubing.
- 3.3.3 Main vents in mechanical room shall be high capacity, Sarco model 13W with DN10 (3/8") dia. discharge tubing piped to the hub drain.

3.4 DRAINS

- 3.4.1 Provide drains at all low points of all liquid carrying systems and at other locations shown on the Drawings.
- 3.4.2 Drains shall consist of a capped DN20 (3/4") threaded hose end valve and cap, location to allow easy connection of drain hose.

3.5 FLUSHING AND CLEANING

- 3.5.1 General
- 3.5.1.1 Inspect the systems, and remove any heavy debris and excessive oil and dirt.
- 3.5.1.2 Flush all completed systems with clear water at the highest obtainable pressure and velocity.

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3.5.1.3 During flushing and cleaning, maintain all isolating and control valves in the open position.

3.6 WATER FILL

3.6.1 Provide each water system with an 'Armstrong' make-up water combination feeder consisting of backflow preventer stop and check valve, strainer, pressure reducing valve, pressure gauge, and full sized quick fill by-pass.

3.6.2 Provide make-up water connections with shut-off valve to all equipment requiring same, such as boilers, cooling towers, etc.

3.7 TESTS

3.7.1 After all pipes have been placed in position, the tightness of all joints and the soundness of all pipes shall be tested as follows:

3.7.1.1 Test all water piping with cold water at a pressure of 1-½ times the working pressure, but not less than 1,035 kPa (150 psi), for a period of not less than four (4) hours, without any drop in pressure.

3.7.1.2 Any leaks found shall be made tight while under pressure. If this is not possible, piping shall be removed, refitted, and retested. Caulking of threaded joints shall not be accepted.

3.8 COMPLETION

3.8.1 Provide a declaration, signed by a responsible officer of the Division 23 – HVAC Subcontractor indicating that the following procedures and tests have been performed in accordance with the drawings and specifications. Provide two (2) copies of the signed declaration to the Consultant.

3.8.1.1 Water pressure test performed and leak free.

END OF SECTION

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1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 - General Requirements, shall apply to and govern this Section.

1.2 SCOPE OF WORK

1.2.1 Provide all labour, materials, tools equipment, training commissioning and certification required to complete the work as shown on the Drawings and specified in this Section, including:

1.2.1.1 All hydronic specialties.

1.3 SHOP DRAWINGS

1.3.1 Submit shop drawings for the following equipment:

1.3.1.1 Strainers

1.3.1.2 Air separators

1.3.1.3 Expansion tanks

1.3.1.4 Centrifugal separator package

1.3.1.5 Chilled water storage tanks

1.3.1.6 BTU meters

2 **PRODUCTS**

2.1 STRAINERS

2.1.1 Provide Y or T type strainers as noted with stainless steel screen. For strainers in copper pipe, provide bronze body type. For other strainers provide ductile-iron (ASTM A536 Grade 65-45-12); semi-steel (ASTM A278 class 30); fabricated steel (ASTM A53 Grade B); or cast steel (ASTM A-216 WCB). Use screwed connections up to and including DN50 (2") and grooved or flanged connections for DN65 (2-½") and larger. Provide strainers of the self-cleaning type or with access to the basket for strainer maintenance.

2.1.2 Provide hose end valves for strainers at pump suction.

2.1.3 Provide stainless steel screens as follows:

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- 2.1.3.1 Water service up to and including:
- | | |
|--|-----------------------------|
| DN50 (2") | 20 mesh |
| DN65 (2-½"), DN80 (3") perforations | 1.6mm (0.062") |
| DN100 – DN300 (4" – 12") and larger | 3.2mm (1/8") perforations |
| DN350 – DN400 (14" – 16") perforations | 6 mesh (3.2mm) |
| DN450 – DN600 (18" – 24") | 4 mesh (5.2mm perforations) |
- 2.1.4 For all strainers of the same type, furnish the same make.
- 2.1.5 Select strainer assemblies to suit the pressure and temperature of the application.
- 2.1.6 All strainers 50 mm (2") and larger shall be provided with blow down connection and valve.
- 2.2 EXPANSION TANKS
- 2.2.1 Air cushion tanks shall be galvanized steel pressurized air cushion bladder type, ASME-rated for 860 kPa (125 psi) and 115°C (240°F), maximum of size as shown on the drawings.
- 2.2.2 Each tank shall be complete with valved gauge glass, drain valve, cradles, support legs, and tapings.
- 2.2.3 Tank shall be replaceable bladder type, pre-pressurized, complete with a butyl bladder compatible with ethylene glycol.
- 2.2.4 Tank shall be vertical configuration, with an aerated skirt and a bottom connection through the skirt.
- 2.3 AIR SEPARATORS
- 2.3.1 Provide line size vortex air separators equal to S.A. Armstrong Model VA.
- 2.4 BTU METERS
- 2.4.1 Provide Badger Meter SDI series flow sensor complete with data industrial 340 BN/MV BTU energy transmitter, or approved equal.

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2.4.2 Provide remote reading totalizer complete with wiring and plastic conduit.

3 **EXECUTION**

3.1 DRAIN PANS

3.1.1 Construct drain pans of galvanized, min. 1.0mm (20-Ga.) sheet with sealed connections. Connect the drain lines to the nearest hub drain or janitor's sink.

3.1.2 Provide drain pans in the following locations:

3.1.2.1 Beneath all pipes passing through Electrical, Battery, Transformer, UPS, Computer and Telephone Rooms and over horizontal runs at bus duct.

3.2 STRAINERS

3.2.1 Provide strainers:

3.2.1.1 In the suction line of all pumps, (except where noted otherwise).

3.2.1.2 Upstream of automatic valves as indicated in plans, schedules, or flow diagrams.

3.2.1.3 Upstream of all pressure reducing valves.

3.2.1.4 Upstream of plate-and-frame heat exchangers (hot and cold sides).

3.2.1.5 Everywhere else as shown or detailed.

3.3 EQUIPMENT CONNECTIONS

3.3.1 Install piping connection to equipment, to prevent any strain on pipe and equipment and to facilitate removal equipment without disconnecting more than the minimum of pipework or shutting down any other piece of equipment.

3.3.2 Install equipment and apparatus requiring servicing and/or replacing with unions or flanges.

3.3.2.1 Unions or flanges for servicing are not required in installations using Victaulic couplings. (The couplings shall serve as disconnect points.)

3.3.3 Install valves, and automatic valve assemblies prefabricated and in

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uniform arrangement.

3.3.4 Install piping, automatic control valves, thermostat wells, orifice plates, etc., and any other appurtenances, supplied under other Sections of this Specification or by the Owner for insertion in piping and equipment.

3.3.5 Provide di-electric fittings between dissimilar metals where corrosion may occur.

3.4 EXPANSION TANKS

3.4.1 Mount tanks on floor where shown on the Drawings.

3.4.2 Refer to the Expansion Tank Schedule for tank sizes.

3.4.3 Piping from the system to the tank shall include an isolating valve and boiler drain. Pipe drain to nearest hub or funnel floor drain.

3.4.4 For tanks over 600mm (24") diameter, provide TSSA's Boilers and Pressure Vessels Safety Program Certificates and inspection openings.

3.5 BTU METERS

3.5.1 Connect meters to metering system and/or BAS.

END OF SECTION

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1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 - General Requirements, shall apply to and govern this Section.

1.2 SCOPE OF WORK

1.2.1 Provide all labour, materials, tools equipment, training commissioning and certification required to complete the work as shown on the Drawings and specified in this Section, including:

1.2.1.1 All rigid supply, return and exhaust air ductwork and plenums.

1.2.1.2 All flexible ductwork.

1.2.1.3 Emergency generator ventilation system.

1.2.1.4 Balancing dampers.

1.2.1.5 Fire dampers.

1.2.1.6 Flexible connections.

1.2.1.7 Acoustic lining.

1.2.1.8 Combination fire/smoke dampers.

1.2.1.9 Backdraft dampers.

1.2.1.10 Wall boxes.

1.2.2 Control and smoke dampers, airflow measuring stations shall be supplied under the work of Division 25 – Integrated Automation and installed as per of the work of this Section.

1.3 SUBMITTALS

1.3.1 Submit shop drawings for all products supplied in this Section.

1.4 DEFINITIONS

1.4.1 References to SMACNA shall mean “HVAC Duct Construction Standards, Metal and Flexible”, current edition.

2 **PRODUCTS**

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2.1 DUCTWORK

- 2.1.1 Fabricate the following ductwork from galvanized steel, in accordance with requirements of SMACNA 1000 Pa (4" w.g.) pressure class:
 - 2.1.1.1 All supply air ductwork from air handling units to air terminal control units.
 - 2.1.1.2 All ventilation air supply ductwork.
 - 2.1.1.3 All ductwork used for smoke exhaust, including relief air ductwork.
 - 2.1.1.4 Kitchen make-up air supply ductwork.
- 2.1.2 Fabricate the following ductwork from aluminum in accordance with requirements of SMACNA 500 Pa (2" w.g.) pressure class:
 - 2.1.2.1 Dishwasher exhaust ductwork.
 - 2.1.2.2 Shower exhaust.
- 2.1.3 Fabricate the following ductwork from 1.6mm (16-gauge) welded black iron:
 - 2.1.3.1 Kitchen exhaust ductwork.
- 2.1.4 Fabricate the following ductwork from galvanized steel, in accordance with requirements of SMACNA 500 Pa (2" w.g.) pressure class:
 - 2.1.4.1 All remaining rigid rectangular ductwork and plenums.
- 2.1.5 Galvanized steel shall be Class G90 have a coating thickness of 275 g/m² (0.9 oz./sq.ft) total both sides galvanizing coat to ASTM A653 standards.
- 2.1.6 Aluminum shall be utility grade with not more than 0.40% copper minimum tensile strength of 110.3 MPa (16,000 psi) and suitable for Pittsburgh lock seam construction. Refer to SMACNA manual for conversion of galvanized duct thickness to acceptable aluminum duct thickness.
- 2.1.7 Construct round ductwork to meet the requirements of SMACNA 1500 Pa (6" w.g.) pressure class and as follows:
 - 2.1.7.1 Provide welded slip joint construction round duct fittings. Wipe

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pipe and fittings with Durodyne S-2 duct sealer before assembly. Secure joints with self-tapping screws, and then brush again with thick coat of duct sealer.

2.1.7.2 Provide die-formed round elbows through to 200mm (8") diameter constructed by 1.0mm (20-gauge) galvanized steel. Provide five-section construction for larger elbows.

2.1.7.3 Provide conical round tees.

2.1.8 Construct flat oval ductwork using galvanized steel construction as follows:

2.1.8.1 Factory fabricated by United Sheet Metal, spiral uniseal through 500mm (20") minor axis, 0.7mm (24-gauge) for up to 600mm (24") major axis.

2.1.8.2 Fittings shall be continuous weld, 1.0mm (20-gauge) up to 900mm (36") major axis.

2.1.8.3 Elbows shall be easy bend.

2.1.8.4 Transitions shall have OTR-10 reinforcement.

2.2 BALANCING DAMPERS

2.2.1 Construct all dampers of the same type of material used for the ductwork.

2.2.2 For dampers in rectangular ductwork:

2.2.2.1 Construct volume dampers not greater than 225mm (9") in height of minimum 1.6mm (16-gauge) steel, centrally hinged. Use a Durodyne type KS-385 linkage.

2.2.2.2 Construct volume dampers with a height greater than 225mm (9") of not less than 1.6mm (16-gauge) steel with reinforced leaves, centrally hinged, bronze or nylon bushings, mounted on a 13mm (½") square rod in 2.7mm (12-gauge), 38mm (1½") channel frame, securely held by a Durodyne KP-22 locking quadrant with indicating device. The dampers shall be of multi-blade, opposed type construction with a maximum blade length not exceeding 1.2m (4 ft) and a maximum blade height of 150mm (6").

2.2.2.3 Allowable leakage when closed against 1kPa (4" w.g.) at 7.62 m/s (1,500 fpm) face velocity 10%. Provide threaded rod and nut (metric thread) lever adjustment with washer and locknut.

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- 2.2.2.4 Place quadrants on insulated cuts on a bracket so that the quadrant lock is outside the insulation at all times. Place quadrants such that the limiting two (2) positions of the damper correspond to the limiting positions of the quadrant.
- 2.2.3 For dampers in round ductwork, use double thickness, aerodynamically shaped, butterfly dampers with rounded edges, tack welded to steel shafts set in nylon bushings complete with glands and asbestos rope packing. Use quadrants as described for low-pressure ductwork louver dampers. Use dampers constructed to function at the indicated pressures, smoothly without undue noise or vibration. Allowable leakage 5% against 1.5kPa (6" w.g.) and at 10.2 m/s (2,000 fpm) face velocity.
- 2.2.4 Splitter dampers to be constructed of galvanized sheet metal, two (2) gauges heavier than the duct, maximum 1.3mm (18-gauge). Splitter dampers up to 600mm (24") will be securely attached to a single steel pivot rod, which will be set in metal sockets attached to duct. End of the splitter to be turned over to form a teardrop and on this end the rod will be connected. On splitter dampers 625mm (25") and larger, provide two (2) rods. These rods will be provided with setscrew locking devices to hold position. Splitter dampers to be made rigid by reinforcing them. Duct panels surrounding splitter damper will not be cross-broken, but will be reinforced to prevent sagging or drumming. Length of splitter shall be at least 300mm (12") long or 1-1/2 times the width of the smaller branch whichever is longer.
- 2.2.5 Quadrants on insulated ducts to be placed on a bracket so that quadrant lock is on surface of insulation. Quadrants will be placed so that the limiting two (2) positions of the damper correspond to the limiting positions of the quadrant.
- 2.3 **FIRE DAMPERS**
- 2.3.1 Provide, where shown and required by ordinance or codes, fire dampers made to NFPA Standard 90A and ULC listed and to the approval of all authorities having jurisdiction. Fire damper shall be complete with steel frame, fusible link, steel blades, stainless steel closure springs and blade lock for horizontal curtain type dampers.
- 2.3.2 Dampers shall be Type 'B' (with pocket) unless space limitations do not permit.
- 2.3.3 Provide horizontal or vertical fire dampers to suit each application.

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2.3.4 Provide dynamic fire dampers for air systems which fan blowers do not shut down during a fire alarm. Provide static fire dampers for air systems which fan blowers shut down during a fire alarm.

2.4 FLEXIBLE CONNECTIONS

2.4.1 Connect fan units to ductwork by means of 150mm (6") wide heavy 'Ventglas' fabric securely fastened to equipment and ductwork by a galvanized steel band, provided with tightening screws. Ensure that all connections are leakproof. Provide 1.3mm (18-gauge) protective collar over flexible connections.

2.5 FLEXIBLE DUCTWORK

2.5.1 Connections to diffusers will be by means of Flexmaster T/L triple-lock aluminum flexible ducting made of dead soft aluminum, and manufactured in a manner to produce a triple-lock mechanical seam forming a continuous and secure air tight joint.

2.6 ACOUSTIC DUCT LINING

2.6.1 Where indicated on drawings, line ductwork inside with fibreglass acoustic duct insulation. Insulation to comply with ULC S110-M.

2.6.2 Facing for low velocity duct liner (max. 12.2 m/s - 2,400 fpm) shall be a tightly bonded mat, stenciled as per NFPA 90.

2.6.3 Facing for circular ducts and medium/high velocity ductwork (over 12.2 m/s - 2,400 fpm), or where indicated on drawings shall be with perforated, minimum 28 percent open area, minimum 0.85mm (22-gauge) thick galvanized steel finish.

2.6.4 Provide lining with minimum thickness and density as follows:

2.6.4.1 In ductwork 25 mm (1") at 24 kg/m³ (1-½ lb/ft³), unless otherwise noted on drawings.

2.6.4.2 In plenums 50 mm (2") at 32 kg/m³ (2 lb/ft³).

2.6.4.3 In linear slot diffuser plenums 13 mm (½") at 24 kg/m³ (1-½ lb/ft³).

2.6.5 Lining media shall have a flamespread classification of not greater than 25, when tested in accordance with ASTM E84, NFPA Standard 255, CAN 4-S102, or UL No. 723. Furthermore, fuel contribution and smoke development rating shall not be greater than 50, when tested in accordance with ASTM E84, NFPA Standard 255, CAN 4-S102, or UL No. 723.

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2.6.6 Lining shall be suitable for duct velocity of 30.5 m/s (6,000 fpm), without erosion damage.

2.6.7 Media shall have the following physical properties:

2.6.7.1 Maximum thermal conductivity of 1.42 W/m² °C (0.24 BTU/ft² hr °F), at 25mm (1") thickness and 24 kg/m³ (1-½ lb/ft³) density.

2.6.7.2 Sound absorption coefficient (NRC) of minimum 0.7, at 25mm (1") thickness and 24 kg/m³ (1-½ lb/ft³) density (ASTM C423).

2.7 BACKDRAFT DAMPERS

2.7.1 Backdraft dampers shall have galvanized steel channel frames, full blade-length shafts, brass, ball or nylon bearings, neoprene blade strips secured to pivot side of blades, counter balance weights and suitable for vertical or horizontal mounting.

2.7.2 Maximum blade length shall be 750mm (30"). Use multiple units for larger sizes.

2.7.3 Maximum resistance to air flow shall be 50 Pa (0.2" w.g.) at design airflow. Increase damper size to meet pressure drop requirement.

2.8 COMBINATION FIRE AND SMOKE DAMPERS

2.8.1 Combination fire/smoke dampers to be Ruskin FSD35 Class III dampers to maintain fire-rating integrity of membrane being pierced. Minimum fire rating shall be 1-½ hours in accordance with UL555.

2.8.2 Assembly to have the following construction:

2.8.2.1 Frame: 127 x minimum 1.6 mm (5 inches x minimum 16 gage) roll formed, galvanized steel hat-shaped channel, reinforced at corners. Structurally equivalent to 2.3 mm (13 gage) U-channel type frame.

2.8.2.2 Blades: Opposed, single skin with 3 longitudinal grooves, minimum 1.6 mm (16 gage) galvanized steel, width maximum 152 mm (6 inches). Flat blades are not acceptable.

2.8.2.3 Bearings: Self-lubricating stainless steel sleeve type, turning in extruded hole in frame.

2.8.2.4 Jamb seal: Stainless steel, flexible metal compression type. Glue-on seals are not acceptable.

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- 2.8.2.5 Linkage: Concealed in frame.
- 2.8.2.6 Axles: Minimum 13mm (½ inch) diameter plated steel, hex-shaped, mechanically attached to blade.
- 2.8.2.7 Mounting: Vertical or Horizontal.
- 2.8.2.8 Temperature release device: Heat-Actuated, Quick Detect
- 2.8.2.8.1 Close (in a controlled manner) and lock damper during test, smoke detection, power failure, or fire conditions through actuator closure spring. At no time shall actuator disengage from damper blades.
- 2.8.2.8.2 Allow damper to be automatically and remotely reset after test or power failure conditions. After exposure to high temperature or fire, inspect damper before reset to ensure proper operation.
- 2.8.2.8.3 Controlled closing and locking of damper in 7 to 15 seconds to allow duct pressure to equalize. Instantaneous closure is not acceptable.
- 2.8.2.9 Actuator: Electric 120 V, 60 Hz, two-position, fail close, externally mounted.
- 2.8.2.10 Finish: Mill galvanized.
- 2.8.2.11 One piece mounting angle with pre-punched screw holes.
- 2.8.2.12 Factory sleeve: Minimum 1.0mm (20 gage) thickness, minimum 432mm (17 inches long. Silicone caulk factory applied to sleeve at damper frame to comply with leakage rating requirements.
- 2.8.2.13 Break-away connections
- 2.8.3 Optional accessories:
 - 2.8.3.1 UL classified dual temperature fire stat, allowing the damper to be reopened after initial closure on heat.
 - 2.8.3.2 Two position indicator switches linked directly to damper blade to remotely indicate damper blade position.
 - 2.8.3.3 Phototelectronic type/Ionization type duct smoke detector, factory mount.
- 2.8.4 Provide multiple dampers where sizes exceed code limitations.

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2.8.5 Select dampers with airflow resistance not exceeding 13 Pa (0.05" w.g.) at design flow rates.

2.9 WALL INTAKE AND EXHAUST BOXES

2.9.1 Intake/Exhaust wall boxes shall be provided equal to Airvent Metal Products model Type A or Type R. Boxes to be constructed of galvanized (corrosion resistant) steel with flanged profile. Air flow pattern shall have a designed velocity differential ratio to prevent the bifurcated air streams from mixing in a high-rise application. The boxes shall be of modular design to allow for left or right duct connections. The boxes shall incorporate spring assisted damper system. The damper mechanisms shall be factory adjusted to suit the building height and barometric condition. Damper blade shall be under constant tension to prevent damper chatter due to wind and stack effect. Both the hinge assembly and the damper tension device shall be completely out of the air stream. Provide tie-down straps for masonry and precast installation. Seams of boxes to be sealed internally using a sealant for leak resistance, ASTM-331, UL listed, conforming to NFPA 90A and 90B with 0 flame spread and smoke development rating. Alternatively, boxes to be of welded construction.

3 **EXECUTION**

3.1 DUCTWORK

3.1.1 All ductwork construction and installation to be in accordance with recommendations of the current SMACNA standards unless otherwise noted in this Section.

3.1.2 Sheet metal, which is not to be insulated, will be cross-broken on the four sides of each panel section. All vertical and horizontal sheet metal barriers, duct offsets; elbows, as well as the panels of straight sections of ducts will be cross-broken. Cross-breaking to be applied to the sheet metal between the standing seams or reinforcing angles. The centre of the cross-break will be of the required height to assure surfaces being rigid. Insulated sheet metal and ducts will not be cross-broken.

3.1.3 Where it is necessary that ducts be divided, due to pipes, hangers, or other obstructions, which must pass through the ducts, provide teardrop shaped deflectors around these obstructions so that they will not interfere with the movement of air. Ductwork around these deflectors to be increased in size to maintain equivalent free area around deflectors. Holes in ductwork to be caulked and cover-

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plated to close any space left between edge of hole and obstruction passing through ducts. The passing of pipes or other obstructions through ducts will only be done when authorized at the Site, by the Consultant.

- 3.1.4 In square elbows and in elbows where radius is less than $1\frac{1}{2}$ x width of duct, sheet metal deflector vanes will be installed the full height of duct, being securely riveted in place. All vanes to be double thickness vanes of same gauge as duct in which they are installed. Vanes to be tack welded. For vane lengths over 1.2m (4 ft) tack weld vanes to 9mm ($\frac{3}{8}$ ") tie-rod at mid-span.
- 3.1.5 All necessary allowances and provisions will be made in the installation of the ducts for structural framing of the building and when changes or offsets are necessary, the required areas shall be maintained. All of these changes however, must be approved, and installed as directed by the Consultant at that time.
- 3.1.6 During installation, the open ends of ducts must be protected with blank, flanged sheet metal baffles, securely attached to prevent debris and dirt from entering.
- 3.1.7 Where ducts are shown connecting to masonry openings and/or along the edges of all plenums at floors, walls, etc., provide a continuous 38mm x 38mm x 4.7mm ($1\frac{1}{2}$ " x $1\frac{1}{2}$ " x $\frac{3}{16}$ ") galvanized angle steel, which will be bolted to the structure and made airtight to same by applying caulking compound on the angles before they are drawn down tight. The sheet metal at these locations will be bolted to the angle steel framing.
- 3.1.8 All air ducts, casings, plenums, etc., to be constructed of lock forming quality prime galvanized steel sheets, which are free from blisters, slivers, imperfectly coated spots, etc., no second quality sheet metal allowed.
- 3.1.9 Ducts to be constructed using double or Pittsburgh lock corner seams. All seams to be hammered down and made airtight. For transverse joint refer to current ASHRAE Guide for low-pressure ductwork.
- 3.1.10 Gauges and reinforcing of sheet metal ductwork will be as indicated in the current SMACNA manual, except 0.55mm (26-gauge) ductwork will not be allowed.
- 3.1.11 All sheet metal connections for apparatus plenum chambers, etc., to be constructed on 1.3mm (18-gauge) metal reinforced with

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38mm x 38mm x 4.7mm (1-1/2" x 1-1/2" x 3/16") galvanized angles up to 2.4m (8 ft) in height. When height exceeds 2.4m (8 ft) angles shall not be less than 50mm x 50mm x 6mm (2" x 2" x 1/4"). In all case provide connections structurally designed for maximum fan pressures.

- 3.1.12 Angles on all apparatus and plenum chambers to be installed on not more than 1.2m (4 ft) centres and at all vertical and longitudinal seams on the plenum construction.
- 3.1.13 Ensure that all openings required through floors, walls, partitions, etc., for the duct system are provided in the exact location.
- 3.1.14 The bottom joint and 150mm (6") of vertical joint on outside air intake ducts and mixing chamber ducts will be soldered and made watertight. Provide drain connection and run copper drainpipe to nearest floor drain.
- 3.1.15 Provide 50mm (2") insulated sheet metal blank off panels behind unused portions of exterior louvers.
- 3.1.16 Connect flexible ductwork using stainless steel worm drive clamps, adjustable clamps, or duct straps applied over two wraps of duct tape.
- 3.1.17 Maximum length of flexible ducts shall be 3.6m (12 ft). Utilize rigid ductwork as required to meet this requirement.
- 3.1.18 Install flexible ductwork clear of ceiling assemblies, light fixtures, etc. Support by 25mm (1"), 0.85mm (22-gauge) galvanized steel straps at 1.5m (5 ft) centres.
- 3.1.19 Frame and install motorized dampers. Attach each motorized damper module to channel framing.
- 3.1.20 Seal all ductwork in accordance with the appropriate SMACNA "Standard Duct Sealing Requirements". All sealants shall be ULC listed in accordance with standard S-102. Where insulation is applied internally to ductwork, metal duct shall act as vapour barrier and all joints to be completely sealed. Ductwork shall be leak tested at the rated pressure in accordance with SMACNA HVAC Duct Leakage Test Manual. A leak test report shall be provided to the Consultant. Duct sealing and leak testing shall be conducted before ductwork is insulated or concealed by drywall to allow for re-sealing or repairing duct sections.

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- 3.1.21 Ductwork modification:
 - 3.1.21.1 Make all necessary allowances and provisions for the structural framing of the building. Do not execute any such changes without permission of the Consultant.
 - 3.1.21.2 Transform or divide low-pressure ducts (up to 500 Pa / 2" w.g. static pressure) as may be required. Maintain the indicated cross sectional areas. Do not exceed an aspect ratio of 4 to 1. Install air stream deflectors when pipes and other small obstructions must pass through ducts, but maintain the free passage area.
 - 3.1.21.3 Transform rectangular ducts for pressures higher than 500 Pa (2" w.g.). Do not exceed the initial pressure drop. Do not exceed an aspect ratio of 4 to 1. Do not pass any obstructions through any of these ducts.
 - 3.1.21.4 Round or oval ducts for pressures higher than 500 Pa (2" w.g.). Do not change dimensions without obtaining approval. Do not pass any obstructions through any of these ducts.
- 3.2 BALANCING DAMPERS
 - 3.2.1 Provide balancing dampers in all locations necessary for balancing the air system including but not necessarily limited to the following locations:
 - 3.2.1.1 Where ducts enter or leave duct shafts, (including ducts to last floor where shafts may not exist).
 - 3.2.1.2 In all supply branches without reheat coil stations (e.g. corridors, electrical rooms, etc.).
 - 3.2.1.3 In all other locations shown on the Drawings.
 - 3.2.2 Note: For clarity of Drawings, balancing dampers mentioned under paragraphs 3.2.1.1. and 3.2.1.2. are not shown or indicated on the Drawings, but must be supplied and installed.
 - 3.2.3 In each branch connection, install splitter dampers in supply ducts and louver dampers in return ducts.
 - 3.2.4 Install duct mounted louver type dampers between angle steel duct framing, using neoprene gasket. In stainless steel ducts, cover the neoprene gaskets with Teflon tape.
 - 3.2.5 Bolt all dampers in plenum wall to a counter frame using a

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neoprene gasket between damper and wall.

- 3.2.6 Install access doors and panels at all dampers, to provide access to the entire damper assembly.

3.3 FIRE DAMPERS, COMBINATION SMOKE/FIRE DAMPERS

- 3.3.1 Before proceeding with any work, submit erection drawings approved by all authorities having jurisdiction showing location and construction details of all fire dampers.

- 3.3.2 Install dampers at locations indicated on the drawings and in accordance with manufacturer's UL approved installation instructions.

- 3.3.3 Install dampers square and free from racking with blades running horizontally.

- 3.3.4 Provide steel retaining angle and steel wall sleeve/collar for proper installation of the damper.

- 3.3.5 Do not compress or stretch damper frame into duct or opening.

- 3.3.6 Handle damper using sleeve or frame. Do not lift damper using blades, actuator, or jackshaft.

- 3.3.7 Enlarge duct sections around fire dampers, to allow unrestricted duct area while damper is in open position. Provide approved type access doors with airtight gaskets, for inspection and servicing of fire dampers. Provide dampers in supply and return take-offs at each floor of the multiple louver type.

- 3.3.8 Install bracing for multiple section assemblies to support assembly weight and to hold against system pressure. Install bracing as needed.

- 3.3.9 Provide fire dampers in all ducts over 0.013m² (0.14 sq.ft) in area in the location shown on drawings, whether or not specifically requested by ordinances and codes.

- 3.3.10 For stainless steel exhaust ducts provide butterfly fire dampers constructed of stainless steel.

- 3.3.11 Line side power wiring and control wiring connections to fire alarm system for combination fire/smoke dampers shall be provided by Division 26 - Electrical. Coordinate wiring requirements and exact location of dampers with Division 26 - Electrical Contractor.

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3.4 CONTROL DAMPERS

- 3.4.1 Install automatic control dampers in all relief ducts to the outside, in all return ducts to the main air handling units from all main return-relief fans, and elsewhere where shown. Install all damper sections between angle steel frames attached to the ductwork.

3.5 WATERPROOF EXHAUST

- 3.5.1 Provide waterproof ductwork where aluminum ductwork is specified in the Contract Documents. All joints shall be made watertight using caulking. Slope ducts back to source to facilitate drainage. Where this is not feasible, provide intermediate drains piped to nearest floor drain. All joints shall be made watertight.

3.6 KITCHEN EXHAUST DUCTS

- 3.6.1 Provide at each change in direction and at every floor in a riser a minimum 450mm x 300mm (18" x 12") access door for inspection and cleaning. Provide access doors in lateral runs not further than 6m (20 ft) on centre. Provide residue trap at the base of each riser with provision for cleanout.
- 3.6.2 Maintain the integrity of all fire rating.
- 3.6.3 Fabrication and installation shall be in strict accordance with NFPA 96.

3.7 CLEANING OF AIR SYSTEMS

- 3.7.1 Wipe clean all ductwork internally before erection.
- 3.7.2 After completing the systems, vacuum clean all ductwork and all apparatus internally through cleanouts.
- 3.7.3 Run air systems for at least twelve (12) operational hours using throwaway filters in place of permanent filters. Include for additional throwaway filter as well as for filters for all air handling units provided under this Contract.
- 3.7.4 Have all ductwork inspected for internal cleanliness. Obtain the Consultant's permission for the installation of all permanent filters in order to facilitate balancing.

3.8 DUCT ACCESS PANELS AND TEST HOLES

- 3.8.1 Access Panels:

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- 3.8.1.1 Provide all access doors of the same material as used for the ducts in which they are to be installed. Ensure through gasketing and suitable fastening materials that the entire systems are completely free from corrosion, water leakage (washable ducts), and air leakage (all ducts).
- 3.8.1.2 Ensure that all duct access doors are easily accessible through the structure.
- 3.8.1.3 All access doors will be in accordance with NFPA Standard 90-A. Construct all duct or apparatus access panels from double thickness frame, 25mm (1") apart, with necessary reinforcing for rigidity. Provide access panels on insulated ducts apparatus with 25mm (1") space filled with fibreglass insulation. Make panels airtight with a continuous rubber gasket. Provide openings in ductwork or casings with continuous galvanized reinforcing bars, extended on insulated ductwork or casings, to the face of the insulation.
- 3.8.1.4 Provide 450mm x 450mm (18" x 18") and smaller panels with at least two (2) brass window sash fasteners, larger panels with at least two (2) brass pin hinges and two (2) fasteners. Make fasteners on wall-through panels operational from inside and outside. Provide all panels with brass drawer type handles (two (2) minimum, each).
- 3.8.1.5 Provide access panels where shown, and in the following locations whether shown or not:
 - 3.8.1.5.1 In ductwork to facilitate full cleaning of all ducts.
 - 3.8.1.5.2 Bottom of all duct risers.
 - 3.8.1.5.3 Next to outside air intakes and outlets.
 - 3.8.1.5.4 At fire dampers.
 - 3.8.1.5.5 Into plenums and apparatus casings to facilitate maintenance and cleaning of all components.
 - 3.8.1.5.6 Immediately upstream and downstream of each reheat coil.
- 3.8.1.6 In ducts vulnerable to settlement of liquids or solids, provide reach-through type access doors size 250mm x 200mm (10" x 8") of rigid construction complete with frame and counter frame, bolted and gasketed. Provide insulated doors in ducts that are to be used for

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access.

3.8.1.7 In all other ducts provide access doors of adequate size to allow for inspection, cleaning and for general maintenance, of dampers, filters, louvers, birdscreens, coils, thermostats, thermometers, firestats, fire linkages and all other duct mounted appurtenances. Provide reach-through type access doors of rigid construction with frame and counter-frame, hinged and sash locked with gasket. Insulate doors for ducts that are to be insulated.

3.8.2 Test Holes:

3.8.2.1 At each main branch in ductwork and at each fan discharge and suction, provide sufficient number of Pitot tube test holes for balancing systems. Also, provide test holes for traverse at fan discharge.

3.8.2.2 Test holes to be located within easy reach of catwalks or ladders.

3.8.2.3 Each test hole will have 19mm ($\frac{3}{4}$ ") clear opening, provided with a metal ring plate with a threaded hole, and a matching screwed head plug. Where these plugs are installed in insulated ductwork, provide an extension collar against which the insulation can be finished.

3.8.2.4 Reinforced holes to be provided where thermometers, manometers, thermostats, gauges, damper rods, etc., occur in ductwork. Extended collars will be provided for the reinforced holes where these occur on insulated ductwork.

3.8.2.5 Where copper tubing passes through ductwork, or casing, provide a rubber grommet to prevent damage to copper tubing.

3.9 ACOUSTIC DUCT LINING

3.9.1 Secure to ductwork with approved fire retardant adhesive suitable for fibreglass insulation using 100% coverage and 2.7mm (12-gauge) anchors, or minimum 1.9mm (14-gauge) weld pins on 400mm (16") centres. Cut-off excess fastener length after mechanical fasteners (speed clips) have been applied. Transverse joints shall be firmly butted with no gaps and longitudinal corner joints shall be overlapped and compressed. Coat all joints, raw edges, rips, and protrusions with approved mastic. Provide continuous sheet metal edge protectors at entering and leaving edges of lined duct sections, and all joints.

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- 3.9.2 Duct dimensions shown are clear inside dimensions. Increase duct dimensions to suit thickness of duct lining.
- 3.9.3 Unless noted otherwise in the Contract Documents, acoustic insulation shall be installed in accordance with SMACNA Standard for Metal and Flexible Duct.
- 3.9.4 Extent of ductwork acoustic lining:
 - 3.9.4.1 Downstream of air terminal control units (CAV, VAV and fan powered), except units supplied with integral attenuator, for min. 1,524mm (5 ft) length.
 - 3.9.4.2 Downstream of heat pump units, for min. 2,438mm (8 ft) overall length, or min. 914mm (3 ft) length beyond the first 90 degree elbow.
 - 3.9.4.3 All toilet exhaust branch ducts which serve different toilet rooms from same riser on the same level unless at least 5m (16 ft) of ductwork, including at least three (3) of 90 degree elbow separate grilles in separate rooms.
 - 3.9.4.4 Air transfer ducts for full length.
 - 3.9.4.5 Return air stub ducts at shaft intake openings for full length.
 - 3.9.4.6 All ductwork serving spaces with noise criteria of NC-30 or lower.
 - 3.9.4.7 Where indicated on the Drawings.
- 3.9.5 Where ductwork velocities exceed 12.2 m/s (2,000 fpm), use of internal lining shall be reviewed with the Consultant in fulfilling the above requirements. If internal lining is deemed unsatisfactory for the particular application, provide perforated metal facing over internal lining, or sound traps as directed.
- 3.10 **INSULATED PLENUMS AND CASINGS**
 - 3.10.1 Provide insulated metal sandwich panels for all exterior intake and exhaust air plenums consisting of prefabricated 1.3mm (18-gauge) galvanized sheet metal panels and 50mm (2") rigid fibreglass insulation with interlocking joints securely fastened.
 - 3.10.2 Provide steel supports, joiner sections, floor channels, opening frames and sealing materials. Provide 1.3mm (18-gauge) minimum channel stiffeners at not greater than 800mm (32") centres.

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- 3.10.3 Connect corners and butt joints with 1.6mm (16-gauge) galvanized sections. Seal all joints with rubber mastic. Use angle joints to attach panel edges to walls.
- 3.10.4 Construct entire plenum to resist deflection and seal sufficiently to avoid air leakage when subjected to a pressure differential between inside and outside of up to 2,490 Pa (10" w.g.)
- 3.10.5 Provide access doors suitable for personnel pass through.
- 3.10.6 Insulate plenum floors with 25mm (1") rigid fibreglass insulation and cover with 1.6mm (16-gauge) galvanized sheet metal panels.
- 3.10.7 Seal penetrations through plenum walls with gland seals.
- 3.10.8 Construct drain pans from 1.6mm (16-gauge) type 304 stainless steel. Weld all joints. Install DN32 (1-¼") DWV drain connection to nearest drain complete with deep seal trap (minimum 100mm / 4"). Install to completely drain the pan.

END OF SECTION

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1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 – General Requirements, shall apply to and govern this Section.

1.2 SCOPE OF WORK

1.2.1 Provide all labour, materials, tools, equipment, training commissioning and certification required to complete the work as shown on the Drawings and specified in this Section, including:

1.2.1.1 Complete noise control system to prevent noise levels from exceeding the room criteria listed in Table 1, Chapter 48 of the ASHRAE 2011 HVAC Applications Handbook.

1.2.2 System shall include sound attenuating units (silencers), sound proofing construction, and external sound proofing, provided under this Section, and acoustic duct lining provided under Section 23 30 13 – Ductwork and Accessories.

1.2.3 In addition to the work covered under this Section, coordinate the equipment supplied under the work of other Sections of this Division and of other Divisions, to comply with the requirements contained in this Section.

1.3 SUBMITTALS

1.3.1 The Division 23 – HVAC Subcontractor shall supply to the noise control manufacturer approved drawings of all equipment to be acoustically attenuated, including sound power level data.

1.3.2 The noise control manufacturer shall supply shop drawings of all silencers to be used on the project. The data shall include dynamic insertion loss, generated noise and pressure drop. Data shall be certified by a qualified independent testing laboratory.

1.3.2.1 The insertion loss shall consist of sound pressure level in the diffuse sound field of a reverberant room where a silencer is substituted for the same length of empty duct and the rest of the system unchanged.

1.3.2.2 The test method used by the Independent Testing Laboratory certifying the silencer data shall be fully described.

1.3.2.3 The certification of the pressure drop, insertion loss, and generated

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noise data shall be based upon tests of the same silencer for all measurements.

- 1.3.3 Submit letter from manufacturer certifying silencers have been installed in accordance with their recommendations and the contract documents.

1.4 QUALITY ASSURANCE

- 1.4.1 Noise levels due to equipment and ductwork shall permit attaining sound pressure levels in all eight (8) octave bands in occupied spaces conforming to room criteria listed in Table 1, Chapter 48 of the ASHRAE 2011 HVAC Applications Handbook.

1.4.2 Acoustical Performance within Equipment Spaces:

- 1.4.2.1 Equipment room noise levels and noise transmission to adjacent buildings shall comply with the local statutory requirements.

1.4.3 Motor Acoustical Performance:

- 1.4.3.1 All motor drives when installed per plans and specifications shall operate with noise levels not exceeding 80 dBA.

- 1.4.3.2 Noise levels shall be determined in accordance with IEEE Standard #85 Test "Procedure for Airborne Noise Measurements on Rotating Electric Equipment".

1.4.4 Transformer Acoustical Performance:

- 1.4.4.1 Maximum permissible sound pressure level when operated under installed conditions shall be 80 dBA when measured with an ANSI S1.4-1983 "Type 1" sound level meter at any point which is 1.0m (40") from the equipment housing.

1.4.5 Air Distribution System; Pressure Reducing Device Noise.

- 1.4.5.1 Maximum permissible sound power levels in octave bands of airborne transmission through the combination of grille, registers, diffusers, terminal units, related pressure reducing devices and fan coil units, when operated in installed condition per Plans and Specifications, shall be no greater than the maximum in the following table for diffuser heights of less than 4m (13 feet) above finished floor level:

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Air Distribution System Equipment/Terminal Device Noise			
Maximum PWL (dB re: 10 ⁻¹² Watt)			
Octave Band	NC-35	NC-40	NC-45
1	62	66	68
2	56	60	63
3	49	54	58
4	46	51	56
5	43	48	53
6	42	47	52
7	41	46	51
8	42	47	52

1.4.5.2 The contractor is hereby advised to exercise the following in order to assure satisfactory acoustical performance of the terminal devices:

1.4.5.2.1 Provide proper duct connections to the terminal inlets, with at least three (3) duct diameters of straight ductwork, either flexible or sheet metal, before the duct attachment to the terminal.

1.4.5.2.2 Ensure proper air balancing.

1.4.5.2.3 Avoid excessive dampering near the terminals.

1.4.6 Variable Volume (VAV) Box, Fan Powered VAV Box, Fan Coil and Heat Pump Unit Above Ceiling; Radiated Noise:

1.4.6.1 Maximum permissible radiated sound power levels in octave bands when operated over occupied spaces in an installed condition, above a ceiling, shall be as per the following table:

Maximum Radiated Sound Power (dB re: 10 ⁻¹² Watt)			
Octave Band	NC-35	NC-40	NC-45

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Maximum Radiated Sound Power (dB re: 10 ⁻¹² Watt)			
Octave Band	NC-35	NC-40	NC-45
1	72	76	79
2	70	74	77
3	61	65	68
4	60	64	68
5	57	62	68
6	56	60	65
7	66	70	75
8	65	70	75

2 PRODUCTS

2.1 GENERAL

- 2.1.1 Silencers shall be of the size, configuration, capacity, and acoustic performance as specified in the Silencer Schedule in the Contract Documents. All silencers shall be factory fabricated and supplied by the same manufacturer.
- 2.1.2 Silencer performance including silencers with fibreglass cloth and Mylar encapsulated media must have been substantiated by laboratory testing according to ASTM E477 and so certified when submitted for approval.
- 2.1.3 Silencer inlet and outlet connection dimensions must be equal to the duct sizes shown on the Drawings. Duct transitions at silencers are not permitted unless shown on the Contract Drawings. A sheet metal elbow in combination with a rectangular silencer is not acceptable as an elbow silencer.
- 2.1.4 Completely prefabricate all silencers using incombustible materials. Silencers shall have rounded inlets and tapered diffuser outlets. Equip circular silencers with centre bodies with spun noses and tapered diffuser outlets.
- 2.1.5 Media shall be incombustible acoustic quality, shot free fibreglass

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insulation with long, resilient fibres bonded with thermosetting resin. Density shall be required to insure conformance with laboratory test data. Fibreglass shall be packed with a minimum 10% compression during silencer assembly. Media shall be bacteria and fungus resistant, resilient such that it will not crumble or break and conform to irregular surfaces. Media shall not cause or accelerate corrosion of aluminum or steel. Mineral wool will not be permitted as a substitute for fibreglass.

- 2.1.6 Media shall have a flamespread classification of not greater than 25, when tested in accordance with ASTM E84, NFPA Standard 255, or UL No. 723. Furthermore, fuel contribution and smoke development rating shall not be greater than 50, when tested in accordance with ASTM E84, NFPA Standard 255 or UL No. 723
- 2.1.7 Silencers shall have 50mm (2") slip connections unless specified otherwise in the Contract Documents. Silencers shall be constructed from galvanized sheet metal or steel sheet. If steel sheet is used, silencers shall be painted with anti-rust prime coat. Supply lifting lugs on units with cross sectional dimensions larger than 600mm (24"). Where silencer is mounted in stainless steel ductwork, the silencer shall be all stainless steel construction to match the ductwork gauges used.
- 2.1.8 Where indicated on the Silencer Schedule, media shall be encapsulated in fibreglass cloth or Mylar film to prevent erosion, shedding, and impregnation of the fibreglass media.
- 2.1.9 All perforated metal shall be adequately stiffened to insure flatness and form. All seams and joints should be mastic filled to insure airtight construction.
- 2.1.10 Silencers shall not fail structurally when subjected to a differential air pressure of 1,992 Pa (8" w.g.)
- 2.2 RECTANGULAR/ELBOW SILENCERS
 - 2.2.1 Rectangular silencers shall be constructed according to one of the following classes. Silencers over 1200 mm (48") in any one cross sectional dimension shall be constructed in modules not exceeding 1200 mm (48").
 - 2.2.2 Class I: Outer shell shall be minimum 0.85mm (22-gauge) and 0.55mm (26-gauge) inner perforated liner of galvanized steel with airtight mastic filled seams and 50 mm (2") slip connections at each end.

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2.2.3 Class II: Outer shell shall be minimum 1.3mm (18-gauge) and 0.85mm (22-gauge) inner perforated liner of galvanized steel with spot-welded and caulked seams and steel angle flanges at each end.

2.2.4 Class III: The outer casing shall be a minimum of 1.6mm (16-gauge) hot rolled steel with all seams continuously welded, 0.85mm (22-gauge) inner perforated liner of galvanized steel and steel angle flanges at each end.

2.3 CROSSTALK SILENCERS

2.3.1 Crosstalk silencers shall be constructed of 0.85mm (22-gauge) galvanized outer shell and 0.55mm (26-gauge) galvanized perforated metal.

2.4 HTL CASINGS

2.4.1 Where indicated on the Silencer Schedule, silencers shall have breakout/in protection (HTL - Type I, II, III) externally applied and completely sealed to the silencer casing by the silencer manufacturer to assure quality controlled transmission loss. The HTL walls shall consist of media, airspace, mass and outer protective metal skin, as required, to obtain the specified room NC level. Standard acoustical panels will not be accepted as HTL Walls.

2.4.2 Such HTL walls will extend from within the mechanical equipment room to a point at which flanking through the silencer casing is not a problem.

2.4.3 Mechanical attachment of the HTL walls to the silencer casing is only permitted at the mechanical room end of the silencer and the termination point of the HTL Wall treatment.

2.5 ACOUSTIC PERFORMANCE

2.5.1 Silencer dynamic insertion loss shall not be less than that listed in the Silencer Schedule. Select silencers to provide the performance stipulated by paragraph 1.2.1.1.

2.5.2 Silencer generated noise shall not be greater than that listed in the Silencer Schedule.

2.5.3 Acoustic performance shall include dynamic insertion loss and generated noise for forward flow (air and noise in same direction)

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or reverse flow (air and noise in opposite direction) in accordance with project's air distribution system requirements.

- 2.5.4 All silencer ratings shall be determined in a duct-to-reverberant room test facility, which provides for airflow in both directions through the test silencer in accordance with the ASTM E477-99 test standard. The test set-up, procedure, and facility shall eliminate all effects due to flanking, directivity, end reflection, standing waves, and reverberation room absorption.

2.6 AERODYNAMIC PERFORMANCE

- 2.6.1 Silencer pressure drops shall not exceed those listed in the Silencer Schedule. Silencer pressure drop measurements shall be made in accordance with the ASTM E477-99 test standard. Tests shall be conducted and reported on the identical units for which acoustical data is presented.

3 **EXECUTION**

3.1 GENERAL

- 3.1.1 Protect all acoustic media from dirt and moisture during construction.
- 3.1.2 Have the manufacturer inspect the complete installation after system start-up and submit a letter to the Consultant stating that the complete vibration isolation and noise control installation is installed in accordance with its Drawings and instructions and operates to its satisfaction.
- 3.1.3 After the system has been air balanced, the noise control manufacturer shall visit the job and check the sound levels in those areas requested by the Consultant. Conduct sound tests as requested by the Consultant. Determine the necessary corrective measures if applicable, and submit a written report.
- 3.1.4 Sound measurements shall be in accordance with the "American Standard Method for the Physical Measurement of Sound S1.2".
- 3.1.5 Sound measuring equipment shall be in accordance with ANSI Standards S1.4 or S1.11.
- 3.1.6 Maximum static pressure loss:
- 3.1.6.1 After installation measure total system pressure before and after attenuators.

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3.1.6.2 If pressure loss exceeds maximum static pressure loss shown in Schedules, at no charge, replace attenuators and/or modify entrance and/or discharge aerodynamic flow to obtain specified performance.

3.2 SOUND PROOF CONSTRUCTION FOR DUCT PENETRATIONS

3.2.1 Required for openings between ductwork and following construction:

3.2.1.1 Equipment room walls.

3.2.1.2 Floors, except in shafts.

3.2.2 Sound proofing

3.2.2.1 Fill openings with fibrous glass blanket or board for full depth of penetration.

3.2.3 Caulk each side of opening with non-hardening, non-aging caulking compound similar to Johns Manville "Duxeal".

END OF SECTION

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1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 - General Requirements, shall apply to and govern this Section.

1.2 SCOPE OF WORK

1.2.1 Provide all labour, materials, tools equipment, training commissioning and certification required to complete the work as shown on the Drawings and specified in this Section, including:

1.2.1.1 All fans, not part of equipment assemblies.

1.3 SUBMITTALS

1.3.1 Provide shop drawings for all fans. Shop drawings shall include sound power levels for inlet and outlet at rated capacity, and fan curves.

1.3.2 As a minimum, provide the following information:

1.3.2.1 Product data sheets indicating rated capacities, sound power levels for inlet and outlet at rated capacity, and fan curves for 75%, 100% and 125% of rated RPM.

1.3.2.2 Physical outline dimension drawing showing required clearances, weights, and location and size of connection entries.

1.3.3 Provide manufacturer's certification letter. Refer to Section 20 00 00 – General Requirements.

2 **PRODUCTS**

2.1 GENERAL

2.1.1 Provide all fans indicated on the Drawings.

2.1.2 Provide all fan ratings based upon tests performed in accordance with code adopted jointly by the ASHRAE and AMCA. Provide each fan with the AMCA seal. Provide fans with a high efficiency and a pressure characteristic that is constantly rising from free delivery to shut-off. Fans to have non-overloading horsepower characteristics.

2.1.3 The fan manufacturer shall provide certified performance curves of

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capacity vs. static pressure; BHP vs. capacity and noise sound power; values at rated RPM and at 75% and 125% of rated RPM. When installed, the fan not performing to the curve will be tested by the fan manufacturer and be 'made good' at no cost to the Owner.

- 2.1.4 Provide all fan wheels statically and dynamically balanced in the manufacturer's plant in accordance with AMCA Standard 204, Balance Quality and Vibration Levels for Fans. Fans to operate quietly and without pulsations.
- 2.1.5 The fan manufacturer shall check that the motor horsepower specified in the Contract Documents is sufficient to accelerate the fan to operating speed without motor overload within normal time limits. If it is found insufficient, the Consultant shall be notified, prior to tendering, and a larger motor and starter will be provided to prevent overloading. If, when installed, motor overload and stopping occur due to fan inertia, the fan manufacturer shall pay all costs incurred for changing motors, starters, wiring, etc.
- 2.1.6 Fans used for smoke exhaust shall be suitable for continuous operation at 205°C (400°F).
- 2.1.7 Fan belts shall be oil and heat resistant, non-static type. Drives shall be precision-machined cast iron type, keyed and securely attached to the wheel and motor shafts. Drives shall be sized for 150% of the installed motor horsepower.
- 2.1.8 For belt driven fans with variable pitch motor drive, the drive must be factory set to the specified fan RPM.
- 2.1.9 For belt driven fans with fixed drives, allow for one (1) drive change for air balancing purposes (parts only, labour by the Subcontractor responsible for the Air Balancing work under Section 20 05 93).
- 2.2 CENTRIFUGAL INLINE FANS – SQI/SQN SERIES
- 2.2.1 Fan shall be duct mounted, belt driven centrifugal square inline (HP – high pressure).
- 2.2.2 (SQI-B, SQI-HP) The fan shall be of bolted and welded construction utilizing corrosion resistant fasteners. Housing shall be minimum 1.3mm (18-gauge) steel with airflow straightening vanes and integral duct flanges. Adjustable motor plate shall utilize threaded studs for positive belt tensioning. Access door and mounting feet shall be located in the specified position.

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- 2.2.3 (SQN-B, SQN-HP) The fan shall be of bolted construction utilizing corrosion resistant fasteners. Housing shall be minimum 1.3mm (18-gauge) galvanized steel with integral duct collars. Bolted access doors shall be provided on three sides, sealed with closed cell neoprene gasketing. Pivoting motor plate shall utilize threaded L-bolt design for positive belt tensioning. Housing shall be pre-drilled to accommodate universal mounting feet for vertical or horizontal installation.
- 2.2.4 Unit shall bear an engraved aluminum nameplate. Nameplate shall indicate design airflow, static pressure, and maximum fan RPM. Unit shall be shipped in ISTA certified transit tested packaging.
- 2.2.5 (SQI-B, SQI-HP only) All steel fan components shall have an electrostatically applied, baked polyester powder coating. Each component shall be subject to a five stage environmentally friendly wash system, followed by a minimum 2-mil thick baked powder finish. Paint must exceed 1,000-hour salt spray under ASTM B117 test method.
- 2.2.6 Wheel shall be centrifugal backward inclined, constructed of 100% aluminum, including a precision-machined cast aluminum hub. Wheel inlet shall overlap an aerodynamic aluminum inlet cone to provide maximum performance and efficiency.
- 2.2.7 Motor shall be heavy-duty type with permanently lubricated sealed ball bearings and furnished at the specified voltage, phase, and enclosure.
- 2.2.8 Bearings shall be designed and individually tested specifically for use in air handling applications. Construction shall be heavy-duty regreasable ball type in a cast iron housing selected for a minimum L50 life in excess of 200,000 hours at maximum cataloged operating speed.
- 2.2.9 Supply the following accessories unless described otherwise in the plans and schedules:
- 2.2.9.1 UL safety disconnect switch
- 2.2.9.2 Wiring between motor and disconnect switch
- 2.2.9.3 Spring vibration isolator set
- 2.2.9.4 Flexible duct connectors (intake and discharge side)

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2.3 DUCT/CEILING INLINE FANS – GN/GC SERIES

- 2.3.1 Fan shall be inline (GN) or ceiling (GC) mounted, direct driven, centrifugal exhaust fan.
- 2.3.2 The fan wheel housing and integral outlet duct shall be injection molded from a specially engineered resin exceeding UL requirements for smoke and heat generation. The outlet duct shall have provision for an aluminum backdraft damper with continuous aluminum hinge rod. The inlet box shall be minimum 0.85mm (22-gauge) galvanized steel. Motor shall be isolation mounted to a one piece galvanized stamped steel integral motor mount/inlet. A field wiring compartment with disconnect receptacle shall be standard. Unit shall be shipped in ISTA Certified Transit Tested Packaging.
- 2.3.3 (GN) To accommodate different mounting positions, an adjustable prepunched mounting bracket shall be provided.
- 2.3.4 (GC) To accommodate different ceiling thickness, an adjustable prepunched mounting bracket shall be provided. A white, high impact styrene injection molded grill shall be provided as standard. Unit shall be designed with provision for field conversion from ceiling to in-line.
- 2.3.5 Wheel shall be centrifugal forward curved type, injection molded of polypropylene resin.
- 2.3.6 Motor shall be open drip proof type with permanently lubricated bearings and include impedance or thermal overload protection and disconnect plug. Motor shall be furnished at the specified voltage.
- 2.3.7 The following accessories shall be provided by the manufacturer:
- 2.3.7.1 Fan mount speed controller
- 2.3.7.2 Wiring between motor and speed controller.
- 2.3.7.3 Reinforced aluminum backdraft damper with continuous hinge rod.

3 **EXECUTION**

3.1 INSTALLATION

- 3.1.1 Install fans as shown, with resilient mountings and fan restraining snubbers as specified with vibration isolation and flexible electrical leads.

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- 3.1.2 Install fans with flexible connections on inlet ductwork and on discharge ductwork in accordance with Section 23 30 13 – Ductwork and Accessories.
- 3.1.3 Provide and install guards on inlets and/or discharge for all fans which are not duct connected.
- 3.1.4 Align shafts, belt drive, and motor, adjust belt tension, and check motor rotation before start-up.
- 3.1.5 Protect motors and fans during construction and rotate fans, by hand, every month between delivery and acceptance of building.
- 3.1.6 Provide torque restrains consisting of spring hangers mounted at 45° angle, for axial fans with 3.73 kW (5 HP) or larger motor and/or 623 Pa (2.5") ESP, installed with flexible connectors.
- 3.1.7 Adjust variable pitch fan/motor sheaves during balancing to achieve specified air quantities.
- 3.1.8 Provide sheaves and belts for final air balance where specified in the Contract Documents.

END OF SECTION

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1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 - General Requirements, shall apply to and govern this Section.

1.2 SCOPE OF WORK

1.2.1 Provide all labour, materials, tools equipment, training commissioning and certification required to complete the work as shown on the Drawings and specified in this Section, including:

1.2.1.1 All VAV terminal units.

1.2.2 Power wiring shall be connected under the work of Division 26 - Electrical.

1.3 SUBMITTALS

1.3.1 Provide shop drawings for all terminal units.

1.3.2 In addition to general submittal requirements, shop drawings shall include sound power data in accordance with the following:

1.3.2.1 All sound power data shall be based on tests conducted in accordance with ANSI/AHRI Standard 880-2011 in an AHRI certified laboratory.

1.3.2.2 Sound data shall include both valve and fan simultaneous operation, and fan only operation (for fan powered boxes).

1.3.2.3 Sound power level in decibels (re. 10** - 12w) shall be submitted for octave bands 2 through 7 for both discharge and radiated sound power. The data shall be tabulated for design minimum inlet static pressure, and minimum inlet pressure plus 25mm w.g. (1" w.g.), with fan operating at an external static pressure of 13mm w.g. (1/2") (for fan powered terminal).

2 **PRODUCTS**

2.1 GENERAL

2.1.1 The Contract Documents are based on selected manufacturer as scheduled or shown in the tender form. If an alternate supplier from the approved equals list is used, the noise and vibration levels of the alternate product shall be equal to or less than the specified

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products. Any additional noise attenuation features required to meet the noise and vibration performance of the specified boxes shall be provided by this Division at no additional cost to the Owner.

- 2.1.2 Terminal units shall be certified under the AHRI Standard 880 Certification Program and carry the AHRI Seal. Noncertified terminals may be submitted after testing at an independent testing laboratory under conditions selected by the engineering consultant in full compliance with AHRI Standard 880. These tests must be witnessed by the engineering consultant with all costs to be borne by the terminal manufacturer. Testing does not ensure acceptance.
- 2.1.3 All components shall be factory installed, wired, calibrated, and tested by the box manufacturer to ensure a fully functional unit.
- 2.1.4 Provide a single 120V (208V for fan powered terminals) power wire for connection to adjacent junction box.

2.2 VARIABLE VOLUME TERMINALS

- 2.2.1 Provide single duct, variable air volume terminals of the sizes and capacities shown in the drawings.
- 2.2.2 The terminal casing shall be minimum 0.76mm (22-gauge) galvanized steel, internally lined with 12mm (½ inch) dual density insulation which complies with requirements of UL 181 and NFPA 90A. All exposed insulation edges shall be coated with NFPA 90A approved sealant to prevent entrainment of fibers in the airstream. The discharge connection shall be slip and drive construction for attachment to metal ductwork. The casing shall be constructed to hold leakage to the maximum values shown in L/s (cfm) in the below table:

Inlet Size	dPs, Pa (in wg)			
	125 (0.5")	250 (1")	500 (2")	750 (3")
4, 5, 6	0.9 (2)	1.4 (3)	1.8 (4)	2.4 (5)
7, 8	1.8 (4)	2.4 (5)	3.3 (7)	4.2 (9)
9, 10	1.8 (4)	2.8 (6)	3.6 (8)	4.8 (10)
12	2.4 (5)	3.3 (7)	4.8 (10)	5.6 (12)

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Inlet Size	dPs, Pa (in wg)			
	125 (0.5")	250 (1")	500 (2")	750 (3")
14	2.8 (6)	4.2 (9)	6.1 (13)	7.2 (16)
16	3.3 (7)	4.8 (10)	6.6 (14)	8.0 (17)

2.2.3

The damper shall be heavy gauge steel with shaft rotating in self-lubricating bearings. Nylon bearings are not acceptable. Shaft shall be clearly marked on the end to indicate damper position. Stickers or other removable markings are not acceptable. The damper shall incorporate a mechanical stop to prevent overstroking and a synthetic seal to limit close-off leakage to the maximum values shown in L/s (cfm) in the below table:

Inlet Size	dPs, Pa (in wg)			
	250 (1")	500 (2")	1,000 (4")	1,500 (6")
4, 5, 6	1.4 (3)	1.8 (4)	2.8 (6)	3.3 (7)
7, 8	1.4 (3)	1.8 (4)	2.8 (6)	3.3 (7)
9, 10	1.4 (3)	1.8 (4)	2.8 (6)	3.3 (7)
12	1.4 (3)	1.8 (4)	2.8 (6)	3.3 (7)
14	1.4 (3)	2.4 (5)	3.3 (7)	3.6 (8)
16	1.8 (4)	2.4 (5)	3.3 (7)	4.2 (9)

2.2.4

Actuators shall be capable of supplying at least 3.9 Nm (35-inch lbs) of torque to the damper shaft and shall be mounted externally for service access. Terminals with internal actuator mounting or linkage connection must include gasketed access panel, removable without disturbing ductwork. Casing with access panel shall be constructed to hold leakage to the maximum values shown in table contained in Subsection 2.2.2 above.

2.2.5

At an inlet velocity of 10.2 m/s (2,000 fpm), the minimum static pressure required to operate any terminal size shall not exceed 32 Pa (0.13 inch w.g.) for the basic terminal.

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2.3 CONTROLS

- 2.3.1 The terminal unit supplier shall provide the airflow sensor, and control transformer.
- 2.3.2 Actuators, flow transducers, zone sensors, and controllers shall be supplied by the Subcontractor responsible for the controls work under Section 25 11 00 to the terminal unit manufacturer for installation, testing, and calibration by the terminal unit manufacturer at the expense of the terminal unit manufacturer. Refer to Division 25 – Integrated Automation.
- 2.3.3 Airflow sensor shall be designed to provide a differential pressure signal, which is amplified over the full capacity range of the terminal. Pressure measuring taps shall be provided external to the unit.
- 2.3.4 Provide all necessary internal control tubing, wiring, and mounting brackets for a complete operating unit.
- 2.3.5 All control components shall be mounted inside a protective metal shroud provided by the terminal unit manufacturer.
- 2.3.6 Primary air delivery shall be pressure independent. Room temperature control shall operate satisfactorily at primary supply duct static pressures ranging from 249 to 1245 Pa (1" to 5" w.g.) Maximum and minimum terminal unit volumes shall be factory set and calibrated. Settings shall be field adjustable.

3 **EXECUTION**

3.1 INSTALLATION

- 3.1.1 Install VAV terminal units in accordance with manufacturer's recommendations.
- 3.1.2 Each terminal unit shall be clearly marked with an identification label listing the terminal's tag number, and minimum and maximum air settings. Coordinate terminal tag number with the Subcontractor responsible for the work of Division 25 - Integrated Automation.
- 3.1.3 Suspend terminals from slab using threaded rod hangers and angle iron trapeze hangers. Refer to Section 20 05 48 - Vibration Isolation for isolator requirements.
- 3.1.4 Refer to Section 23 30 13 – Ductwork and Accessories for acoustic

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lining requirements of downstream ductwork.

END OF SECTION

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Section No.: **23 37 13**
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1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 - General Requirements, shall apply to and govern this Section.

1.2 SCOPE OF WORK

1.2.1 Provide all labour, materials, tools equipment, training commissioning and certification required to complete the work as shown on the Drawings and specified in this Section, including:

1.2.1.1 All supply, return, and exhaust air grilles and diffusers, including all specified ancillaries.

1.3 SUBMITTALS

1.3.1 Provide shop drawings for all registers, grilles, and diffusers.

1.3.2 Shop drawings to indicate dimensions, construction details, finishes and materials, accessories, performance data including throw, pressure drop and sound performance at the specified air flow rates.

1.3.3 Review requirements of outlets as to size, finish, and type of mounting with the Consultant prior to submitting shop drawings and schedules of outlets.

2 **PRODUCTS**

2.1 GENERAL

2.1.1 Air outlet application to be based on required maximum space noise levels. Refer to Section 23 33 19 – Duct Silencers.

2.1.2 Provide baffles to direct air away from walls, columns or other obstructions within the radius of diffuser operation.

2.1.3 Provide plaster frame for diffusers located in plaster and gypsum board surfaces.

2.1.4 Provide anti-smudge frames or plaques on diffusers located in rough textured surfaces such as acoustical plaster.

2.2 REGISTERS, GRILLES AND DIFFUSERS

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2.2.1 Refer to the Diffuser and Grille Schedule on Drawings.

3 **EXECUTION**

3.1 AIR OUTLETS (DIFFUSERS, GRILLES AND REGISTERS)

3.1.1 Paint the inside of all duct openings with black flat paint before installing diffusers or registers to it.

3.1.2 Provide sponge rubber gasket around all register frames to ensure an airtight seal against finished wall or ceiling.

3.1.3 Registers and diffusers will be installed in such a manner as to facilitate repeated removals without damaging ceiling or wall construction and finish.

3.1.4 Positions indicated are approximate only. Check location of outlets with the Consultant and make necessary adjustments in position to conform to architectural features, sprinklers, symmetry and lighting arrangement.

3.1.5 Provide diffusers, grilles, and registers as shown on schedule.

END OF SECTION

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1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 - General Requirements, shall apply to and govern this Section.

1.2 SCOPE OF WORK

1.2.1 Provide all labour, materials, tools equipment, training commissioning and certification required to complete the work as shown on the Drawings and specified in this Section, including:

1.2.1.1 Ductwork connection to louvers. (Louvers provided by others).

1.2.1.2 All prefinished exterior and interior fixed louvers, not provided by the Architectural Division. Exterior exhaust louvres at suites are supplied by window system's manufacturer.

1.2.1.3 Ductwork connection to louvres.

1.3 SUBMITTALS

1.3.1 Provide submittals specified and as required to assess conformance with the Contract Documents, in accordance with the General Conditions.

1.3.2 Shop Drawings:

1.3.2.1 Submit shop drawings for review by Consultant.

1.3.2.2 Show complete layout of all louvres, full details of construction including sill, jamb and head members, structural supports, type and thickness of materials, duct connections, blank-off areas, all dimensions and all other items and accessories for a complete installation.

1.3.3 Samples:

1.3.3.1 Submit duplicate samples of each finish and colour required for Consultant approval.

1.4 DESIGN

1.4.1 Design all members to withstand within acceptable deflection limitations their own weight, and the minimum 138 kPa (20 psi) design load due to the pressure and suction of wind as calculated

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in accordance with the Building Code of Ontario, based on a 30-year probability.

- 1.4.2 Deflection limits for all members - a maximum of 1/175 of the span under design loading. Submit wind load calculations to the Consultant for approval before commencing fabrication.
- 1.4.3 Design louvres such that an area of 45% minimum of the face area allows free passage of air for standard louvres and 30.9% for acoustical louvres.
- 1.4.4 Fixed exterior louvres shall be storm-proof type. Fabricate exterior louvres without mullions or reinforcing visible on the outside. Finished appearance shall be that of continuous horizontal blades housed in a rectangular frame. Provide weep holes at 610 mm (24 inches) on centre for drainage to exterior.

1.5 DELIVERY AND STORAGE

- 1.5.1 Brace units to prevent distortion during shipment and protect finished surfaces by heavy wrappings.
- 1.5.2 Store in protective wrapping, until required for installation.

2 **PRODUCTS**

2.1 LOUVERS

- 2.1.1 Air louvers and birdscreen in outside wall for air intakes and outlets will be provided by Division 23.

2.2 MANUFACTURER AND TYPE

- 2.2.1 Louver specification is based on louvres as manufactured by Construction Specialties Ltd. Equivalent product manufactured by E.H. Price Limited and Empco are also acceptable provided they meet all design criteria and material standard.
- 2.2.2 Model numbers quoted are C/S.
 - 2.2.2.1 Exterior Fixed Ventilation Louvres: C/S #4135
 - 2.2.2.2 Interior Fixed Louvres: C/S GS #410

2.3 MATERIALS

- 2.3.1 Aluminum: Extrusions of aluminum alloy 6063-T5 temper.

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- 2.3.2 Steel: CSA G40.15 galvanized finish.
- 2.3.3 Fastenings: type 304 stainless steel.
- 2.3.4 Aluminum Finish: Fluoropolymer Kynar 500 Resin. "Acroflur" by Valspar (2 coat system) or Acrynar by PPG. Colour to be selected by the Consultant.
- 2.3.5 Bird Screens: Intercrimp, 1.6 mm (1/16") Ø aluminum wire, 12 mm (1/2") mesh in an extruded aluminum frame, for all exterior active louvres. Screening shall be replaceable within frames.
- 2.3.6 Insulation: Mineral wool Roxul RXL 40, 90 mm (3.5") thick.
- 2.3.7 Steel Sheet: 1.90mm (14-ga.) flat galv. steel to ASTM A-446 grade A, G90 coating hot-dip.
- 2.3.8 Steel Finish: Baked enamel, manufacturers standard. Colour from standard range.
- 2.4 **FABRICATION**
- 2.4.1 Fit and assemble in shop.
- 2.4.2 Provide for anticipated expansion and contraction of frames and supports at maximum 6.1 m (20 ft) on centre.
- 2.4.3 Accurately fit elements at intersections and joints, plumb and level.
- 2.4.4 Isolate dissimilar metals, metal and concrete and metal and masonry with heavy coat of bituminous paint.
- 2.4.5 Fabricate aluminum frame and sill from minimum 200mm (0.08") thick aluminum extrusions, blades to be 102 mm (4") wide x 3.18 mm (0.125") storm proof type, with reinforcing bosses. Galvanized steel louvres to be fabricated out of 1.32mm (18-ga.) galv. steel sheet, blades to be roll-formed and stepped for max. weather resistance.
- 2.4.6 Structural supports to be minimum 51 x 51 x 6 mm (2" x 2" x 1/6") galv. steel angles or extruded aluminum tees.
- 2.4.7 Provide all accessories and other items for a complete installation.
- 2.4.8 Provide necessary templates and instructions where fastenings or anchors have to be built in by others. Verify dimensions on the site before preparing drawings or proceeding with shop work.

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2.4.9 Supply and build in 1.29mm (16-ga.) sheet aluminum flashing at head and sills to prevent entry of moisture into building.

3 EXECUTION

3.1 INSTALLATION

3.1.1 This Contractor shall provide insulated galvanized sheet metal blank-offs on all unused sections of the louvers. Blank-off sections shall be a sandwich panel made of 1.3mm (18-gauge) outer skin, 51mm (2") rigid fibreglass insulation, and 1.0mm (20-gauge) inner skin. Panels shall be securely fastened to louver and caulked airtight.

3.2 EXAMINATION

3.2.1 Examine surfaces to which louvers are to be attached and do not commence installation unless such surfaces are satisfactory.

3.2.2 Commencement of installation will denote acceptance of surfaces.

3.3 INSTALLATION

3.3.1 Installation of louvers by the louver manufacturer's own erection crews.

3.3.2 Install louvers plumb, true and in line. Provide bird screens to active sections of fixed louvers and where free flow-through ventilation is required.

3.3.3 Installed units shall be free of rattle, vibration, and distortion.

3.3.4 Provide and install 51 mm (2") thick insulated blank-off metal panel to inactive sections of louvers. Match colour of metal to colour of louvers. Panels shall be securely fastened to louvers and caulked airtight.

3.3.5 Install steel louvers to interior of air intake shafts in parking levels, where supply fans are installed. All exterior louvers to be aluminum.

END OF SECTION

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Section No.: **23 83 33**
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1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 – General Requirements, shall apply to and govern this Section.

1.2 SCOPE OF WORK

1.2.1 Provide electric heaters as indicated on the drawings and specified herein.

1.3 ELECTRICAL EQUIPMENT AND WORK

1.3.1 Read together with Division 26 – Electrical and adhere to its requirements. Supply and install all electrical apparatus, which is required and is not covered by Division 26 – Electrical.

1.4 SHOP DRAWINGS

1.4.1 Submit shop drawings for the following product:

1.4.1.1 Electric Cabinet Heaters.

2 **PRODUCTS**

2.1 ELECTRIC CABINET HEATERS

2.1.1 CSA approved heavy gauge, galvanized, baked enamel steel enclosure, resilient mounted fans and motor, open coil heating elements with protecting screen both faces, replaceable filters.

2.1.2 Integral grilles on surfaces and recessed units. Built-in thermostat.

2.1.3 Duct collars on inlet and outlet of ceiling mounted units. Remote thermostat. Mounting brackets.

2.1.4 Contactors, high limit switches, step-down transformers and isolating disconnect switches.

2.1.5 Three speed fan selector switch built in to unit.

2.1.6 Thermal protected motor, manual reset, with prelubricated sealed bearings.

3 **EXECUTION**

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3.1 GENERAL

- 3.1.1 Install heaters in accordance with manufacturer's recommendations.

END OF SECTION



DIVISION 25 – INTEGRATED AUTOMATION
SPECIFICATIONS
FOR THE
CITY OF TORONTO - DAYCARE CENTRE (METRO HALL)
55 JOHN STREET
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DISCIPLINES MECHANICAL
ELECTRICAL
PLUMBING
LIGHTING DESIGN
COMMUNICATIONS & AV
SECURITY & RISK
COMMISSIONING
ENERGY SERVICES

Our Project No. 2021-0245

Issued for Approval

October 1, 2024

SEAL:



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Section 25 11 00	Basic Materials, Interface Devices and Sensors
Section 25 90 00	Sequences of Operation
Appendix A	Standard Building Automation System (BAS) Owner Requirements

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1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 – General Requirements shall apply to and govern this Section.

1.2 SCOPE OF WORK

1.2.1 Connect all mechanical equipment to existing Siemens Building Automation System (BAS) utilizing Direct Digital Control (DDC) to serve new mechanical and associated systems as described on the drawings and in this specification.

1.2.2 New controls components shall seamlessly integrate with existing building automation system (Siemens Apogee).

1.2.3 Building Automation System shall adhere to the requirements of Appendix A City of Toronto Building Automation (BAS) System Owner Requirements.

1.2.4 Provide all labour, materials, Products, equipment, and services to supply, install, and commission the electronic control and monitoring system with electronic actuation as specified in Specification Division 25 – Integrated Automation.

1.2.5 Provide all computer hardware and software, operator input/output communication devices, communication units, a communication interface to digital system controllers, field sensors, and controls as required to meet the specified performance.

1.2.6 Provide all labour, including calibration, commissioning, software programming and data base generation, generation of colour graphics and additional work necessary to provide a complete and fully operating system.

1.2.7 Provide all necessary wiring for fully complete and functional control system as specified in the Contract Documents.

1.3 GENERAL SYSTEM REQUIREMENTS

1.3.1 Provide a single architecture common data base microprocessor based electronic control and monitoring BAS system for air handling equipment, heating and cooling and other specified systems employing distributed processing and direct digital control (DDC) with electronic sensing and electronic actuation to conform with the specification requirements. The BAS shall consist of the

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following:

- 1.3.1.1 Stand-Alone DDC Controllers
- 1.3.1.2 Application Specific Controllers
- 1.3.2 The system shall be modular in nature and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, DDC Controllers, Application Specific Controllers, and operator devices.
- 1.3.3 The BAS shall be designed and implemented entirely for use and operation on the Internet and the Owner's Intranet. This functionality for operational access shall extend down to the field panel and field point level.
- 1.3.4 The primary Controls Application Nodes (AN) shall be fully IT compatible nodes operating over the industry standard IT infrastructure provided for the Project. The Subcontractor responsible for the work of Division 25 (BAS Contractor) shall coordinate with the IT infrastructure support staff or Subcontractors to ensure compatibility and performance of the operation of the BAS over the LAN/WAN made available for its shared use. If the Owner's LAN/WAN is not made available at time of commissioning, this Division shall supply an independent network cabling system for this Division's communication.
- 1.3.5 The Controls Systems Tier 1 network shall be configured on IT industry standard off-the-shelf technologies compatible with other building systems and Project network arrangements.
- 1.3.6 All aspects of the Controls Systems Operator Interface shall be provided to operate through an IT industry standard Web Browsers such as Internet Explorer, Firefox, Chrome or Opera.
- 1.3.7 The Web Browser based Operator Interface provided shall incorporate complete tool sets, operational information displays, multi-Window displays and other interactive aids to assist interpretation and ease of use. Simple HTML based web page displays are not acceptable.
- 1.3.8 The Web Browser based Operator Interface provided shall not require the procurement or licensing of any special or proprietary software from the BAS Contractor or its suppliers for the Controls Systems OWS.

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- 1.3.9 As required for the functional operation of the Controls Systems, the BAS Contractor shall provide all necessary digital processor programmable Server(s). These Server(s) shall be utilized for Controls Systems Application configuration, for archiving, reporting and trending of data, for Operator transaction archiving and reporting, for network information management, for alarm annunciation, for Operator Interface tasks, for Controls Application management and the like. These Server(s) shall utilize IT industry standard data base platforms such as Microsoft SQL Server and Microsoft Data Engine (MSDE) or approved equal.
- 1.3.10 Provide a fully distributed processing, on-line, real-time, direct digital control Controls Systems Application in compliance with all applicable codes and as approved by the Authorities Having Jurisdiction (AHJ) at the Site. All communication between Controls Application Nodes shall be digital only.
- 1.3.11 All Controls Systems Application facilities and features shall be accessible via Enterprise Intranet and Internet Browser with user ID or Password access control for user access.
- 1.3.12 The Controls Systems Application shall support auto-dial/auto-answer communications to allow Controls Systems Nodes to communicate with other remote Controls Systems Nodes via standard telephone lines. The lines shall be provided by the Owner at the Owner's cost.
- 1.3.13 The Controls Systems Application network shall utilize an open architecture capable of each and all of the following:
- 1.3.13.1 Utilizing standard Ethernet communications and operate at a minimum speed of 100 Mb/sec.
- 1.3.13.2 Connecting via BACnet at the Tier 1 level in accordance with ANSI/ASHRAE Standard 135-2001.
- 1.3.13.3 Connecting via LonMark as per ANSI/EIA 709 (LonWorks) to LonMark FTT-10 transceivers at the Tier 2 level.
- 1.3.13.4 Connecting via manufacturer specific Protocol at the Tier 2 level. (i.e. Johnson Controls N2).
- 1.3.14 Downloading and Uploading
- 1.3.14.1 Provide the capability to generate and modify the Controls Systems Application software-based sequences, database

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elements, associated operational definition information, and user-required revisions to same at any designated Workstation together with the means to download same to the associated Controls Systems Application Node.

- 1.3.14.2 The Controls Systems Application software tool provided for the generation of custom and database definitions shall be resident in both the Controls Systems Application Node and Controls Systems Application Server(s).
- 1.3.14.3 Provide the capability to upload Controls Systems Application operating software information, database items, sequences, and alarms to designated Server(s).
- 1.3.14.4 The functions of this Part shall be governed by the codes, approvals, and regulations applying to this Controls Systems Application as provided.
- 1.3.15 System architectural design shall eliminate dependence upon any single device for alarm reporting and control execution. Each DDC Controller shall operate independently by performing its own specified control, alarm management, operator I/O and data collection. The failure of any single component or network connection shall not interrupt the execution of control strategies at other operational devices.
- 1.3.16 DDC Controllers shall be able to access any data from, or send control commands and alarm reports directly to, any other DDC Controller or combination of controllers on the network without dependence upon a central processing device. DDC Controllers shall also be able to send alarm reports to multiple operator workstations without dependence upon a central processing device.
- 1.3.17 Provide English language operator interface using readily understood English language abbreviations and mnemonics.
- 1.3.18 Future buildings must have the ability to communicate to this building using the BACNet Protocol. The successful Controls Contractor shall provide a PICS (Protocol Implementation Conformance Statement) for the BACNet Gateway. (Minimum conformance of Class 4). The intent is to ensure that existing and future buildings using alternate manufacturers will be able to integrate to this building.

1.4 SYSTEM PERFORMANCE

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- 1.4.1 The system shall conform to the following:
- 1.4.1.1 Graphic Display. The system shall be dashboard based, and also capable of displaying a graphic with 20 dynamic points/objects with all current data within 10 seconds.
- 1.4.1.2 Graphic Refresh. The system shall update a graphic with 20 dynamic points/objects with all current data within 8 seconds.
- 1.4.1.3 Object Command. The maximum time between the command of a binary object by the operator and the reaction by the device shall be less than 2 seconds. Analog objects should start to adjust within 2 seconds.
- 1.4.1.4 Object Scan. All changes of state and change of analog values will be transmitted over the high-speed Ethernet network such that any data used or displayed at a controller or workstation will have been current within the previous 2 seconds.
- 1.4.1.5 Alarm Response Time. The maximum time from when an object goes into alarm to when it is annunciated at the workstation shall not exceed 45 seconds.
- 1.4.1.6 Program Execution Frequency. Custom and standard applications shall be capable of running as often as once every 1 second. The Contractor shall be responsible for selecting execution times consistent with the mechanical process under control.
- 1.4.1.7 Performance. Programmable controllers shall be able to execute DDC PID control loops at a frequency of at least once per second. The controller shall scan and update the process value and output generated by this calculation at this same frequency.
- 1.4.1.8 Multiple Alarm Annunciation. All workstations on the network must receive alarms within 5 seconds of each other.
- 1.4.1.9 Reporting Accuracy. The system shall report all values with an end-to-end accuracy as listed or better than those listed in the below table.

Measured Variable	Reported Accuracy
Space Temperature	±0.5°C [±1°F]
Ducted Air	±0.5°C [±1°F]
Outside Air	±1.0°C [±2°F]
Dewpoint	±1.5°C [±3°F]

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Measured Variable	Reported Accuracy
Water Temperature	±0.5°C [±1°F]
Delta-T	±0.15°C [±0.25°F]
Relative Humidity	±5% RH
Water Flow	±5% of full scale
Airflow (terminal)	±10% of full scale (see Note
Airflow (measuring stations)	±5% of full scale
Air Pressure (ducts)	±25 Pa [±0.1 "W.G.]
Air Pressure (space)	±3 Pa [±0.01 "W.G.]
Water Pressure	±2% of full scale (see Note
Electrical (A, V, W, Power factor)	5% of reading (see Note 3)
Carbon Monoxide (CO)	±5% of reading
Carbon Dioxide (CO ₂)	±50 ppm
Note 1: 10%-100% of scale	
Note 2: For both absolute and differential	
Note 3: Not including utility-supplied meters	

1.4.1.10 Energy Reporting. The operating software shall have as standard, dashboard widgets which can be selected by the operator to create individual interface points as well as multi-trend graphics as standard.

1.4.1.11 Stability of Control. Control loops shall maintain measured variable at setpoint within the tolerances listed in the below table.

Controlled Variable	Control Accuracy	Range of Medium
Air Pressure	±50 Pa [±0.2" w.g.] ±3 Pa [±0.01" w.g.]	0-1.5 kPa [0-6" w.g.] -25 to 25 Pa [-0.1 to 0.1" w.g.]
Airflow	±10% of full scale	
Temperature	±0.5°C [±1.0°F]	
Humidity	±5% RH	
Fluid Pressure	±10 kPa [±1.5 psi]	0-1 kPa [1-150 psi]
Pressure Differential	±250 Pa [±1.0" w.g.]	0-12.5 kPa [0-50" w.g.]

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1.5 COMMUNICATION

- 1.5.1 All control products provided for this project shall comprise a BACnet internetwork. Communication involving control components (i.e., all types of controllers and Operator Workstations) shall conform to ANSI/ASHRAE Standard 135-2004, BACnet.
- 1.5.2 Each BACnet device shall operate on the BACnet Data Link/Physical layer protocol specified for that device as defined in this Section.
- 1.5.3 The Contractor shall provide all communication media, connectors, repeaters, bridges, hubs, switches, and routers necessary for the internetwork.
- 1.5.4 All controllers shall have a communication port for connections with the Operator Workstations using the BACnet Data Link/ Physical layer protocol.
- 1.5.5 Communication services over the internetwork shall result in operator interface and value passing that is transparent to the internetwork architecture as follows:
- 1.5.6 Connection of an Operator Workstation device to any one controller on the internetwork will allow the operator to interface with all other controllers as if that interface were directly connected to the other controllers. Data, status information, reports, system software, custom programs, etc., for all controllers shall be available for viewing and editing from any one controller on the internetwork.
- 1.5.7 All database values (e.g., objects, software variables, custom program variables) of any one controller shall be readable by any other controller on the internetwork. This value passing shall be automatically performed by a controller when a reference to an object name not located in that controller is entered into the controller's database. An operator/installer shall not be required to set up any communication services to perform internetwork value passing.
- 1.5.8 The time clocks in all applicable controllers shall be automatically synchronized daily. An operator change to the time clock in any controller shall be automatically broadcast to all controllers on the network.

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- 1.5.9 The network shall have the following minimum capacity for future expansion:
 - 1.5.9.1 Each Building Controller shall have routing capacity for 99 controllers.
 - 1.5.9.2 The Building Controller network shall have capacity for 1000 Building Controllers.
 - 1.5.9.3 The system shall have an overall capacity for 12,500 Building Controller, Advanced Application Controller, and Application Specific Controller input/output objects.
- 1.6 QUALITY ASSURANCE
 - 1.6.1 All labour, material, equipment and software not specifically referred to herein or on the plans, but are required to meet the functional intent, shall be provided without additional cost to the Owner.
 - 1.6.2 Materials and equipment shall be the catalogue products of a single manufacturer regularly engaged in production and installation of automatic temperature control systems and shall be manufacturer's latest standard design that complies with the specification requirements. Products referenced under this Section establish the minimum acceptable standards of the Product features, quality, and performance.
 - 1.6.3 The BAS Contractors shall be manufacturers or licensed factory representatives and installers of the manufacturers, specified for the local area in which the Site is located.
 - 1.6.4 The installing Subcontractor shall have an established working relationship with the Control System Manufacturer.
 - 1.6.5 The installing Subcontractor shall have successfully completed Control System Manufacturer's classes on the control system. The installing Subcontractor shall present for review the certification of completed training, including the hours of instruction and course outlines upon request.
 - 1.6.6 All products used in this installation shall be new, currently under manufacture, and shall be applied in standard off the shelf products. This installation shall not be used as a test site for any new products unless explicitly approved by the Owner or Consultant in writing. Spare parts shall be available for at least 5

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years after completion of this Contract.

1.6.7 The BAS Contractor shall have single source responsibility for the complete installation and proper operation of the DDC control system and BAS, including debugging and proper calibration of each component in the entire system.

1.6.8 During the initial design the Owner will supply the BAS Contractor a range of BACnet addresses the BAS will run on. The BAS network will run either BACnet over IP or BACnet over MSTP. All BAS points will be network visible so that other BACnet systems can auto discover them. The Contractor shall consult with the Owner during the development of addresses.

1.6.9 The BAS shall be compatible with future control Products for 10 years or more.

1.6.10 Include all software, associated licensing, upgrades, and labour/materials for two (2) years from the date of the Total Performance of the Work.

1.7 REFERENCE STANDARDS

1.7.1 All work, materials, and equipment shall comply with the rules and regulations of all codes and ordinances of the local, provincial, and federal authorities. Such codes, when more restrictive, shall take precedence over these plans and Specifications.

1.7.2 Provide electrical and electronic equipment which is CSA approved where such approval is required by the regulatory authorities.

1.7.3 Provide ASCII American Standard for Communication and Information Interchange code input/output devices with standard EIA Electronic Industry Association interface.

1.8 SUBMITTALS

1.8.1 The Contractor shall provide shop drawings or other submittals on all hardware, software, and installation to be provided. No work may begin on any segment of this project until submittals have been reviewed and approved for conformity with the design intent. All drawings shall be done in DXF or pdf format and provided on magnetic/optical disk and as full-size drawings. When manufacturer's cut sheets apply to a product series rather than a specific product, the data specifically applicable to the project shall be highlighted or clearly indicated by other means. Each submitted

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piece of literature and drawings shall clearly reference the specification and/or drawing that the submittal is to cover. General catalogs shall not be accepted as cut sheets to fulfill submittal requirements. Submittals shall include:

- 1.8.1.1 A complete bill of materials of equipment to be used shall be listed indicating quantity, manufacturer, model number, and other relevant technical data.
- 1.8.1.2 Manufacturer's description and technical data, such as performance curves, product specification sheets, and installation/maintenance instructions for each system component.
- 1.8.1.3 Wiring diagrams and layouts for each control panel. Show all termination numbers.
- 1.8.1.4 A schematic diagram for all control wiring, communication wiring and power wiring shall be provided. Provide a schematic drawing of the central system installation. Label all cables and ports with computer manufacturers' model numbers, function and data link protocol(s). Show all interface wiring to the control system.
- 1.8.1.5 Schematic diagrams for all field sensors and controllers. Provide floor plans of all sensor locations and control hardware on the BAS graphics as it relates to the equipment being controlled.
- 1.8.1.6 Provide detailed riser diagrams of wiring between central control unit, operator workstation(s), routers, gateways and all control panels.
- 1.8.1.7 Examples of the color graphic dashboard screens shall be provided. Provide 3 screen shots from 5 existing projects representing various systems. For each screen, provide a conceptual layout of pictures and data, and show or explain which other screens can be directly accessed.
- 1.8.1.8 A schematic diagram of each controlled system. The schematics shall have all control points/objects labeled and with point/object names shown or listed. The schematics shall graphically show the location of all control elements in the system.
- 1.8.1.9 A complete control points list.
- 1.8.1.10 An instrumentation list for each controlled system. Each element of the controlled system shall be listed in table format. The table shall show element name, type of device, manufacturer, model

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number, and product data sheet number.

- 1.8.1.11 A complete description of the operation of the control system, including sequences of operation. The description shall include and reference a schematic diagram of the controlled system.
- 1.8.1.12 A point/object list for each system controller including inputs and outputs (I/O), point/object number, the controlled device associated with the I/O point/object, and the location of the I/O device. Software flag points/objects, alarm points/objects, etc.
- 1.8.1.13 A BACnet Protocol Implementation Conformance Statement (PICS) for each type of controller and Operator Workstation included in the submittal. PICS shall include for each Product, as a minimum, a list of BACnet functional groups supported, BACnet services supported, BACnet data link options available and BACnet objects provided.
- 1.8.1.14 Point-to-point verification check sheets once completed.
- 1.8.2 Upon completion of the Work, provide a complete set of 'as-built' drawings, application software and layout colour graphics on compact disc. Drawings shall be provided as AutoCAD™ compatible files. Two complete sets of hard copies are also to be provided to the Owner.
- 1.9 OWNERSHIP OF PROPRIETARY MATERIAL
- 1.9.1 All project-developed software and documentation shall become the property of the Owner. These include, but are not limited to:
 - 1.9.1.1 Project graphic images
 - 1.9.1.2 Record drawings
 - 1.9.1.3 Project database
 - 1.9.1.4 Project-specific application programming code
 - 1.9.1.5 All documentation
- 2 **PRODUCTS**

Not used.
- 3 **EXECUTION**

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3.1 BAS DEMONSTRATION

- 3.1.1 All BAS Demonstration shall take place on the main Control Systems Server and WAN. Schedule to add system to main Control Systems Server and WAN with Owner at least two (2) weeks in advance to the demonstration. At the time of request, provide all documentation that the following criteria are met:
- 3.1.1.1 Updated BAS submittals in electronic and hard copy to the Owner including the updated riser diagram for the system.
- 3.1.1.2 Reports on verification of Network Layout Verification including but not limited to Building Controller locations, cable routes with length of cable between controllers and any trunk extenders or trunk isolators.
- 3.1.1.3 Reports on verification of electrical characteristics of BAS network, communications and electrical integrity of Building Controllers.
- 3.1.1.4 Reports on verification of traffic on BAS Network including but not limited to COVs between Building Controllers, point commands by the operator, point commands by program across the network, alarm reporting on the network, any unresolved points in the system, integrity of the ports on any Building Controller isolator/extender and results of Building Controller tests running at selected baud rate.
- 3.1.1.5 Demonstrate to the Owner the updates of databases without errors or faults between the temporary Control Systems Server and Building Controllers. If there is no temporary server, demonstrate to Owner after system is added to main Control Systems Server.
- 3.1.1.6 Reports on verification of system log files, interruption of log files of system traffic and overall acceptable operation of the system where a temporary Control Systems Server is utilized.
- 3.1.2 Demonstrate the operation of the BAS hardware, software, and all related components and systems to the satisfaction of the Owner. Schedule the demonstration with the Owner seven (7) calendar days in advance. Demonstration shall not be scheduled until all hardware and software submittals, and the Start-Up Test Report are approved. If the Work fails to conform to the Contract Documents, and additional Site visits by the Owner are to be scheduled for re-demonstration, the Contractor shall reimburse the Owner for costs of subsequent Site visits.

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- 3.1.3 The Contractor shall supply all personnel and equipment for the demonstration, including, but not limited to instruments, ladders, etc. The Contractor-supplied personnel must be competent with and knowledgeable of all project-specific hardware, software, and the HVAC systems. All training documentation and submittals shall be at the Site.
- 3.1.4 Demonstration shall typically involve small representative samples of systems/equipment randomly selected by the Owner.
- 3.1.5 The system shall be demonstrated following the same procedures used in the Start-Up Test by using the approved checklists. Demonstration shall include, but not necessarily be limited to, the following:
 - 3.1.5.1 Demonstrate that required software is installed on BAS workstations. Demonstrate that graphic screens, alarms, trends, and reports are installed as submitted and approved.
 - 3.1.5.2 Demonstrate that points specified and shown can be interrogated and/or commanded (as applicable) from all workstations, as specified in the Contract Documents.
 - 3.1.5.3 Demonstrate that remote dial-up communication abilities are in accordance with these Specifications.
 - 3.1.5.4 Demonstrate correct calibration of input/output devices using the same methods specified for the Start-Up Tests. A maximum of 10 percent of I/O points shall be selected at random by the Owner for demonstration. Upon failure of any device to meet the specified end-to-end accuracy, an additional 10 percent of I/O points shall be selected at random by the Owner for demonstration. This process shall be repeated until 100 percent of randomly selected I/O points have been demonstrated to meet specified end-to-end accuracy.
 - 3.1.5.5 Demonstrate that all DDC and other software programs exist at respective field panels. The Direct Digital Control (DDC) programming and point database shall be as submitted and approved.
 - 3.1.5.6 Demonstrate that all DDC programs accomplish the specified sequence of operation.
 - 3.1.5.7 Demonstrate that the panels and DDC network of panels automatically recover from power failures within five (5) minutes after power is restored.

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- 3.1.5.8 Demonstrate that the stand-alone operation of panels meets the requirements of these Specifications. Demonstrate that the panels' response to LAN communication failures meets the requirements of these Specifications.
- 3.1.5.9 Identify access to equipment selected by the Owner. Demonstrate that access is sufficient to perform required maintenance.
- 3.1.5.10 Demonstrate that required trend graphs and trend logs are set up per the requirements. Provide a sample of the data archive. Indicate the file names and locations.
- 3.1.6 BAS Demonstration shall be completed and approved prior to the Substantial Performance of the Work.
- 3.1.7 Any tests successfully completed during the demonstration will be recorded as passed for the functional performance testing and will not have to be retested.
- 3.2 **BAS ACCEPTANCE PERIOD**
- 3.2.1 After approval of the BAS Demonstration and prior to Total Performance of the Work, Acceptance Period shall commence. Acceptance Period shall not be scheduled until all HVAC systems are in operation and have been accepted, all required cleaning and lubrication has been completed (i.e., filters changed, piping flushed, strainers cleaned, and the like), and TAB report has been submitted and approved. Acceptance Period and its approval will be performed on a system-by-system basis if mutually agreed upon by the Contractor and the Owner.
- 3.2.2 Operational Test: At the beginning of the Acceptance Period, the system shall operate properly for set period as agreed with the Owner without malfunction, without alarm caused by control action or device failure, and with smooth and stable control of systems and equipment in conformance with these Specifications. At the end of this period, the Contractor shall forward the trend logs to the Owner for review. The Owner shall determine if the system is ready for functional performance testing and document any problems requiring the Contractor's attention.
- 3.2.2.1 If the systems are not ready for functional performance testing, the Contractor shall correct problems and provide notification to the Owner that all problems have been corrected. The Acceptance Period shall be restarted at a mutually scheduled time for an additional period.

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- 3.2.2.2 This process shall be repeated until Owner issues notice that the BAS is ready for functional performance testing.
- 3.2.3 During the Acceptance Period, the Contractor shall maintain a hard copy log of all alarms generated by the BAS. For each alarm received, the Contractor shall diagnose the cause of the alarm, and shall list on the log for each alarm, the diagnosed cause of the alarm, and the corrective action taken. If in the Contractor's opinion, the cause of the alarm is not the responsibility of the Contractor, the Contractor shall immediately notify the Owner.
- 3.2.4 Once 5 consecutive days of alarm-free operation are complete and documented, operator training may begin.
- 3.3 TRAINING
- 3.3.1 Upon completion of the work and prior to the Substantial Performance of the Work, the Owner's operating and maintenance personnel shall be given complete instructions on the operation and maintenance of the complete system. Include a description of the information flow from field sensors, contacts and devices to the ASCs. Give an overview of the system's communication network to provide a better understanding to the operator of the interplay between initiating devices, field hardware panels, system communications, and their importance within the operating BAS.
- 3.3.2 An Owner's manual prepared for this project by BAS Contractor shall be used in conjunction with the training. Two copies of the Owner's manual shall be provided.
- 3.3.3 During system commissioning and at such time as acceptable performance of the BAS hardware and software has been established, the BAS Contractor shall provide on-site operator instruction to the owner's operating personnel. Operator instruction shall take place during normal working hours and shall be performed by a competent representative of the BAS Contractor, familiar with the BAS software, hardware, and accessories.
- 3.3.4 The Subcontractor responsible for the work of Division 25 shall provide instruction to the Owner's designated personnel on the operation of all equipment within the central equipment center and describe its intended use with respect to the programmed functions specified. Operator orientation of the BAS shall include, but not be limited to, the overall operational program, equipment functions (both individually and as part of the total integrated system), commands, system generation, advisories, and appropriate

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operator intervention required in responding to the system's operation.

3.4 WARRANTY

- 3.4.1 Labor and materials for the control system specified shall be warranted free from defects for a period of 24 months after final completion and acceptance. Control system failures during the warranty period shall be adjusted, repaired, or replaced at no additional cost or reduction in service to the Owner. The Contractor shall respond to the Owner's request for warranty service within 24 hours during normal business hours.
- 3.4.2 All work shall have a single warranty date, even when the Owner has received beneficial use due to an early system start-up. If the work specified is split into multiple contracts or a multi-phase contract, then each contract or phase shall have a separate warranty start date and period.
- 3.4.3 At the end of the final start-up, testing, and commissioning phase, if equipment and systems are operating satisfactorily to the Owner, the Owner will sign certificates certifying that the control system's operation has been tested and accepted in accordance with the terms of this specification. The date of acceptance shall be the start of warranty.
- 3.4.4 Operator workstation software, project-specific software, graphic software, database software, and firmware updates which resolve known software deficiencies as identified by the Contractor shall be provided at no charge during the warranty period. Any upgrades or functional enhancements associated with the above mentioned items also can be provided during the warranty period for an additional charge to the Owner by purchasing an in-warranty technical support agreement from the Contractor. Written authorization by the Owner must, however, be granted prior to the installation of any of the above-mentioned items.
- 3.4.5 The control contractor shall have in place the capability to monitor the operation of the system on a 24-hour basis.
- 3.4.6 Parts, which have a wear-out characteristic, such as printer ink cartridges, etc., shall not be counted as failures within the terms of this warranty, if they fail or become worn out beyond their stated life expectancy.
- 3.5 WARRANTY PHASE BAS OPPOSITE SEASON TRENDING AND

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- 3.5.1 Throughout the warranty phase, trend logs shall be maintained. The Contractor shall forward archive trend logs to the Owner for review upon the Owner's request. The Owner will review these and notify the Contractor of any warranty work required.
- 3.5.2 Within twelve (12) months of the Substantial Performance of the Work, the Contractor shall schedule and conduct with the Owner an opposite season functional performance testing. The BAS Contractor shall participate in this testing and remedy any deficiencies identified.
- 3.6 BAS COMMISSIONING
- 3.6.1 Refer to Section 20 08 00 - Commissioning.
- 3.7 CONTROL STRATEGIES
- 3.7.1 Refer to Section 25 90 00 – Sequences of Operation for control sequences and to the associated control schematics on the Drawings for the required number of control loops. Provide all hardware and software necessary to achieve specified control. The sequence of events required for each control loop is described for each system in the control sequence.

END OF SECTION

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1 **GENERAL**

1.1 GENERAL

1.1.1 Sections 20 00 00 and 25 00 00 – General Requirements shall apply to and govern this Section.

1.1.2 Conform to the requirements of Section 26 00 00 - General Electrical Requirements.

1.2 SCOPE OF WORK

1.2.1 Provide all labour, materials, tools, equipment, training, commissioning and certification required to complete the work as shown on the Drawings and specified in this Section, including:

1.2.1.1 Wiring.

1.2.1.2 Control Valves and Actuators.

1.2.1.3 Control Dampers and Actuators.

1.2.1.4 Control Panels.

1.2.1.5 Sensors.

1.2.1.6 Electric Control Components (Switches, EP Valves, Thermostats, Relays, etc.).

1.2.1.7 Transducers.

1.2.1.8 Current Switches.

1.2.1.9 Nameplates.

1.2.1.10 Testing Equipment.

1.2.2 Provide the following electrical work as part of the work of this Section, complying with requirements of Division 26 – Electrical and the requirements of this Section.

1.2.2.1 Control wiring between field-installed controls, indicating devices, and unit control panels in this Section, and as specified in other Sections of this Division and under Divisions 20, 21, 22 and 23.

1.2.2.2 Interlock wiring between electrically interlocked devices, sensors, and between a hand or auto position of motor starters as indicated

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for all mechanical and controls.

- 1.2.2.3 Wiring associated with annunciator and alarm panels (remote alarm panels) and connections to their associated field devices.
- 1.2.2.4 Power wiring to field panels and other devices requiring a main supply from circuit breakers provided by Division 26 – Electrical in local emergency power and emergency lighting panels.
- 1.2.2.5 All other necessary wiring for fully complete and functional control system as specified in the Contract Documents.

1.3 ELECTRICAL WIRING

- 1.3.1 All wiring shall be in accordance with the latest edition of the Ontario Electrical Safety Code and Division 26 - Electrical. This includes wiring between control components and wiring from such components to electrical circuits of fans, pumps, and any other equipment.
- 1.3.2 Electrical interlock wiring of field devices (i.e., flow switches, thermostats) associated with equipment specified under other Sections of Division 25 and under Divisions 21, 22 and 23 is the responsibility of this Section, unless indicated otherwise in the Contract Documents.

1.4 CO-ORDINATION OF WORKS

- 1.4.1 The BAS Contractor shall design, provide, install, test, commission, and guarantee the system.
- 1.4.2 Provide all control devices, instrumentation, relays, auxiliary contacts, and transformers as specified in the Contract Documents and as required to meet the control and monitoring points and sequence of operation.
- 1.4.3 Extend control wiring requiring interfacing to systems by Division 26 – Electrical (i.e. fire alarm system, diesel generator control panel, etc.) to respective panel for termination by Division 26 - Electrical.
- 1.4.4 Dampers
 - 1.4.4.1 Manual balancing dampers, fire dampers, combination fire/smoke dampers and back draft dampers are provided as part of the work of their respective Divisions.

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- 1.4.5 Smoke dampers shall be supplied as part of the work of this Division and installed under Division 23 - HVAC. The BAS Contractor shall provide and connect all associated damper actuators and damper position sensor devices.
- 1.4.5.1 The BAS Contractor shall supply all remaining automatic control dampers not integral part of equipment specified elsewhere in Division 23. These dampers are to be installed as part of the work of Division 23 – HVAC under the direction of the BAS Contractor who will be fully responsible for the proper operation of the dampers. The BAS Contractor shall provide and connect all associated damper actuators.
- 1.4.5.2 The BAS Contractor shall provide and connect all damper actuators for dampers specified as an integral part of equipment specified elsewhere in the Contract Documents.
- 1.4.6 Automatic Control Valves
- 1.4.6.1 The BAS Contractor shall supply all automatic control valves required by the sequences of operation and not integral part of equipment specified elsewhere in Divisions 22 and 23. These valves are to be installed as part of the work of Division 22 – Plumbing and Division 23 – HVAC, under the direction of the BAS Contractor who will be fully responsible for the proper operation of the valves. The BAS Contractor shall provide and connect all associated valve actuators.
- 1.4.7 VAV and CAV Controls
- 1.4.7.1 Supply all actuators, flow transducers, and controllers to VAV/CAV terminal unit manufacturer for installation by the terminal unit manufacturer at the expense of the terminal unit manufacturer. Refer to Section 23 36 00 - Air Terminal Units.
- 1.4.8 Work by other sections
- 1.4.8.1 The following equipment is supplied by the BAS Contractor, installed under Division 22 and 23, and connected by the BAS Contractor.
- 1.4.8.1.1 Air flow measuring stations
- 1.4.8.1.2 Water pressure sensors
- 1.4.8.1.3 Water pressure taps, thermal wells, flow switches, flow meters, etc.

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that will have wet surfaces, shall be installed under the applicable piping Section under the direction of the BAS Contractor who will be fully responsible for the proper installation and application.

- 1.4.8.2 Division 26 - Electrical shall provide:
 - 1.4.8.2.1 120-volt AC 15 amp dedicated emergency power circuits for power to the Building Automation System, including all mechanical rooms and control panels.
 - 1.4.8.2.2 Termination at fire alarm system, diesel generator control panel, etc.
 - 1.4.8.3 All other installation work required for the complete installation of the Building Automation System shall be provided by the BAS Contractor.
 - 1.4.8.4 The BAS Contractor shall co-ordinate the control work involving Divisions 20, 21, 22, 23 and 26 - Electrical.

1.5 SUBMITTALS

- 1.5.1 Provide shop drawings for:
 - 1.5.1.1 Control Valves and Actuators.
 - 1.5.1.2 Control Dampers and Actuators.
 - 1.5.1.3 Control Panels.
 - 1.5.1.4 Sensors.
 - 1.5.1.5 Electric Control Components (Switches, EP Valves, Thermostats, Relays, etc.).
 - 1.5.1.6 Transducers.
 - 1.5.1.7 Current Switches.
 - 1.5.1.8 Testing Equipment.

2 **PRODUCTS**

2.1 GENERAL

- 2.1.1 All materials shall meet or exceed all applicable referenced standards, and conform to codes and ordinances of authorities

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having jurisdiction.

- 2.1.2 Provide electronic, and electric control products in sizes and capacities indicated, consisting of valves, dampers, controllers, sensors, and other components as required for complete installation. Except as otherwise indicated in the Contract Documents, provide manufacturer's standard materials and components as published in their product information; designed and constructed as recommended by manufacturer, and as required for application indicated.

2.2 WIRING

2.2.1 Communication Wiring:

- 2.2.1.1 Communication wiring shall be provided in a customized color jacketing material. Material color shall be as submitted and approved by the Owner. In addition, all wiring jackets shall be labeled "BAS" in three (3) foot or fewer intervals along the length of the jacket material. An example is provided below:

Purpose	Function	Color	Label
Building Level	Communication	Orange	BAS Building Level Communication
Floor level	Communication	Blue	BAS Floor Level Communication
Inputs/Outputs	Panel to device	White	BAS Input Output Device Cable
24VAC	Control power	White/Black tracer	BAS 24 VAC Control Power

- 2.2.1.2 The BAS Contractor shall supply all communication wiring between Building Controllers, Routers, Gateways, AAC's, ASC's and local and remote peripherals (e.g., operator workstations, printers, and modems).
- 2.2.1.3 Local Supervisory LAN: For any portions of this network required under this Section of the Specification, the BAS Contractor shall use multimode fiber (62.5 micron) or Category 5E cable per TIA/EIA 68 (10BaseT). Network shall be run with no splices and

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separate from any wiring over 30V.

- 2.2.1.4 Primary and Secondary Controller LANs: Communication wiring shall be individually 100% shielded pairs per manufacturer's recommendations for distances installed, with overall PVC cover, Class 2, plenum-rated run with no splices and separate from any wiring over 30V. Shield shall be terminated and wiring shall be grounded as recommended by building controller manufacturer.
- 2.2.2 Signal Wiring:
 - 2.2.2.1 Signal wiring to all field devices, including, but not limited to, all sensors, transducers, transmitters, switches, etc. shall be twisted, 100% shielded pair, minimum 18-gage wire, with PVC cover. Signal wiring shall be run with no splices and separate from any wiring above 30V.
 - 2.2.2.2 Signal wiring shield shall be grounded at controller end only unless otherwise recommended by the controller manufacturer.
- 2.2.3 Low Voltage Analog Output Wiring:
 - 2.2.3.1 Low voltage control wiring shall be minimum 18-gage, twisted pair, 100% shielded, with PVC cover, Class 2 plenum-rated. Low voltage control wiring shall be run with no splices separate from any wiring above 30V.
- 2.2.4 Control Panels:
 - 2.2.4.1 Provide control panels with suitable brackets for wall mounting, unless noted otherwise, for each control system. Locate panel adjacent to systems served. Mount center of control panels 1,524mm (60 inches) above finished floor or roof.
 - 2.2.4.2 Interior mount: Fabricate panels of 0.0625mm (16-gauge) furniture-grade steel, totally enclosed on four sides, with removable perforated backplane, hinged door and keyed lock, with manufacturer's standard shop-painted finish and color.
 - 2.2.4.3 Exterior mount: 0.0625mm (16-gauge) 304 or 316 stainless steel NEMA 4X enclosure. Panel shall have hinged door, keyed lock, and integral, thermostatically controlled heater. Provide hinged deadfront inside panel when flush-mounted control and/or indicating devices are included in panel. Fiberglass or aluminum, as applicable, to be used when gases that are being used in the panel area are corrosive to stainless steel.

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- 2.2.4.4 Provide UL-listed cabinets for use with line voltage devices.
- 2.2.4.5 Control panel shall be completely factory wired and piped, and all electrical connections made to a terminal strip.
- 2.2.4.6 All gauges and control components shall be identified by means of nameplates.
- 2.2.4.7 All control tubing and wiring shall be run neatly and orderly in open slot wiring duct with cover.
- 2.2.4.8 Provide a 150mm x 150mm (6" x 6") minimum wireway (metal wiring/tubing) trough across the entire width of the panel mounted to the top of the panel with close nipples of sufficient size for additional 50% wiring and tubing capacity. Wireways shall not be less than 610mm (24") in length. Control panel wiring shall be installed and distributed in the wireway to minimize routing of wiring and tubing within the control panel. Wireway construction to be the same as the associated control panel.
- 2.2.4.9 Complete wiring and tubing termination drawings shall be mounted in, and a second set mounted adjacent to, each panel in a frame with Lexan cover of sufficient size to be easily readable.
- 2.3 **AUTOMATIC CONTROL DAMPERS**
- 2.3.1 Provide factory fabricated automatic control dampers of sizes, velocity and pressure classes as required for smooth, stable, and controllable airflow. For dampers located near fan outlets, provide dampers rated for fan outlet velocity and close-off pressure, and recommended by damper manufacturer for fan discharge damper service. Control dampers used for smoke dampers shall comply with UL 555S. Control dampers used for fire dampers shall comply with UL 555.
- 2.3.2 Supply control dampers with a leakage rate of less than 15 L/s / m² (3 cfm/sq. ft.) at 249 Pa (1" w.g.) static pressure difference.
- 2.3.3 Use opposed blade type dampers for modulating service. Dampers for two position service, face and bypass and mixing may be parallel blade type.
- 2.3.4 Construct aluminum airfoil blades of minimum 2.0mm (12-gauge) extruded aluminum. Blades to be 150mm (6") wide single air foil design.

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- 2.3.5 Construct damper frames of extruded aluminum channel with grooved inserts for vinyl seals. Standard frames are 50mm x 100mm x 15mm (2" x 4" x 5/8") on linkage side, and 25mm x 100mm x 25mm (1" x 4" x 1") on the other sides.
- 2.3.6 Provide 22mm (7/8") hexagon extruded aluminum pivot rods that interlock into the blade section. Bearings to be double sealed type with a Celcon inner bearing on a rod within a Polycarbonate outer bearing inserted into frame so that the outer bearing cannot rotate.
- 2.3.7 Design the bearing to prevent metal-to-metal or metal-to-bearing riding surfaces. Interconnecting linkage shall have a separate Celcon bearing to eliminate friction in linkage.
- 2.3.8 Blade linkage hardware is to be installed in a frame out of the air stream. All hardware to be made of non-corrosive reinforced material or cadmium plated steel.
- 2.3.9 Supply overlapping damper seals that minimize air leakage.
- 2.3.10 Insulate all dampers in direct contact with outside air with 22mm (7/8") thick polyurethane foam. Blade construction must provide a 100% thermal break. Insulate frame with polystyrene.
- 2.3.11 Maximum allowable damper blade length is 1016mm (40") per section.
- 2.3.12 Provide dampers greater than two sections wide with a jackshaft.
- 2.3.13 Acceptable dampers are: T. A. MORRISON (TAMCO) 1000 / 9000 and RUSKIN CD-50 / CD-2000.
- 2.4 STANDARD SERVICE CONTROL VALVES
- 2.4.1 Control valve sizing and selection is the responsibility of the BAS Contractor. Provide a valve schedule that lists the requirements of the valves for Cv, close off, temperature, etc. This should be a result of analyzing the valves performance across the range of control.
- 2.4.2 Valves to be factory fabricated of type, body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated in the Contract Documents.
- 2.4.3 Control valves shall be equipped with heavy-duty actuators, selected to proper close-off rating for each individual application.

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- 2.4.4 Minimum close-off rating shall be considered at dead head rating of the pump.
- 2.4.5 The control valve assembly shall be provided and delivered from a single manufacturer as a complete assembly.
- 2.4.6 Characterized Control Valves
- 2.4.6.1 50mm (2") and smaller: nickel-plated forged brass body rated at 2,758 kPa (400 psi), stainless steel ball and blowout proof stem, female NPT end fittings, with a dual EPDM O-ring packing design, fiberglass reinforced Teflon seats, and a TEFZEL flow characterizing disc. 20mm ($\frac{3}{4}$ ") and smaller for terminal units: nickel plated forged brass body rated at 4,137 kPa (600 psi), chrome plated brass ball and blowout proof stem, female NPT end fittings, with a dual EPDM O-Ring packing design, fiberglass reinforced Teflon seats, and a TEFZEL flow characterizing disc.
- 2.4.6.2 65mm (2-1/2") through 80mm (3"): GG25 cast iron body according to ANSI Class 125, standard class B, stainless steel ball and blowout proof stem, flange to match ANSI 125 with a dual EPDM O-ring package design, PTFE seats, and a stainless steel flow characterizing disc.
- 2.4.7 Plug-Type Globe Pattern for Water Service:
- 2.4.7.1 Where not specifically indicated in the Contract Documents, modulating valves shall be sized for maximum full flow pressure drop between 50% and 100% of the branch circuit it is controlling unless scheduled otherwise. Two-position valves shall be same size as connecting piping or size using a pressure differential of 6.9 kPa (1 psi).
- 2.4.7.2 Single Seated (Two-way) Valves: Valves shall have equal-percentage characteristic for typical heat exchanger service and linear characteristic for building loop connections unless otherwise scheduled on the drawings. Valves shall have cage-type trim, providing seating and guiding surfaces for plug on 'top-and-bottom' guided plugs.
- 2.4.7.3 Double Seated (Three-way) Valves: Valves shall have linear characteristic. Valves shall be balanced-plug type, with cage-type trim providing seating and guiding surfaces on 'top-and-bottom' guided plugs.
- 2.4.7.4 Two- and Three-Way Modulating: twice the load pressure drop, but

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not more than 34.5 kPa (5 psig).

- 2.4.7.5 50mm (2") and smaller: ANSI Class 250 bronze body, stainless steel stem, brass plug, bronze seat, and a TFE packing.
- 2.4.7.6 65mm (2-1/2") and larger: ANSI Class 125 or 250 as applicable, cast iron body, stainless steel stem, bronze plug, bronze seat, and a TFE V-ring packing.
- 2.4.7.7 Two- and three-way globe valves shall be used only if characterized control valves do not fit the sizing criteria or application.
- 2.4.8 Plug-Type Globe Pattern for Steam Service:
 - 2.4.8.1 Two-Position: line size or sized using 10% of inlet gauge pressure.
 - 2.4.8.2 Modulating: 103 kPa (15 psig) or less: inlet steam pressure, the pressure drop shall be 80% of inlet gauge pressure. Higher than 103 kPa (15 psig) inlet steam pressure: the pressure drop shall be 42% of the inlet absolute pressure.
 - 2.4.8.3 Characteristics: Modified equal-percentage characteristics. Cage-type trim, providing seating and guiding surfaces for plug on "top and bottom" guided plugs.
 - 2.4.8.4 50mm (2") and smaller: ANSI Class 250 bronze body; stainless steel seat, stem and plug; and a TFE packing.
 - 2.4.8.5 65mm (2-1/2") and larger: ANSI Class 125 or 250 as applicable, cast iron body, stainless steel seat, stem and plug, and a TFE V-ring packing.
- 2.4.9 Ball Type:
 - 2.4.9.1 Brass or bronze body; one-, two-, or three-piece design; threaded ends; reinforced Teflon seat; stainless steel ball; standard or 'V' style port; stainless steel stem, blow-out proof design, extended to match thickness of insulation.
 - 2.4.9.2 Rating: Cold service pressure 4,138 kPa (600 psi) WOG; Steam working pressure 1,034 kPa (150 psi).
- 2.4.10 Segmented or Characterized Ball Type:
 - 2.4.10.1 Carbon steel (ASTM 216) body, one-piece design with wafer style ends; reinforced teflon (PTFE) seat; stainless steel ASTM A351

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ball; segmented design port with equal-percentage characteristic; stainless steel stem.

2.4.10.2 Rating: Cold service pressure 1,380 kPa (200 psi) WOG

2.4.11 Pressure Independent Control Valves

2.4.11.1 50mm (2") dia and smaller: forged brass body rated at no less than 2,758 kPa (400 psi), chrome plated brass ball and stem, female NPT union ends, dual EPDM lubricated O-rings and a brass or TEFZEL characterizing disc.

2.4.11.2 65mm (2-1/2") through 150mm (6") dia: GG25 cast iron body according to ANSI Class 125, standard class B, stainless steel ball and blowout proof stem, flange to match ANSI 125 with a dual EPDM O-ring packing design, PTFE seats, and a stainless steel flow characterizing disc.

2.4.11.3 Accuracy: The control valves shall accurately control the flow from 0 to 100% full rated flow with an operating pressure differential range of 34.5 kPa (5 psi) to 345 kPa (50 psi) differential across the valve with a valve body accuracy of +/- 5% variance due to differential pressure fluctuation or +/- 10% total assembly error incorporating differential pressure fluctuation, manufacturing tolerances and valve hysteresis.

2.4.11.4 Flow Characteristics: Equal percentage characteristics.

2.4.11.5 All actuators shall be capable of being electronically programmed in the field by use of external computer software or a dedicated handheld tool for the adjustment of flow. Programming using actuator mounted switches or multi-turn actuators are not acceptable. Actuators for 3-wire floating (tri-state) and for two-position 15mm (1/2") to 25mm (1") pressure independent control valves shall fail in place and have a mechanical device inserted between the valve and the actuator for the adjustment of flow.

2.4.11.6 Coil optimization 65mm (2-1/2") through 150mm (6") shall be accomplished by utilizing a pressure independent control valve assembly; two temperature sensors providing feedback of coil inlet water temperature and coil outlet water temperature; and a flow meter to provide analog flow feedback. Software shall control the valve to avoid the coil differential temperature from falling below a programmed setpoint. Independent trend logs data shall be available by means of BACnet MS/TP trending data to include, but not be limited, to inlet and outlet coil water temperatures, valve

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position, absolute flow, absolute valve position, absolute power and heating/cooling energy in BTU/hr.

- 2.4.11.7 The BAS Contractor shall ensure that the manufacturer provides a published commissioning procedure following the guidelines of the National Environmental Balancing Bureau (NEBB) and the Testing Adjusting Balancing Bureau (TABB).
- 2.4.11.8 The control valve shall require no maintenance and shall not include replaceable cartridges.
- 2.4.12 Butterfly valves may be provided for two-position service. Where indicated on the Drawings, supply motorized butterfly valves complete with pipe tee of same rating as piping specification. Supply tight shut-off valves equipped with a limit switch for position indication.
 - 2.4.12.1 50mm (2") to 300mm (12"): valve body shall be full lugged cast iron 1,379 kPa (200 psig) body with a 304 stainless steel disc, EPDM seat, extended neck and shall meet ANSI Class 125/150 flange standards. Disc-to-stem connection shall utilize an internal spline. The shaft shall be supported at four locations by RPTFE bushings.
 - 2.4.12.2 350mm (14") and larger: valve body shall be full lugged cast iron 1,034 kPa (150 psig) body with a 304 stainless steel disc, EPDM seat, extended neck and shall meet ANSI Class 125/150 flange standards. Disc-to-stem connection shall utilize a dual-pin method to prevent the disc from settling onto the liner. The shaft shall be supported at four locations by RPTFE bushings.
 - 2.4.12.3 Butterfly valves for medium pressure service: valve body shall be full lugged carbon steel ANSI Class 300 body with a 316 stainless steel disc without a nylon coating, RTFE seat, and be ANSI Class 300 flange standards. Blowout-proof shaft shall be 17-4ph stainless steel and shall be supported at four locations by glass-backed TFE bushings. Valve packing shall be Chevron TFE and shall include fully adjustable packing flange and separable packing gland. Valve body shall have long stem design to allow for 50mm (2") insulation (minimum). Valve face-to-face dimensions shall comply with API 609 and MSS-SP-68. Valve assembly shall be completely assembled and tested, ready for installation.
- 2.4.13 The BAS Contractor shall ensure that the manufacturer warrants all components for a period of 5 years from the date of production, with the first two years unconditional.

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2.4.14 Cavitation Trim:

2.4.14.1 Provide cavitation trim where indicated and/or required, designed to eliminate cavitation and noise while maintaining an equal percentage characteristic. Trim shall be a series of plates with orifices to break the pressure drop into multi-stages.

2.5 VALVE AND DAMPER ACTUATORS

2.5.1 Size actuators and linkages to operate their appropriate dampers or valves with sufficient reserve torque or force to provide smooth modulating action or 2-position action as specified. Select spring-return actuators with manual override to provide positive shut-off of devices as they are applied.

2.5.2 Provide electric actuators of the enclosed reversible gear drive type that can accept modulating control signals as required. Actuators using balance relays or mechanical travel limiting switches are not acceptable.

2.5.3 Electric damper actuators shall be spring return on outdoor air service.

2.5.4 Valves installed for outdoor service applications must be provided with actuators that operate satisfactorily at -30°C (-22°F) through 50°C (122°F).

2.5.5 Coupling shall be V-bolt dual nut clamp with a V-shaped, toothed cradle.

2.5.6 Mounting: actuators shall be capable of being mechanically and electrically paralleled to increase torque if required.

2.5.7 Fail-Safe Operation: mechanical, spring-return mechanism

2.5.8 Actuators to be overload protected electronically throughout rotation and come with electronic fail safe actuator for pressure independent valves 50mm (2-1/2") through 150mm (6").

2.5.9 Proportional actuators shall be fully programmable through an EEPROM without the use of actuator mounted switches.

2.5.10 Housing: minimum requirement NEMA type 2 / IP54 mounted in any orientation.

2.6 POSITIONERS

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2.6.1 Positive positioning relays shall be provided on damper motors and valves when required to provide sufficient power, sequencing, repeatability, or speed of response. Positioner shall allow field adjustment of both starting pressure and operating span. Positioner shall provide an antilock feature and shall provide accurate positioning without excessive air bleed.

2.7 SMOKE DAMPERS

2.7.1 Provide Ruskin SD-35, Class I smoke dampers where indicated on the Drawings.

2.7.2 Provide parallel blade type dampers, suitable for horizontal or vertical mounting. Provide multiple dampers where sizes exceed code limitations.

2.7.3 Select dampers with airflow resistance not exceeding 13 Pa (0.05" w.g.) at design flow rates.

2.8 SMOKE DAMPER MOTORS

2.8.1 Size for torque required for damper seal at load conditions with one actuator per damper section. Mechanically paralleled or 'piggybacked' actuators are not permitted.

2.8.2 Coupling shall be V-bolt dual nut clamp with a V-shaped toothed cradle. Aluminum clamps or set screws are not acceptable.

2.8.3 Overload protection: microprocessor or an electronic based motor controller providing burnout protection if stalled before full rotation is reached. The actuator shall be electronically cut off at full open to eliminate noise generation with the holding noise level to be inaudible.

2.8.4 Actuator timing shall be per OBC and NFPA requirements.

2.8.5 Temperature rating: actuator shall have a UL555S listing by the damper manufacturer for 177°C (350°F).

2.8.6 Proportional smoke and fire damper actuators shall meet all requirements specified above and shall modulate 0-100% open in response to a 2-10vdc or 4-20mA control signal. A 2-10vdc feedback output shall provide a 2-10vdc signal for position indication.

2.8.7 Balancing smoke and fire damper actuators shall meet all requirements specified above and shall include an integral

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adjustable maximum opening potentiometer for airflow adjustment.

2.8.8 A manual override winder and locking mechanism shall be provided for override operation of the actuator on a loss of power to the actuator.

2.8.9 Actuator to include auxiliary switches for signaling, fan control, or position indication.

2.8.10 Housing for combination fire/smoke damper actuator to be steel, aluminum is not acceptable.

2.9 GENERAL FIELD DEVICES

2.9.1 Provide field devices for input and output of digital (binary) and analog signals into controllers (BCs, AACs, ASCs). Provide signal conditioning for all field devices as recommended by field device manufacturers and as required for proper operation in the system.

2.9.2 BAS Contractor shall assure that all field devices are compatible with controller hardware and software.

2.9.3 Field devices specified herein are generally 'two-wire' type transmitters, with power for the device to be supplied from the respective controller. If the controller provided is not equipped to provide this power, is not designed to work with 'two-wire' type transmitters, if field device is to serve as input to more than one controller, or where the length of wire to the controller will unacceptably affect the accuracy, the BAS Contractor shall provide 'four-wire' type equal transmitter and necessary regulated DC power supply or 120 VAC power supply, as required.

2.9.4 For field devices specified hereinafter that require signal conditioners, signal boosters, signal repeaters, or other devices for proper interface to controllers, the BAS Contractor shall provide proper devices, including 120V power as required. Such devices shall have accuracy and repeatability equal to, or better than, the accuracy and repeatability listed for respective field devices.

2.9.5 Accuracy: As stated in this Section, accuracy shall include combined effects of nonlinearity, non-repeatability and hysteresis.

2.10 ELECTRONIC TEMPERATURE SENSORS

2.10.1 Supply factory calibrated temperature sensors that utilize 1000-Ohm nickel wire or platinum (RTDs).

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- 2.10.2 Temperature sensors utilized for measuring duct temperatures shall incorporate an averaging style temperature element (RTD) of sufficient length to ensure a proper average of the variation across the full cross section of the duct.
- 2.10.3 Temperature sensors utilized for measurement of fluid temperatures shall incorporate a separate well of a material suitable for the service.
- 2.10.3.1 Water service – brass
- 2.10.3.2 Steam service - 304 SS
- 2.10.3.3 Ethylene/propylene glycol service - 304 SS
- 2.10.4 Temperature sensors utilized for wall mounting in occupied spaces and connected to ASCs used for terminal unit control must be complete with a momentary contact switch for override initiation, concealed temperature setpoint adjustment and telephone style jack for connection of a portable service terminal.
- 2.10.5 Supply sensors with the following accuracy:
 - 2.10.5.1 Duct and water insertion sensors +/- 0.5% at 20°C (68°F)
 - 2.10.5.2 Duct averaging sensors +/- 1.0% at 20°C (68°F)
 - 2.10.5.3 Space sensors +/- 0.5% at 20°C (68°F)
- 2.11 AIRFLOW MONITORING STATIONS
 - 2.11.1 Airflow measuring stations must be designed and built to comply with, and provide results in accordance with accepted practice as defined for system testing in the ASHRAE Handbook of Fundamentals, as well as the Industrial Ventilation Handbook.
 - 2.11.2 Where required, incorporate air straightening to ensure an accurate flow profile.
 - 2.11.3 Utilize total pressure and static pressure probes and incorporate averaging manifolds, internal piping, and connections for an external differential pressure/flow transmitter. Hot wire anemometer technology is also acceptable
 - 2.11.4 Airflow stations incorporated into the flow channels of silencers must be a series of probes inserted and tubed together according to design criteria, to provide an acceptable airflow profile.

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2.11.5 Connect air flow monitoring devices supplied as part of equipment such as air terminal units to the BAS as required based on the Sequences of Operation set out in Section 25 90 00.

2.12 TEMPERATURE SWITCHES

2.12.1 Temperature sensing element shall be liquid, vapour, or bimetallic type.

2.12.2 Supply adjustable setpoint and differential.

2.12.3 Snap action type rated at 120 volts, 15 Amps, or 24 volts DC as required.

2.12.4 Sensors shall operate automatically and reset automatically. Temperature switches shall be of the following types:

2.12.4.1 Room Type suitable for wall mounting on standard electrical box with or without protective guard.

2.12.4.2 General Purpose Duct Type suitable for insertion into air ducts, insertion length of 450mm (18 inches).

2.12.4.3 Thermowell Type complete with compression fitting for 20mm ($\frac{3}{4}$ " NPT well mounting of length of 100 mm (4 inches). Immersion wells shall be stainless steel.

2.13 CARBON DIOXIDE SENSORS

2.13.1 Supply carbon dioxide sensors for air quality control purposes with the following characteristics:

2.13.1.1 Measurement Range – 0-2000 ppm CO₂

2.13.1.2 Accuracy +/- 100 ppm

2.13.1.3 Repeatability +/- 20 ppm

2.13.1.4 Drift +/- 100 ppm per year

2.13.1.5 Output Signal 0-10 VDC proportional over the 0-2000 ppm range

2.13.1.6 Response time 20 seconds maximum

2.13.1.7 Operating conditions 0-50°C (32-122°F), 10-100% RH non-condensing

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2.13.2 Provide one single point calibration kit

2.14 DAMPER STATUS SWITCHES

2.14.1 Damper status switches shall be lever operated, activated by damper blade movement, and mounted securely on damper frame.

2.14.2 Damper switch shall have contact rating of 5 Amperes at 120V AC and be C.S.A. approved.

2.15 OCCUPANCY SENSORS

2.15.1 Provide passive infrared sensors, which shall operate on 24 VDC, with a current draw of 26 mA. Sensors shall be sealed and gasketed and be moisture and dust proof. The passive infrared sensor shall utilize a temperature compensated dual element sensor and a multi-element Fresnel lens.

2.15.2 Provide isolated relay with normally open, normally closed, and common outputs for use with HVAC control.

2.16 CONTROL RELAYS

2.16.1 Supply and install load relays capable of switching 10 Amps at 120/1/60.

2.17 CONTROL TRANSFORMERS

2.17.1 Furnish and install control transformers as required. Control transformers shall be machine tool type, and shall be ULC and CSA listed. Primary and secondary sides shall have replaceable fuses in accordance with the NEC. Transformer shall be properly sized for application, and mounted in minimum NEMA 1 enclosure.

2.18 ELECTRIC PUSH BUTTON SWITCH

2.18.1 Switch shall be momentary contact, oil tight, push button, with number of N.O. and/or N.C. contacts as required. Contacts shall be snap-action type, and rated for minimum 120 VAC operation.

2.19 PILOT LIGHT

2.19.1 Panel-mounted pilot light shall be NEMA ICS 2 oil tight, transformer type, with screw terminals, push-to-test unit, LED type, rated for 120 VAC.

2.20 ALARM HORN

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2.20.1 Panel-mounted audible alarm horn shall be continuous tone, 120 VAC Sonalert solid-state electronic signal.

2.21 NAMEPLATES

2.21.1 Duct and pipe mounted sensors and panels shall be provided with minimum size 75mm x 25mm x 3.2mm (3" x 1" x 1/8") lamacoid nameplates, clearly identifying the equipment and functions with letter and number designation. Nameplates shall be mechanically secured and listed in the Operating and Maintenance manual.

2.22 TESTING EQUIPMENT

2.22.1 The BAS Contractor shall test and calibrate all signaling circuits of all field devices to ascertain that required digital and accurate analog signals are transmitted, received, and displayed at system operator terminals, and make all repairs and recalibrations required to complete test. The BAS Contractor shall be responsible for test equipment required to perform these tests and calibrations. Test equipment used for testing and calibration of field devices shall be at least twice as accurate as respective field device (e.g., if field device is +/- 0.5% accurate, test equipment shall be +/- 0.25% accurate over same range).

3 **EXECUTION**

3.1 PREPARATION

3.1.1 Examine areas and conditions under which control systems are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to the BAS Contractor.

3.2 GENERAL REQUIREMENTS

3.2.1 Installation shall meet or exceed all applicable federal, provincial, and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

3.2.2 Install systems and materials in accordance with manufacturer's instructions, roughing-in Drawings and details shown on Drawings. Install electrical components and use electrical products complying with requirements of the Ontario Electrical Safety Code and all local codes.

3.2.3 Install all equipment, accessories, conduits, and interconnecting

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wiring in a neat manner by skilled and qualified workmen using the latest standard practices of the industry.

- 3.2.4 Notify the Consultant in writing of any conflict between these specifications and manufacturer's instructions.
- 3.2.5 Retain, at no additional cost to the owner, original equipment suppliers to provide contacts that are required on the point schedules and in the software and sequences specified. Provide the necessary relays and transformers required to interconnect equipment.
- 3.2.6 All equipment installed shall be mechanically stable and, as necessary, fixed to wall or floor. Anti-vibration mounts shall be provided, if required, for the proper isolation of equipment.
- 3.2.7 Install equipment to allow for easy maintenance access. Ensure equipment does not interfere in any way with access to adjacent equipment and personal traffic in the surrounding space.
- 3.2.8 Install equipment in locations providing ventilation and ambient conditions for its specified function.
- 3.2.9 Install all electrical wiring in conformance with the requirements of the local electrical authority, the Ontario Building Code and, unless otherwise indicated in the Contract Documents, the Specification Sections of Division 26 – Electrical.
- 3.2.10 Install low voltage wiring in accordance with the control manufacturer's recommendations. Run all wiring in a protective conduit in areas where exposed or where required to meet with applicable codes. Plenum rated (FT6) type cables may be used in accordance with applicable codes, in concealed, accessible locations such as ceiling spaces and wall cavities.
- 3.2.11 Shield and ground communication trunk wiring at a single end. Do not splice trunk cables.
- 3.3 **INSTALLATION OF CONTROLLED DEVICES AND SENSORS**
- 3.3.1 Supply equipment to be installed under the work of other Divisions in accordance with their work schedule.
- 3.3.2 Coordinate final location of all sensors with the Consultant's field representative prior to installation.
- 3.3.3 Sensor assemblies and elements must be readily accessible.

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Provide access doors as required to allow for easy replacement and servicing.

- 3.3.4 Support field mounted transmitters and sensors on pipe stands or channel brackets.
- 3.3.5 Locate all sensing elements to correctly sense measured variable. Isolate elements from vibrations and temperatures, which could affect measurement.
- 3.3.6 Install temperature sensing elements with thermal paste to ensure accurate reading.
- 3.3.7 Install averaging type RTDs in serpentine configuration with adequate provision for the mechanical protection of the sensor. Support along its entire length.
- 3.3.8 Modifications to plenum and ductwork must achieve the intent of the Contract Documents and adhere to the following:
- 3.3.9 Mount sensors with extension necks such that access to sensors is not restricted by insulation.
- 3.3.10 Keep cutting to a minimum and perform in a neat and workmanlike manner.
- 3.3.11 Provide patches and access covers of the same material and thickness as adjoining ductwork. Provide necessary reinforcing and fastening materials.
- 3.3.12 Repair insulation to maintain integrity of insulation and vapor barrier jacket. Use hydraulic insulating cement to fill voids and finish with material matching or compatible with adjacent jacket material.
- 3.3.13 Provide gaskets, seals, and insulation to restore to, or exceed as found conditions in areas where the BAS Contractor has made modifications.
- 3.3.14 All damper actuators shall be rigidly mounted and supplied with heavy-duty linkage consisting of a crank arm, pushrod, and swivel ball joint to connect to the damper shaft. Secure linkages in such a manner as to prevent slipping under normal operating torque.
- 3.3.15 Where the point schedules indicate that auxiliary contact provision, provide all instrumentation, wiring, conduit, power supplies, and services as required to integrate these points into the BAS.

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- 3.3.16 Provide interposing and motor control relays at the local item of equipment or at the associated MCC as applicable. Provide all relays, wiring, conduit, power supplies, and services as required integrating these points into the BAS.
- 3.3.17 Control Wiring:
- 3.3.17.1 The term "control wiring" is defined to include providing of wire, conduit, and miscellaneous materials as required for mounting and connection of electric control devices.
- 3.3.17.2 Install complete wiring system for electric control systems. Conceal wiring except in mechanical rooms and areas where other conduit and piping are exposed. Installation of wiring shall generally follow building lines. Install in accordance with the latest edition of the Ontario Electrical Safety Code and Division 26 - Electrical. Fasten flexible conductors bridging cabinets and doors, neatly along hinge side, and protect against abrasion. Tie and support conductors neatly.
- 3.3.17.3 Install control wiring conductors, without splices between terminal points, color-coded. Install in neat workmanlike manner, securely fastened.
- 3.3.17.4 Communication wiring, signal wiring and low voltage control wiring shall be installed separate from any wiring over 30V. Signal wiring shield shall be grounded at controller end only, unless otherwise recommended by the controller manufacturer.
- 3.3.17.5 All WAN and LAN communication wiring shield shall be terminated as recommended by controller manufacturer. All WAN and LAN communication wiring shall be labeled with a network number, device ID at each termination and shall correspond with the WAN and LAN system architecture and floor plan submittals.
- 3.3.17.6 Install all control wiring external to panels in electric metallic tubing or raceway. Installation of wiring shall generally follow building lines. Provide compression type connectors. Install wiring in galvanized rigid steel conduit at all exterior locations and where subjected to moisture. Install in PVC Schedule 40 conduit if encased in concrete. All conduits penetrating partitions, walls or floors shall be sealed with a submitted and approved fire/smoke sealant material to prevent migration of air through the conduit system.
- 3.3.17.6.1 The BAS Contractor shall be fully responsible for noise immunity

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and rewire in conduit if electrical or RF noise affects performance.

- 3.3.17.6.2 Accessible locations are defined as areas inside mechanical equipment enclosures, such as heating and cooling units, instrument panels etc.; in accessible pipe chases with easy access, or suspended ceilings with easy access. Installation of wiring shall generally follow building lines.
- 3.3.17.6.3 Run in a neat and orderly fashion, bundled where applicable, and completely suspended (strapped to rigid elements or routed through wiring rings) away from areas of normal access. Tie and support conductors neatly with suitable nylon ties and not to exceed 1.52m (5 foot) intervals.
- 3.3.17.6.4 Conductors shall not be supported by the ceiling system or ceiling support system. Conductors shall be pulled tight and be installed as high as practically possible in ceiling cavities. Wiring shall not be laid on the ceiling or duct.
- 3.3.17.6.5 Conductors shall not be installed between the top cord of a joist or beam and the bottom of roof decking.
- 3.3.17.7 Communication cabling shall be provided in an Owner approved color dedicated to the BAS.
- 3.3.17.8 Number-code or color-code conductors appropriately for future identification and servicing of control system. Code shall be as indicated on approved installation drawings.
- 3.3.18 Install control valves so that actuators, wiring, and tubing connections are accessible for maintenance. Where possible, install with valve stem axis vertical, with operator side up. Where vertical stem position is not possible or would result in poor access, valves may be installed with stem horizontal. Do not install valves with stem below horizontal, or down.
- 3.3.19 Averaging temperature sensors shall cover no more than 0.61 sq.m per linear meter (2 sq.ft per linear foot) of sensor length except where indicated. Sensor shall be installed in location where flow is sufficiently homogeneous and adequately mixed. Install averaging sensors in a serpentine configuration with adequate provision for the mechanical protection of the sensor. Support along its entire length.
- 3.3.20 Install airflow measuring stations per manufacturer's recommendations in an unobstructed straight length of duct

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(except those installations specifically designed for installation in fan inlet). For installations in fan inlets, provide on both inlets of double inlet fans and provide inlet cone adapter as recommended by AFM station manufacturer.

- 3.3.21 Install fluid flow sensors per manufacturer's recommendations in an unobstructed straight length of pipe.
- 3.3.22 Provide element guard for relative humidity sensors as recommended by manufacturer for high velocity installations. For high limit sensors, position remote enough to allow full moisture absorption into the air stream before reaching the sensor.
- 3.3.23 Water differential pressure transmitters shall be installed in a valve bypass arrangement to protect against over pressure damaging the transmitter. Establish required locations and coordinate installation of valve bypass with the respective Subcontractors.
- 3.3.24 Install steam differential pressure transmitters as shown on the Drawings per manufacturer's instructions.
- 3.3.25 Install pipe surface mount temperature sensors with thermally conductive paste at pipe contact point. Where sensor is to be installed on an insulated pipe, the BAS Contractor shall neatly cut insulation, install sensor, repair or replace insulation and vapor barrier, and adequately seal vapor barrier.
- 3.3.26 Where possible, install flow switches in a straight run of pipe at least 15 diameters in length to minimize false indications.
- 3.3.27 Adjust current switches for motor status monitoring so that setpoint is below minimum operating current and above motor no load current.
- 3.3.28 Supply Duct Pressure Transmitters:
 - 3.3.28.1 Install pressure tips with at least four (4) 'round equivalent' duct diameters of straight duct with no takeoffs upstream. Install static pressure tips securely fastened with tip facing upstream in accordance with manufacturer's installation instructions. Locate the transmitter at an accessible location to facilitate calibration.
 - 3.3.28.2 On VAV Systems, locate down-duct transmitter pressure tips approximately 2/3 of the hydraulic distance to the most remote terminal in the air system.

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3.4 IDENTIFICATION OF EQUIPMENT

- 3.4.1 Identify each piece of equipment, including sensors, controlled devices, and control panels, with a nameplate identifying the equipment and functions with a letter and number designation.
- 3.4.2 Nameplates shall be minimum size 75mm x 25mm (3" x 1") and 3.2mm (1/8") thick laminated plastic with black face and white center and 6.4mm (1/4") deep engraved lettering. Nameplates shall be securely attached to the equipment.
- 3.4.3 Printed nametags are acceptable for cabinet mounted components providing they are securely attached.

3.5 ACCEPTANCE AND TESTING PROCEDURES

- 3.5.1 The BAS Contractor shall request completion acceptance in writing and advise the Consultant of situations that would prevent a complete testing of overall system performance.
- 3.5.2 Work and/or systems installed under this Division and under Divisions 21, 22 and 23 shall be fully functioning prior to Demonstration and Acceptance Phase. The BAS Contractor shall start, test, adjust, and calibrate all work and/or systems under this Contract, as described below:
 - 3.5.2.1 Inspect the installation of all devices. Review the manufacturer's installation instructions and validate that the device is installed in accordance with them.
 - 3.5.2.2 Verify proper electrical voltages and amperages, and verify that all circuits are free from faults.
 - 3.5.2.3 Verify integrity/safety of all electrical connections.
 - 3.5.2.4 Coordinate with the Subcontractor responsible for the TAB work to obtain control settings that are determined from balancing procedures. Record the following control settings as obtained from the Subcontractor responsible for the TAB work, and note any TAB deficiencies in the BAS Start-Up Report:
 - 3.5.2.4.1 Optimum duct static pressure setpoints for VAV air handling units.
 - 3.5.2.4.2 Minimum outside air damper settings for air handling units.
 - 3.5.2.4.3 Optimum differential pressure setpoints for variable speed pumping systems.

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- 3.5.2.4.4 Calibration parameters for flow control devices such as VAV terminal units and flow measuring stations.
- 3.5.2.5 The BAS Contractor shall provide a hand-held device as a minimum to the Subcontractor responsible for the TAB work to facilitate calibration. Connection for any given device shall be local to it (i.e. at the VAV terminal unit or at the thermostat). Hand-held device or portable operator's terminal shall allow querying and editing of parameters required for proper calibration and start-up.
- 3.5.2.6 Test, calibrate, and set all digital and analog sensing and actuating devices. Calibrate each instrumentation device by making a comparison between the BAS display and the reading at the device, using an instrument, which shall be at least twice as accurate as the device to be calibrated (e.g., if field device is +/-0.5 percent accurate, test equipment shall be +/-0.25 percent accurate over same range). Record the measured value and displayed value for each device in the BAS Start-up Report.
- 3.5.2.7 Check and set zero and span adjustments for all transducers and transmitters.
- 3.5.2.8 For dampers and valves:
 - 3.5.2.8.1 Check for adequate installation including free travel throughout range and adequate seal.
 - 3.5.2.8.2 Where loops are sequenced, check for proper control without overlap.
- 3.5.2.9 For actuators:
 - 3.5.2.9.1 Check to insure that device seals tightly when the appropriate signal is applied to the operator.
 - 3.5.2.9.2 Check for appropriate fail position, and that the stroke and range is as required.
 - 3.5.2.9.3 For sequenced electronic actuators, calibrate per manufacturer's instructions to required ranges.
- 3.5.2.10 Check each digital control point by making a comparison between the control command at the CU and the status of the controlled device. Check each digital input point by making a comparison of the state of the sensing device and the Operator Interface display. Record the results for each device in the BAS Start-Up Report.

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- 3.5.2.11 For outputs to reset other manufacturer's devices (for example, VSDs) and for feedback from them, calibrate ranges to establish proper parameters. Coordinate with representative of the respective manufacturer and obtain their approval of the installation.
- 3.5.3 Sensor Checkout and Calibration:
 - 3.5.3.1 Verify that all sensor locations are appropriate and are away from causes of erratic operation. Verify that sensors with shielded cable are grounded only at one end. For sensor pairs that are used to determine a temperature or pressure difference, make sure they are reading within 0.1 degrees C (0.2 degrees F) of each other for temperature and within a tolerance equal to 2 percent of the reading of each other for pressure. Tolerances for critical applications may be tighter.
 - 3.5.3.2 Calibrate all sensors using one of the following procedures:
 - 3.5.3.2.1 Sensors without transmitters: Make a reading with a calibrated test instrument within 150mm (6 inches) of the site sensor at various points across the range. Verify that the sensor reading (via the permanent thermostat, gauge or BAS) is within the tolerances specified for the sensor. If not, adjust offset and range, or replace sensor. Where sensors are subject to wide variations in the sensed variable, calibrate sensor within the highest and lowest 20 percentage of the expected range.
 - 3.5.3.2.2 Sensors with transmitters: Disconnect sensor. Connect a signal generator in place of sensor. Connect ammeter in series between transmitter and BAS control panel. Using manufacturer's resistance-temperature data, simulate minimum desired temperature. Adjust transmitter potentiometer zero until the ammeter reads 4 mA. Repeat for the maximum temperature matching 20 mA to the potentiometer span or maximum and verify at the OI. Record all values and recalibrate controller as necessary to conform to tolerances. Reconnect sensor. Make a reading with a calibrated test instrument within 150mm (6 inches) of the site sensor. Verify that the sensor reading (via the permanent thermostat, gauge or BAS) is within the tolerances specified. If not, replace sensor and repeat. For pressure sensors, perform a similar process with a suitable signal generator.
 - 3.5.3.3 Sensors shall be within the tolerances specified for the device.
- 3.5.4 Coil Valve Leak Check:

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- 3.5.4.1 Verify proper close-off of the valves. Ensure the valve seats properly seat by simulating the maximum anticipated pressure difference across the circuit. Demonstrate to the Owner the verification of zero flow by measuring the coil differential pressure. If there is pressure differential, close the isolation valves to the coil to ensure the conditions change. If they do, this validates the valve is not closing. Remedy the condition by adjusting the stroke and range, increasing the actuator size/torque, replacing the seat, or replacing the valve as applicable.
- 3.5.5 Valve Stroke Setup and Check:
 - 3.5.5.1 For all valve and actuator positions checked, verify the actual position against the Operator Interface readout.
 - 3.5.5.2 Set pumps to normal operating mode. Command valve closed, verify that valve is closed, and adjust output zero signal as required. Command valve open, verify position is full open and adjust output signal as required. Command the valve to various few intermediate positions. If actual valve position doesn't reasonably correspond, replace actuator or add pilot positioner.
- 3.5.6 After completion of installation and in cooperation with Subcontractors responsible for the related work of other Specification Sections, adjust each control device and component to ensure that the operations are in accordance with the Sequences of Operation specified in Section 20 95 00.

END OF SECTION

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1 **GENERAL**

1.1 GENERAL

1.1.1 Sections 20 00 00 and 25 00 00 – General Requirements shall apply to and govern this Section.

1.2 SCOPE OF WORK

1.2.1 Refer to the below sequence of operation and associated control schematics for the required number of control loops. Provide all hardware and software necessary to achieve specified control. The sequence of events required for each control loop is described for each system in the control sequence.

1.2.2 Revise the controls shop drawing sequences of operation and create an “As-built or As Functioning Sequence of operation “to be included into the Operations and Maintenance Manuals.

1.2.3 The operators’ workstation to include a Sequence of Operation tab to provide a narrative to the operator regarding equipment / system operation.

2 **PRODUCTS**

Not used.

3 **EXECUTION**

3.1 GENERAL

3.1.1 When motorized equipment is operating, BAS shall totalize runtime in hours for use in maintenance operations.

3.1.2 Where parallel or duplex equipment is provided, BAS shall alternate lead equipment such that runtime is equalized.

3.1.3 Provide adjustable time delay between damper or valve opening and equipment start/stop to avoid operation with a closed system.

3.1.4 Select components to fail safe. Priority in descending order is: life safety, protection of equipment, and comfort.

3.1.5 Schedule operation of systems according to schedules provided by the Owner, and/or optimal start/stop program, and/or Operator keyboard entry.

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- 3.1.6 All low limit thermostats (freezestats), in addition to providing a DI control point, shall be hardwired to the equipment starter to shut down the system upon sensing an air temperature below 2°C (36°F).
- 3.1.7 Shut down fans upon detection (via BAS sensors) of supply or return air temperatures in excess of 67°C (135°F).
- 3.1.8 Co-ordinate the provision of duct mounted smoke detectors by Division 26 - Electrical. Detectors shall be hardwired to the respective fan starter to shut the fan down upon detection of smoke.
- 3.1.9 Co-ordinate fire alarm system fan shutdown where provided via the BAS with Division 26 - Electrical.
- 3.1.10 Fan systems shall not be started if motorized damper end switch indicates that the damper is not fully open. Alarm abnormal status of damper to BAS and start standby system if applicable.
- 3.1.11 Unscheduled shutdown of either the supply or return fan shall result in a system shutdown, and an abnormal status alarm condition at the BAS, and start-up of the standby system if applicable.
- 3.1.12 Static pressure control on all VAV air systems shall be sensed at a position 2/3 downstream of the supply fan. Shut system down if static pressure exceeds 498 Pa (2" w.c.)
- 3.1.13 Airside free cooling control shall be enabled based on enthalpy control.
- 3.1.14 All noted setpoints shall be operator-adjustable, and subject to tuning during system commissioning.
- 3.1.15 Status of motors shall be by current draw unless noted otherwise in the Contract Documents.
- 3.2 FAN COIL UNITS
- 3.2.1 Each fan coil unit shall be individually scheduled from the BAS. The operator shall also have the option of scheduling a group of fan coil units together on a single time schedule.
- 3.2.2 Controls Contractor is responsible for interfacing to fan coil unit thermostats or control boards to allow regular operation. Any relays required are the responsibility of the Controls Contractor.

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- 3.2.3 Fan coil unit DDC controller shall modulate the heating and chilled water valves to maintain space at the temperature setpoint. Cooling setpoint shall be initially set for 22.8°C (73°F). Cooling command shall be energized above 22.8°C (73°F). Heating command shall be energized below 21.7°C (71°F).
- 3.2.4 The supply fan shall run continuously when the unit is enabled. Supply fan shall be cycled in the night setback and setup modes as required to maintain the night setback/setup temperature setpoints.
- 3.3 AIR HANDLING UNIT
- 3.3.1 Unit off:
- 3.3.1.1 This mode is initiated by loss of supply or return fan status or by time schedule from BAS.
- 3.3.1.2 Outdoor air and exhaust dampers are closed, recirculation air damper is open. Supply and return fans are off. Glycol heating valve is open.
- 3.3.2 Start-up:
- 3.3.2.1 Start-up is initiated by time schedule from the BAS.
- 3.3.2.2 Outdoor air and exhaust dampers open to preset minimum position. Supply and return fans start.
- 3.3.3 Temperature Control:
- 3.3.3.1 Modulate the outdoor air and exhaust dampers between preset minimum and fully open positions, and the recirculation air damper to closed position based on comparison of return air and outdoor air temperature and of supply air temperature setpoint (economizer mode).
- 3.3.3.2 When the supply air temperature is below setpoint, initially 12.8°C (55°F) and the outdoor air damper is in preset minimum position, the glycol heating valve shall be enabled and modulated to maintain setpoint. Monitor glycol temperatures in and out of the coil. .
- 3.3.3.3 When the supply air temperature is above setpoint and the outdoor air damper is in preset minimum position, the cooling coil valve shall be enabled and modulated to maintain setpoint.
- 3.3.4 Demand Control Ventilation:

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- 3.3.4.1 The outside air damper shall modulate to maintain the minimum outside air design set point (adjustable)
- 3.3.4.2 The minimum outside air CFM will be increased on a trip and respond setpoint sequence. Each VAV zone associated with the HU will be capable of registering a vote for more ventilation air. Upon a demand for one or more CO2 sensors/zone, the outside air damper opening shall gradually increase up to the design maximum (adjustable)
- 3.3.4.3 As the demand for ventilation decreases from the CO2 sensors, the outside air damper shall gradually close to the minimum position.
- 3.3.5 Shutdown:
 - 3.3.5.1 Supply and return fans are off, outdoor air and exhaust dampers are closed, recirculation air damper is open. Heating valve is open.
 - 3.3.5.2 Alarm if the closed position end switch of the outdoor air or exhaust dampers did not make after two (2) minutes the unit is shut down.
- 3.3.6 Alarm at the BAS and modulate the glycol heating valve to fully open position if the freezestat is activated.
- 3.3.7 Monitor pressure drop across air filters.
- 3.3.8 The unit shall be started and stopped by the FMS based on an operator-defined time of day schedule. After hours, an override button on each VAV box thermostat will start the compartment unit serving that VAV box for a predetermined amount of time (initially 2 hours).
- 3.3.9 The air handling unit DDC controller shall maintain the duct static pressure by modulating the supply fan VFD from a static pressure sensor, located as shown on the drawings. If sensor is not located on drawings, it shall be located 2/3 of the way down the longest run of straight ductwork.
- 3.3.10 The controls contractor shall be responsible for providing a temperature and static pressure gauge in the supply ductwork at each compartment unit. Mount gauges in such a manner that they may be viewed by standing in the mechanical room without a ladder.

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3.3.11 Setpoint shall be adjusted by the BAS based on supply fan VFD speed as follows:

3.3.11.1 VFD < 40%, Setpoint = 18.3°C (65°F)

3.3.11.2 VFD > 80%, Setpoint = 12.8°C (55°F)

3.3.12 40% < VFD < 80%, Setpoint is linear between above values.

3.4 VAV BOXES

3.4.1 Modulate the damper to maintain the airflow setpoint as measured by the flow transducer. The airflow setpoint shall be changed based on the zone temperature. As the zone temperature rises above setpoint, the airflow setpoint is increased. Below the zone temperature setpoint, the airflow setpoint is lowered to minimum airflow. Airflow setpoints are indicated on the Drawings. Program all setpoints prior to air balancing.

3.4.2 Monitor all VAV discharge air temperatures

3.4.3 Interlocked with room CO2 sensor for demand control ventilation

3.4.4 Zone temperature setpoint shall be set at 23.1°C (73.5°F). Below 23.1°C (73.5°F), the VAV box shall be set to minimum flow. Unoccupied setpoint shall be set to 26.7°C (80°F). If the compartment unit serving the floor is on, but the VAV box is in unoccupied mode, the VAV box shall maintain unoccupied setpoint.

3.4.5 Zone thermostats shall have a programmable adjustment to allow occupant to adjust setpoint by +/- 1°C (1.8°F) (value is programmable). Temporary occupancy button on thermostat shall be a momentary contact. Pressing the button will energize the compartment unit serving that floor, and set the zone into occupied mode.

3.5 VAV BOXES WITH PERIMETER FAN COIL HEATING

3.5.1 Modulate the damper to maintain the airflow setpoint as measured by the flow transducer. The airflow setpoint shall be changed based on the zone temperature. As the zone temperature rises above setpoint, the airflow setpoint is increased. Below the zone temperature setpoint, the airflow setpoint is lowered to minimum airflow. Airflow setpoints are indicated on the Drawings. Program all setpoints prior to air balancing.

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- 3.5.2 Monitor all VAV discharge air temperatures
- 3.5.3 Interlocked with room CO2 sensor for demand control ventilation
- 3.5.4 Zone temperature setpoint shall be set at 23.1°C (73.5°F). Below 23.1°C (73.5°F), the VAV box shall be set to minimum flow. Heating shall be enabled & modulated to maintain setpoint less 1°C (1.8°F) deadband. Unoccupied setpoint shall be set to 26.7°C (80°F) (cooling) and 16.7°C (62°F) (heating). If the compartment unit serving the floor is on, but the VAV box is in unoccupied mode, the VAV box shall maintain unoccupied setpoint. During unoccupied hours, radiation heating shall maintain unoccupied setpoint.

3.6 ELECTRICAL ROOM VENTILATION

- 3.6.1 Through a DDC controller, a space temperature sensor shall sequence the exhaust fans to maintain space setpoint temperature according to the following schedule:

- exhaust fans on above 23.9°C (75°F)

3.7 MISCELLANEOUS EXHAUST FANS

- 3.7.1 When exhaust fan is off, close respective damper.
- 3.7.2 When exhaust fan is activated based on time of day schedule, open damper before starting fan.

3.8 MISCELLANEOUS CONTROL POINTS

- 3.8.1 Monitor the following additional points via the BAS.

MISCELLANEOUS CONTROL POINTS			
DESCRIPTION	LOCATION	TYPE	REMARKS
Hydronic BTU Meter	Meter Panel	DI	Pulse Counter for Consumption (1x)
Domestic Water Check Meters	Meter Panel	DI	Pulse Counter for Consumption (3x)

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END OF SECTION



Standard Building Automation System (BAS) Owner Requirements

APPENDIX A

November, 2019

Version & revision number: 6.1.5

This document is the standard for use in new construction, retrofits and upgrades in City of Toronto facilities and shall not be amended in any way without written consent from the Corporate Real Estate Management (CREM) Division.

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NOT REQUIRED

This section includes the central building automation system components and network protocol specifications. It may be used as section 23 09 23 or 23 09 93 depending on specification format used.

In addition to this section it will be necessary to add project specific sections for control components and sequences of operation.

The intent of this specification is to describe the minimum features required for a new installation. For renovation or refit type projects, it will be necessary to determine to what extent any existing system can be upgraded or modified within the parameters of the project budget to achieve the general intent of this specification and provide appropriate edits.

PART 1 - GENERAL

1.0 GENERAL REQUIREMENTS

- 1.1 Conform to all, "Mechanical General Provisions".
- 1.2 The "provide" in this Division shall be interpreted as "supply and install".
- 1.3 All work shall conform to Canadian Metric Practice Guide CSA CAN3-2234.1.76
- 1.4 Provide all required adapters between metric and imperial components.
- 1.5 Metric descriptions in this Division are nominal equivalents of Imperial values.
- 1.6 All equipment and material to be new, CSA certified, manufactured to minimum standard quoted including additional specified requirements.
- 1.7 Where there is no alternative to supply equipment that is not CSA certified, submit such equipment to Inspection Authorities for special inspection and obtain approval before delivery of equipment to site.
- 1.8 Use new products the manufacturer is currently manufacturing and selling for use in new installations. Do not use this installation as a product test site unless explicitly approved in writing by the owner. Spare parts shall be available for at least five years after completion of this contract.
- 1.9 Use material and equipment available from a regular production by manufacturer concerned.

2.0 WORK INCLUDED

Add to this section any site specific qualifications that may apply to the specific project with respect to application of the specified requirements for the system.

- 2.1 The City of Toronto has standardized Building Automation Systems utilizing native BACnet area, system and application controllers. Extend the existing Framework as detailed herein.
- 2.2 The system shall support standard Web browser access via the City's Intranet/Internet. It shall support a minimum of 100 simultaneous users with the ability to access the graphical data and real time values simultaneously. (Refer to Section 7.16)
- 2.3 Provide an open protocol Building Automation System (BAS) incorporating Direct Digital Control (DDC), equipment monitoring, and control consisting of: A PC based Operator Work Station (OWS) with colour graphic data displays; Microcomputer based Building Controllers (BCs) and Microcomputer based Advanced Application Controllers (AACs) and Application Specific Controllers (ASCs) interfacing **directly** with sensors,

actuators and environmental delivery systems (i.e., HVAC units, boilers, chillers, lighting systems, etc.); electric controls and mechanical devices for all items indicated on drawings described herein including dampers, valves, panels and compressed air plant.

- 2.4 City of Toronto has standardized the use of Direct Digital Controllers (DDC) and End Devices. No **NEW** pneumatic control devices shall be connected or incorporated into the BAS network. It applies to new installations as well as retrofit applications.
- 2.5 Open Protocols by definition are to be BACnet (ASHRAE Standard 135 – Annex J) and Haystack only.
- 2.6 Provide BAS controllers (BCs, AACs and ASCs) based on native BACnet (ASHRAE Standard 135 – Annex J) protocols.
- 2.7 Provide submittals, data entry, electrical installation, programming, startup, test and validation acceptance documentation, and system warranty.

3.0 WORK BY OTHERS

- 3.1 Access doors and setting in place of valves, flow meters, water pressure and differential taps, flow switches, thermal wells, dampers, air flow stations, and current transformers shall be by others.

4.0 QUALITY ASSURANCE

4.1 Codes and Approvals:

- 4.1.1 Work, materials, and equipment shall comply with the Ontario Building Code, Ontario Electrical Code, ANSI/ASHRAE 135-2004: Data Communication Protocol for Building Automation and Control Systems (BACnet) and Authorities having jurisdiction over this work. All devices shall be ULC, UL or FM listed and labeled for the specific use, application and environment to which they are applied.
 - 4.1.2 The BAS shall comply with NFPA 90A Air Conditioning and 90B Warm Air Heating, Air Conditioning.
 - 4.1.3 All electronic equipment shall conform to the requirements of CSA for electromagnetic emissions standards and placed in approved locations such that it does not interfere with building equipment or computers.
- 4.2 Provide satisfactory operation without damage at 110% above and 85% below rated voltage and at 3 hertz variation in line frequency. Provide static, transient, and short circuit protection on all inputs and outputs. Communication lines shall be protected against incorrect wiring, static transients and induced magnetic interference. Bus connected devices shall be AC coupled, or equivalent so that any single device failure will not disrupt or halt bus communication.

5.0 ABBREVIATIONS AND SYMBOLS

- 5.1 All letter symbols and engineering unit abbreviations utilized in information displays ANSI/ISA S5.5 and printouts shall conform to ANSI 710.19/IEEE 260-letter symbols for SI and certain other units of measurement.
- 5.2 Specification Nomenclature - Acronyms used in this specification are as follows:

AAC	Advanced Application Controller
ASC	Application Specific Controller
BAS	Building Automation System
BC	Building Controller

BIBB	BACnet Interoperability Building Blocks
DDC	Direct Digital Controls
GUI	Graphical User Interface
HTTP	Hyper Text Transfer Protocol
LAN	Local Area Network
ODBC	Open Database Connectivity protocol
OOT	Object Oriented Technology
OPC	Object linking and embedding for Process Control
OWS	Operator Workstation
PDA	Personnel Data Assistant device
PICS	Protocol Implementation Conformance Statement
PWS	Portable Workstation
SNVTS	Standard Network Variables Types
SQL	Standard Query Language
TCP/IP	Transmission Control Protocol / Internet Protocol
TCU	Terminal Control Unit
WAN	Wide Area Network
WAP	Wireless Application Protocol device
WBI	Web Browser Interface
XML	Extensible Markup Language
XIF	External Interface Files

6.0 APPROVED CONTROL SYSTEMS

Applicable to new construction projects, new installations within existing buildings and major retrofit/overhaul of existing BAS systems.

6.1 Any vendors that are authorized dealers or distributors of the following control systems are acceptable:

- 6.1.1 Delta Controls
- 6.1.2 Reliable Controls
- 6.1.3 Schneider Electric SmartX series
- 6.1.4 Distech Controls
- 6.1.5 Johnson Controls Facility Explorer
- 6.1.6 Honeywell CIPer series, Spyder models 5 or 7

6.2 BAS Systems Integration:

- 6.2.1 All control systems must be integrated to the City's J2 Innovations Fluid Integration (FIN) server, including but not limited to the following:
 - 6.2.1.1 graphical user interface (monitoring & control)
 - 6.2.1.2 alarming
 - 6.2.1.3 data trending
 - 6.2.1.4 data archiving
 - 6.2.1.5 Project Haystack naming convention
- 6.2.2 The installer must be licensed by J2 Innovations to sell, install, program and configure Fluid INtegration (FIN).
- 6.2.3 Building Controllers (BC) must be Tridium Niagara JACE with the Haystack module and driver. The installer must be a licensed Tridium system integrator for any Tridium BCs or embedded or edge Niagara Framework products used. Soft JACE is not accepted.

6.3 Licensing Requirements

- 6.3.1 Licenses shall be provided to and in the name of the City of Toronto
- 6.3.2 Licenses shall be perpetual, transferrable, assignable and royalty-free

- 6.3.3 Tridium licenses shall allow all Workbench/Supervisor brands complete system access and functionality.
- 6.4 Installer and Manufacturer Qualifications
- 6.4.1 Installer shall have an established working relationship with Control System Manufacturer.
- 6.4.2 Installer shall have successfully completed Control System Manufacturer's control system training. Upon request, Installer shall present record of completed training including course outlines.
- 6.4.3 It is the intent of this specification to define an open protocol state-of-the-art distributed computerized Building Management and Control System which is user friendly, has known reliability, is extremely responsive, and which is to be designed, installed, implemented, and supported by a local office of approved bidders.
- 6.4.4 BAS contractor shall provide three locations of successful installations of similar open protocol computer based systems. Sites provided must consist of more than 150 hardware inputs/outputs. Project sites must be local to the location of this project.
- 6.5 System Administration
- 6.5.1 Administrator credentials shall be sent to BAS@Toronto.ca for retention by the City. Credentials shall include any and all accounts and passwords required for complete system access, including but not limited to Station and Platform credentials.

7.0 SYSTEM DESIGN

For retrofit projects where a gateway might be considered the most appropriate economic decision for interface to an existing automation system, remove article 7.2.

- 7.1 The system shall consist of a network of Building Controllers (BC), Advanced Application Controllers (AAC), Application Specific Controllers (ASC), and Smart Actuators (SA). Every device in the system which executes control logic and directly controls HVAC equipment must conform to a standard BACnet Device profile as specified in ANSI/ASHRAE 135-2004, BACnet Annex L. Unless otherwise specified, hardwired actuators and sensors may be used in lieu of BACnet Smart Actuators and Smart Sensors.
- 7.2 Systems utilizing gateways will not be considered. A gateway device is considered to be a device where only mapping of system points from one protocol to another occurs. A gateway device cannot perform higher-level energy management functions such as Outdoor Air Optimization, Electrical Demand Limiting and the like.
- 7.3 The Building Automation System software shall employ object-oriented technology (OOT) for representation of all data and control devices within the system. The supplied system must incorporate the ability to access all data using standard Web browsers without requiring proprietary operator interface and configuration programs. An Open Database Connectivity (ODBC) or Structured Query Language (SQL) compliant server database is required for all system database parameter storage. This data shall reside on a BAS server for all database access. Systems requiring proprietary database and user interface programs shall not be acceptable.
- 7.4 A hierarchical topology is required to assure reasonable system response times and to manage the flow and sharing of data without unduly burdening the customer's internal Intranet network. Systems employing a flat single tiered architecture shall not be acceptable. Maximum acceptable response time from any alarm occurrence (at the point of origin) to the point of annunciation shall not exceed 5 seconds for network connected user interfaces. Maximum acceptable response time from any alarm occurrence (at the point of origin) to the point of annunciation shall not exceed 60 seconds for remote or dial-up connected user interfaces.

8.0 BACnet.

- 8.1 Building Controllers (BCs). Each BC shall conform to BACnet Building Controller (B-BC) device profile as specified in ANSI/ASHRAE 135-2004, BACnet Annex L and shall be listed as a certified B-BC in the BACnet Testing Laboratories (BTL) Product Listing.
- 8.2 Advanced Application Controllers (AACs). Each AAC shall conform to BACnet Advanced Application Controller (B-AAC) device profile as specified in ANSI/ASHRAE 135-2004, BACnet Annex L and shall be listed as a certified B-AAC in the BACnet Testing Laboratories (BTL) Product Listing.
- 8.3 Application Specific Controllers (ASCs). Each ASC shall conform to BACnet Application Specific Controller (B-ASC) device profile as specified in ANSI/ASHRAE 135-2004, BACnet Annex L and shall be listed as a certified B-ASC in the BACnet Testing Laboratories (BTL) Product Listing.
- 8.4 Smart Actuators (SAs). Each SA shall conform to BACnet Smart Actuator (B-SA) device profile as specified in ANSI/ASHRAE 135-2004, BACnet Annex L and shall be listed as a certified B-SA in the BACnet Testing Laboratories (BTL) Product Listing.
- 8.5 Smart Sensors (SSs). Each SS shall conform to BACnet Smart Sensor (B-SS) device profile as specified in ANSI/ASHRAE 135-2004, BACnet Annex L and shall be listed as a certified B-SS in the BACnet Testing Laboratories (BTL) Product Listing.

8.6 BACnet Communication.

- 8.6.1 Each BC shall reside on or be connected to a BACnet network using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol and BACnet/IP addressing.
- 8.6.2 BACnet routing shall be performed by BCs or other BACnet device routers as necessary to connect BCs to networks of AACs and ASCs.
- 8.6.3 Each AAC shall reside on a BACnet network using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol with BACnet/IP addressing, or it shall reside on a BACnet network using the MS/TP Data Link/Physical layer protocol.
- 8.6.4 Each ASC shall reside on a BACnet network using the MS/TP Data Link/Physical layer protocol.
- 8.6.5 Each SA shall reside on a BACnet network using the MS/TP Data Link/Physical layer protocol.
- 8.6.6 Each SS shall reside on a BACnet network using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol with BACnet/IP addressing, or it shall reside on a BACnet network using MS/TP Data Link/Physical layer protocol.
- 8.6.7 The maximum number of controllers on an MS/TP network/subnet shall be no more than 64 or the manufacturer recommended limit, whichever is less.
- 8.6.8 An approved addressing scheme must be obtained from BAS@Toronto.ca and be included on project shop drawings (specifically the BAS network architecture diagrams) prior to installation. Buildings without approved schemes shall not exist on the City WAN.
- 8.6.9 BAS shall transfer data between controllers on a stand-alone BAS network. One (1) data drop per building will be provided to establish connection to central server. Should back end programming and configuration be inaccessible via this one (1) data drop, an additional data drop will be provided to allow City BAS Team to communicate to the base building control system using manufacturer software tools.
- 8.6.10 Access to City central servers will not be provided during construction. Database and graphics are merged with central server after project deficiency lists have been cleared (including graphics deficiencies). This merging must be coordinated with the application

- 8.6.11 The City Ethernet connection shall be fully segregated and isolated from the BAS LAN via the secondary BC Ethernet port. A City static IP address will be provided by Technical Services Division (TSD) for this connection. The City's divisional project manager or designate will coordinate this request.

9.0 COMMUNICATION

- 9.1 Service Port. Each controller shall provide a service communication port for connection to a Portable Operator's Terminal. Connection shall be extended to space temperature sensor ports where shown on drawings.
- 9.2 Signal Management. BC and ASC operating systems shall manage input and output communication signals to allow distributed controllers to share real and virtual object information and to allow for central monitoring and alarms.
- 9.3 Data Sharing. Each BC and AAC shall share data as required with each networked BC and AAC.
- 9.4 Stand-Alone Operation. Each piece of equipment specified in the sequence of operation shall be controlled by a single controller to provide stand-alone control in the event of communication failure. All I/O points specified for a piece of equipment shall be integral to its controller. Provide stable and reliable stand-alone control using default values or other method for values normally read over the network.

10.0 ENVIRONMENT

Controller hardware shall be suitable for anticipated ambient conditions.

- 10.1 Controllers used outdoors or in wet ambient conditions shall be mounted in waterproof enclosures and shall be rated for operation at -29°C to 60°C (-20°F to 140°F).
- 10.2 Controllers used in conditioned space shall be mounted in dust-protective enclosures and shall be rated for operation at 0°C to 50°C (32°F to 120°F).

11.0 REAL-TIME CLOCK

- 11.1 Controllers that perform scheduling shall have a real-time clock.

12.0 SERVICEABILITY

- 12.1 Controllers shall have diagnostic LEDs for power, communication, and processor.
- 12.2 Wires shall be connected to a field-removable modular terminal strip or to a termination card connected by a ribbon cable.
- 12.3 Each BC and AAC shall continually check its processor and memory circuit status and shall generate an alarm on abnormal operation. System shall continuously check controller network and generate alarm for each controller that fails to respond.

13.0 MEMORY

- 13.1 Controller memory shall support operating system, database, and programming requirements.

- 13.2 Each BC and AAC shall retain BIOS and application programming for at least 72 hours in the event of power loss.
- 13.3 Each ASC and SA shall use nonvolatile memory and shall retain BIOS and application programming in the event of power loss. System shall automatically download dynamic control parameters following power loss.

14.0 IMMUNITY TO POWER AND NOISE

- 14.1 Controllers shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 1 m (3 ft).

15.0 POWERFAIL RESTART

- 15.1 In the event of the loss of normal power, there shall be an orderly shutdown of all controllers to prevent the loss of database or operating system software. Non-volatile memory shall be incorporated for all controller configuration data, and battery back-up shall be provided to support the real-time clock and all volatile memory for a minimum of 72 hours.
- 15.2 Upon restoration of normal power, the controller shall automatically resume full operation without manual intervention. The controllers shall incorporate random start sequences to ensure a power spike does not result.
- 15.3 Controller memory shall not be lost during a power failure.
- 15.4 The user shall have the capability of loading or re-loading all software via the OWS or the local terminal port.

16.0 DYNAMIC DATA ACCESS

- 16.1 All operator devices, either network resident or connected via dial-up modems, shall have the ability to access all point status and application report data, or execute control functions for any and all other devices via the local area network. Access to data shall be based upon logical identification of building equipment.

17.0 INPUT AND OUTPUT INTERFACE

- 17.1 General. Hard-wire input and output points to BCs, AACs, ASCs, or SAs.
- 17.2 Protection. Shorting an input or output point to itself, to another point, or to ground shall cause no controller damage. Input or output point contact with up to 24 V for any duration shall cause no controller damage.
- 17.3 Binary Inputs. Binary inputs shall monitor the on and off signal from a remote device. Binary inputs shall provide a wetting current of at least 12 mA and shall be protected against contact bounce and noise. Binary inputs shall sense dry contact closure without application of power external to the controller.
- 17.4 Pulse Accumulation Inputs. Pulse accumulation inputs shall conform to binary input requirements and shall accumulate up to 10 pulses per second.
- 17.5 Analog Inputs. Analog inputs shall monitor low-voltage (0-10 Vdc), current (4-20 mA), or resistance (thermistor or RTD) signals. Analog inputs shall be compatible with and field configurable to commonly available sensing devices.
- 17.6 Binary Outputs. Binary outputs shall send an on-or-off signal for on and off control. Building Controller binary outputs shall have three-position (on-off-auto) override switches and status lights. Outputs shall be selectable for normally open or normally closed operation.
- 17.7 Analog Outputs. Analog outputs shall send a modulating 0-10 Vdc or 4-20 mA signal as required to properly control output devices. Each Building Controller analog output shall have a two-position (auto-manual) switch, a manually adjustable potentiometer, and status lights. Analog outputs shall not drift more than 0.4% of range annually.
- 17.8 Tri-State Outputs. Control three-point floating electronic actuators without feedback with tri-state outputs (two coordinated binary outputs). Tri-State outputs may be used to provide analog output control in zone control and terminal unit control applications such as VAV terminal units, duct-mounted heating coils, and zone dampers.
- 17.9 Universal Inputs and Outputs. Inputs and outputs that can be designated as either binary or analog in software shall conform to the provisions of this section that are appropriate for their designated use.

18.0 POWER SUPPLIES AND LINE FILTERING

- 18.1 Power Supplies: Control transformers shall be UL listed. Furnish Class 2 current-limiting type or furnish over-current protection in primary and secondary circuits for Class 2 service in accordance with CEC requirements. Limit connected loads to 80% of rated capacity.
- 18.1.1 DC power supply output shall match output current and voltage requirements. Unit shall be full-wave rectifier type with output ripple of 5.0 mV maximum peak-to-peak. Regulation shall be 1.0% line and load combined, with 100-microsecond response time for 50% load changes.

Unit shall have built-in over-voltage and over-current protection and shall be able to withstand 150% current overload for at least three seconds without trip-out or failure.

18.1.2 Unit shall operate between 0°C and 50°C (32°F and 120°F). EM/RF shall meet FCC Class B and VDE 0871 for Class B and MILSTD 810C for shock and vibration.

18.1.3 Line voltage units shall be UL recognized and CSA listed.

18.2 Power Line Filtering.

18.2.1 Provide internal or external transient voltage and surge suppression for workstations and controllers. Surge protection shall have:

18.2.1.1 Dielectric strength of 1000 V minimum

18.2.1.2 Response time of 10 nanoseconds or less

18.2.1.3 Transverse mode noise attenuation of 65 dB or greater

18.2.1.4 Common mode noise attenuation of 150 dB or greater at 40-100 Hz

19.0 AUXILIARY CONTROL DEVICES

19.1 Electric Damper and Valve Actuators.

19.1.1 Stall Protection. Mechanical or electronic stall protection shall prevent actuator damage throughout the actuator's rotation.

19.1.2 Spring-return Mechanism. Actuators used for power-failure and safety applications shall have an internal mechanical spring-return mechanism or an uninterruptible power supply (UPS).

19.1.3 Signal and Range. Proportional actuators shall accept a 0-10 Vdc or a 0-20 mA control signal and shall have a 2-10 Vdc or 4-20 mA operating range. (Floating motor actuators may be substituted for proportional actuators in terminal unit applications as described in paragraph 16.8)

19.1.4 Wiring. 24 Vac and 24 Vdc actuators shall operate on Class 2 wiring.

19.1.5 Manual Positioning. Operators shall be able to manually position each actuator when the actuator is not powered. Non-spring-return actuators shall have an external manual gear release. Spring-return actuators with more than 7 N·m (60 in.-lb) torque capacity shall have a manual crank.

19.2 Binary Temperature Devices.

19.2.1 Low-Voltage Space Thermostats. Low-voltage space thermostats shall be 24 V, bimetal-operated, mercury-switch type, with adjustable or fixed anticipation heater, concealed setpoint adjustment, 13°C-30°C (55°F-85°F) setpoint range, 1°C (2°F) maximum differential, and vented ABS plastic cover.

19.2.2 Line-Voltage Space Thermostats. Line-voltage space thermostats shall be bimetal-actuated, open-contact type or bellows-actuated, enclosed, snap-switch type or equivalent solid-state type, with heat anticipator, UL listing for electrical rating, concealed setpoint adjustment, 13°C-30°C (55°F-85°F) setpoint range, 1°C (2°F) maximum differential, and vented ABS plastic cover.

- 19.2.3 Low-Limit Thermostats. Low-limit airstream thermostats shall be UL listed, vapor pressure type. Element shall be at least 6 m (20 ft) long. Element shall sense temperature in each 30 cm (1 ft) section and shall respond to lowest sensed temperature. Low-limit thermostat shall be manual reset only.
- 19.3 Temperature Sensors
 - 19.3.1 Type. Temperature sensors shall be Resistance Temperature Device (RTD) or thermistor (10K).
 - 19.3.2 Duct Sensors. Duct sensors shall be single point or averaging. Averaging sensors shall be a minimum of 1.5 m (5 ft) in length per 1 m² (10 ft²) of duct cross-section.
 - 19.3.3 Immersion Sensors. Provide immersion sensors with a separable stainless steel well. Well pressure rating shall be consistent with system pressure it will be immersed in. Well shall withstand pipe design flow velocities.
 - 19.3.4 Space Sensors. Space sensors shall have setpoint adjustment, override switch, display, and communication port.
 - 19.3.5 Differential Sensors. Provide matched sensors for differential temperature measurement.
- 19.4 Humidity Sensors.
 - 19.4.1 Differential Sensors. Provide matched sensors for differential temperature measurement.
 - 19.4.2 Duct and room sensors shall have a sensing range of 20%-80%.
 - 19.4.3 Duct sensors shall have a sampling chamber.
 - 19.4.4 Outdoor air humidity sensors shall have a sensing range of 20%-95% RH and shall be suitable for ambient conditions of 40°C-75°C (40°F-170°F).
 - 19.4.5 Humidity sensors shall not drift more than 1% of full scale annually.
- 19.5 Flow Switches. Flow-proving switches shall be paddle (water service only) or differential pressure type (air or water service). Switches shall be UL listed, SPDT snap-acting, and pilot duty rated (125 VA minimum).
 - 19.5.1 Paddle switches shall have adjustable sensitivity and NEMA 1 enclosure unless otherwise specified.
 - 19.5.2 Differential pressure switches shall have scale range and differential suitable for intended application and NEMA 1 enclosure unless otherwise specified.
- 19.6 Relays.
 - 19.6.1 Control Relays. Control relays shall be plug-in type, UL listed, and shall have dust cover and LED "energized" indicator. Contact rating, configuration, and coil voltage shall be suitable for application.
 - 19.6.2 Time Delay Relays. Time delay relays shall be solid-state plug-in type, UL listed, and shall have adjustable time delay. Delay shall be adjustable $\pm 100\%$ from setpoint shown. Contact rating, configuration, and coil voltage shall be suitable for application. Provide NEMA 1 enclosure for relays not installed in local control panel.
- 19.7 Override Timers.
 - 19.7.1 Unless implemented in control software, override timers shall be spring-wound line voltage, UL Listed, with contact rating and configuration required by application. Provide 0-6 hour calibrated dial unless otherwise specified. Flush mount timer on local control panel face or where shown.

19.8 Current Transmitters.

19.8.1 AC current transmitters shall be self-powered, combination split-core current transformer type with built-in rectifier and high-gain servo amplifier with 4-20 mA two-wire output. Full-scale unit ranges shall be 10 A, 20 A, 50 A, 100 A, 150 A, and 200 A, with internal zero and span adjustment. Unit accuracy shall be $\pm 1\%$ full-scale at 500 ohm maximum burden.

19.8.2 Transmitter shall meet or exceed ANSI/ISA S50.1 requirements and shall be UL/CSA recognized.

19.8.3 Unit shall be split-core type for clamp-on installation on existing wiring.

19.9 Current Transformers.

19.9.1 AC current transformers shall be UL/CSA recognized and shall be completely encased (except for terminals) in approved plastic material.

19.9.2 Transformers shall be available in various current ratios and shall be selected for $\pm 1\%$ accuracy at 5 A full-scale output.

19.9.3 Use fixed-core transformers for new wiring installation and split-core transformers for existing wiring installation.

19.10 Voltage Transmitters.

19.10.1 AC voltage transmitters shall be self-powered single-loop (two-wire) type, 4-20 mA output with zero and span adjustment.

19.10.2 Adjustable full-scale unit ranges shall be 100-130 Vac, 200-250 Vac, 250-330 Vac, and 400-600 Vac. Unit accuracy shall be $\pm 1\%$ full-scale at 500 ohm maximum burden.

19.10.3 Transmitters shall meet or exceed ANSI/ISA S50.1 requirements and shall be UL/CSA recognized at 600 Vac rating.

19.11 Voltage Transformers.

19.11.1 AC voltage transformers shall be UL/CSA recognized, 600 Vac rated, and shall have built-in fuse protection.

19.11.2 Transformers shall be suitable for ambient temperatures of 4°C-55°C (40°F-130°F) and shall provide $\pm 0.5\%$ accuracy at 24 Vac and 5 VA load.

19.11.3 Windings (except for terminals) shall be completely enclosed with metal or plastic.

19.12 Power Monitors.

19.12.1 Power monitors shall be three-phase type and shall have three-phase disconnect and shorting switch assembly, UL listed voltage transformers, and UL listed split-core current transformers.

19.12.2 Power monitors shall provide selectable output: rate pulse for kWh reading or 4-20 mA for kW reading. Power monitors shall operate with 5 A current inputs and maximum error of $\pm 2\%$ at 1.0 power factor or $\pm 2.5\%$ at 0.5 power factor.

19.13 Current Switches.

19.13.1 Current-operated switches shall be self-powered, solid-state with adjustable trip current. Select switches to match application current and DDC system output requirements.

19.14 Pressure Transducers.

- 19.14.1 Transducers shall have linear output signal and field-adjustable zero and span.
- 19.14.2 Continuous operating conditions of positive or negative pressure 50% greater than calibrated span shall not damage transducer sensing elements.
- 19.14.3 Water pressure transducer diaphragm shall be stainless steel with minimum proof pressure of 1000 kPa (150 psi). Transducer shall have 4-20 mA output, suitable mounting provisions, and block and bleed valves.
- 19.14.4 Water differential pressure transducer diaphragm shall be stainless steel with minimum proof pressure of 1000 kPa (150 psi). Over-range limit (differential pressure) and maximum static pressure shall be 2000 kPa (300 psi.) Transducer shall have 4-20 mA output, suitable mounting provisions, and 5-valve manifold.
- 19.15 Differential Pressure Switches. Differential pressure switches (air or water service) shall be UL listed, SPDT snap-acting, pilot duty rated (125 VA minimum) and shall have scale range and differential suitable for intended application and NEMA 1 enclosure unless otherwise specified.

20.0 NETWORKS

- 20.1 BAS contractor to coordinate with the City's IT department for the connections to the City's Network.
- 20.2 Design for the Network LAN (BC LAN) shall include the following provisions:
 - 20.2.1 Provide access to the BC LAN from a remote location, via the Intranet.
 - 20.2.2 The network LAN shall utilize BACnet/IP (ASHRAE standard SPC-135A-2004 - Annex L) for communication between BCs. Manufacturer specific proprietary protocols, gateways, or protocol converters are not acceptable for this project. The OWS shall communicate to the BCs utilizing standard Ethernet to IEEE 802.3 Standards.
 - 20.2.3 High-speed data transfer rates for alarm reporting, quick report generation from multiple controllers and upload/download efficiency between network devices.
 - 20.2.4 Detection and accommodation of single or multiple failures of workstations, controller panels and the network media. The network shall include provisions for automatically reconfiguring itself to allow all operational equipment to perform their designated functions as effectively as possible in the event of single or multiple failures.
 - 20.2.5 Message and alarm buffering to prevent information from being lost.
 - 20.2.6 Error detection, correction, and retransmission to guarantee data integrity.
 - 20.2.7 Default device definition to prevent loss of alarms or data, and ensure alarms are reported as quickly as possible in the event an operator device does not respond.
 - 20.2.8 Commonly available, multiple sourced, networking components shall be used to allow the system to coexist with other networking applications such as office automation. ETHERNET is the only acceptable technology.
 - 20.2.9 Synchronization of the real-time clocks in all BC panels shall be provided.
 - 20.2.10 The BC LAN shall be a 100 Megabits/sec Ethernet network supporting BACnet, Java, XML, HTTP, and CORBA IIOP for maximum flexibility for integration of building data with enterprise information systems and providing support for multiple Building Controllers (BCs), user workstations and where specified, a local server. Local area network minimum physical and media access requirements:
 - 20.2.10.1 Ethernet; IEEE standard 802.3

- 20.2.10.2 Cable; 100 Base-T, UTP-8 wire, category5
- 20.2.10.3 Minimum throughput; 10 Mbps, with ability to increase to 100 Mbps

20.2.11 Provide access to the BC LAN via a Wireless Application Protocol (WAP) device as well. Through this connection the BC LAN will provide authorized staff with the ability to monitor and control the BAS from any location within the City network through a web browser, cellular phone, pager, WebPads, or PDA. (Pocket Computer).

21.0 SERVER FUNCTION

21.1 Local connections shall be via an Ethernet LAN.

21.2 It shall be possible to provide access to all Building Control Units (BC) via a single connection to the server. In this configuration, each Building Control Unit (BC) can be accessed from an Operator Workstation (OWS) using a standard Web browser by connecting to the BAS LAN. The server shall provide the following functions, as a minimum:

- 21.2.1 Global Data Access: The server shall provide complete access to distributed data defined anywhere in the system.
- 21.2.2 Distributed Control: The server shall provide the ability to execute global control strategies based on control and data objects in any Building Control Unit (BC) in the network, local or remote.
- 21.2.3 The server shall include a master clock service for its subsystems and provide time synchronization for all Building Control Units (BC).
- 21.2.4 The server shall accept time synchronization messages from trusted precision Atomic Clock Internet sites and update its master clock based on this data.
- 21.2.5 The server shall provide scheduling for all Building Control Units and their underlying field control devices.
- 21.2.6 The server shall provide demand limiting that operates across all Building Control Units. The server must be capable of multiple demand programs for sites with multiple meters and or multiple sources of energy. Each demand program shall be capable of supporting separate demand shedding lists for effective demand control.
- 21.2.7 The server shall implement the BACnet Command Prioritization scheme (16 levels) for safe and effective contention resolution of all commands issued to Building Control Units. Systems not employing this prioritization shall not be accepted.
- 21.2.8 Each Building Control Unit supported by the server shall have the ability to archive its log data, alarm data and database to the server, automatically. Archiving options shall be user-defined including archive time and archive frequency.
- 21.2.9 The server shall provide central alarm management for all Building Control Units supported by the server. Alarm management shall include:
 - 21.2.10 Routing of alarms to display, printer, email and pagers
 - 21.2.11 View and acknowledge alarms
 - 21.2.12 Query alarm logs based on user-defined parameters
- 21.2.13 The server shall provide central management of log data for all Network Control Units supported by the server. Log data shall include process logs, runtime and event counter logs, audit logs and error logs. Log data management shall include:
 - 21.2.14 Viewing and printing log data
 - 21.2.15 Exporting log data to other software applications
 - 21.2.16 Query log data based on user-defined parameters
- 21.2.17 Minimum BACnet features supported are
 - Standard BACnet Objects (Analog In/Out/Value, BinaryInput/Output/Value, Multi-State -- Input/Output/Value, Schedule(export), Calendar(export), Trend(Export), Device).
 - Segmented Capability (Segmented Request-Segmented Response).
 - Application Services (Read Property, Read Property Multiple, Write Property, Write Property Multiple, Confirmed Event, Notification, Acknowledge Alarm, Get Alarm Summary Who-has, I-have, Who-is, I-am, Subscribe COV, Confirmed COV notification, Unconfirmed COV notification).

-BACnet Broadcast Management

22.0 SCOPE OF WORK

- 22.1 The work covered by this specification and related sections consists of providing shop drawings, equipment, labour, materials, engineering, technical supervision, and transportation as required to furnish and install a fully operational BAS to monitor and control the facilities listed herein, and as required to provide the operation specified in strict accordance with these documents, and subject to the terms and conditions of the contract. The work in general consists of but is not limited to, the following:
 - 22.1.1 The preparation of submittals and provision of all related services.
 - 22.1.2 Operator workstations located as listed in the specifications (**OWS will be provided by the City's IT, SEE PART 2, SECTION 1.1.4).**
 - 22.1.3 Furnish and install all controllers to achieve system operation, any control devices, conduit and wiring, in the facility as required to provide the operation specified.
 - 22.1.4 Furnish and load all software required to implement a complete and operational BAS.
 - 22.1.5 Furnish complete operating and maintenance manuals and field training of operators, programmers, and maintenance personnel.
 - 22.1.6 Perform acceptance tests, commissioning or re-commissioning as indicated.
 - 22.1.7 Provide full documentation for all application software and equipment.
 - 22.1.8 Miscellaneous work as indicated in these specifications.

23.0 PERMITS, FEES AND CODES

- 23.1 Apply for, obtain and pay for all permits, licenses, inspections, examinations and fees required. Also submit, if required, information and other data that may be obtained from the Engineer. Should the authorities require the information on specific forms, fill in these forms by transcribing the information provided by the Engineer.
- 23.2 BAS contractor shall obtain and pay for the police clearance certificates if required for the project.
- 23.3 Arrange for inspection of all work by the authorities having jurisdiction over the Work. On completion of the Work, present to the Engineer the final unconditional certificate of approval of the inspecting authorities.
- 23.4 Comply with the requirements of the latest edition of the applicable ULC or CSA standards, the requirements of the Authorities, Federal, Provincial/Territorial and Municipal Codes, the applicable standards of ULC and all other authorities having jurisdiction. These Codes and Regulations constitute an integral part of these Specifications.
- 23.5 Where there is no alternative to supply equipment which is CSA certified, submit such equipment to the local electrical authority for special inspection and obtain approval before delivery of equipment to site.
- 23.6 In case of conflict, applicable Codes take precedence over the Contract Documents. In no instance reduce the standard or Scope of Work or intent established by the Drawings and Specifications by applying any of the Codes referred to herein.
- 23.7 Before starting any work, submit the required number of copies of documentation to the authorities for their approval and comments. Comply with any changes requested as part of the Contract, but notify the

Engineer immediately of such changes, for proper processing of these requirements. Prepare and furnish any additional drawings, details or information as may be required.

24.0 COORDINATION

- 24.1 All work shall be performed at times acceptable to the Engineer/Construction Manager. Provide work schedule at the start of the job for the approval of the Engineer/Construction Manager. Schedule shall show when all staff and sub-contractors shall be on-site.
- 24.2 Organize all sub-contractors and ensure that they maintain the schedule.
- 24.3 Full cooperation shall be shown with other sub-contractors to facilitate installations and to avoid delays in carrying out the work.
- 24.4 Notify Engineer/Construction Manager of any changes to the schedule. Send any schedule changes and weekly progress reports via fax to Engineer/Construction Manager.
- 24.5 Where, in the judgment of the Engineer/Construction Manager, the work could disrupt the normal operations in or around the building, contractor shall schedule work to eliminate or minimize interference, subject to owner's approval.
- 24.6 When connecting to the existing systems, advise the Engineer/Construction Manager and obtain permission to so. Perform work at a time acceptable to the Engineer/Construction Manager and Owner.

24.0 SUPERVISION OF PERSONNEL

- 24.1 Maintain at this building qualified personnel and supporting staff with proven experience in erecting, supervising, testing, and adjusting projects of comparable nature and complexity.
- 24.2 Supervisory personnel and their qualifications are subject to the approval of the Owner.
- 24.3 All personnel working on-site shall sign in as required by the Owner and shall wear company identification.
- 24.4 When requested and for whatever reason, remove personnel and/or support staff from project. Take immediate action. Contractors and subcontractors may require police clearance.

25.0 ELECTRICAL WORK AND SAFETY REQUIREMENTS

- 25.1 Control and interlock wiring and installation shall comply with national and local electrical codes, and manufacturer's recommendations.
- 25.2 CEC Class 1 (line voltage) wiring shall be UL listed in approved raceway as specified by CEC.
- 25.3 Low-voltage wiring shall meet CEC Class 2 requirements. Subfuse low-voltage power circuits as required to meet Class 2 current limit.
- 25.4 CEC Class 2 (current-limited) wires not in raceway but in concealed and accessible locations such as return air plenums shall be UL listed for the intended application.
- 25.5 Install wiring in raceway where subject to mechanical damage and at levels below 3 m (10ft) in mechanical, electrical, or service rooms.
- 25.6 Do not install Class 2 wiring in raceway containing Class 1 wiring. Boxes and panels containing high voltage wiring and equipment may not be used for low-voltage wiring except for the purpose of interfacing the two (e.g., relays and transformers).

- 25.7 Install Class 1 and Class 2 wiring in separate raceways. Boxes and panels containing high-voltage wiring and equipment shall not be used for low-voltage wiring except for the purpose of interfacing the two through relays and transformers.
- 25.8 Do not install wiring in raceway containing tubing.
- 25.9 Run exposed Class 2 wiring parallel to a surface or perpendicular to it and tie neatly at 3 m (10 ft) intervals.
- 25.10 Use structural members to support or anchor plenum cables without raceway. Do not use ductwork, electrical raceways, piping, or ceiling suspension systems to support or anchor cables.
- 25.11 Secure raceways with raceway clamps fastened to structure and spaced according to code requirements. Raceways and pull boxes shall not be hung on or attached to ductwork, electrical raceways, piping, or ceiling suspension systems.
- 25.12 Size raceway and select wire size and type in accordance with manufacturer's recommendations and CEC requirements.
- 25.13 Include one pull string in each raceway 2.5 cm (1 in.) or larger.
- 25.14 Use color-coded conductors throughout.
- 25.15 Locate control and status relays in designated enclosures only. Do not install control and status relays in packaged equipment control panel enclosures containing Class 1 starters.
- 25.16 Conceal raceways except within mechanical, electrical, or service rooms. Maintain minimum clearance of 15 cm (6 in.) between raceway and high-temperature equipment such as steam pipes or flues.
- 25.17 Install insulated bushings on raceway ends and enclosure openings. Seal top ends of vertical raceways.
- 25.18 Terminate control and interlock wiring related to the work of this section. Maintain at the job site updated (as-built) wiring diagrams that identify terminations.
- 25.19 Flexible metal raceways and liquid-tight flexible metal raceways shall not exceed 1 m (3 ft) in length and shall be supported at each end. Do not use flexible metal raceway less than ½ in. electrical trade size. Use liquid-tight flexible metal raceways in areas exposed to moisture including chiller and boiler rooms.
- 25.20 Install raceway rigidly, support adequately, ream at both ends, and leave clean and free of obstructions. Join raceway sections with couplings and according to code. Make terminations in boxes with fittings. Make terminations not in boxes with bushings.
- 25.21 All equipment and systems installed under this Contract shall be grounded, isolated, or conditioned as required to permit equipment to continue to function normally, without interruption, in the event of radio frequency interference (RFI), electromagnetic interference (EMI), power surges/dips or other electrical anomalies.
- 25.22 It shall be the responsibility of the Contractor or his Sub-contractor to ensure that any coring of holes through the walls or floors will not penetrate existing conduits, cables or mechanical equipment in or under the floor slabs or walls. He shall be responsible to take any and all action as deemed necessary by the Project Manager to correct any such penetrations at his cost. No coring shall be undertaken unless the Project Manager gives permission. Scan walls and floors prior to core drilling to identify hidden piping. Ensure that water does not flow into equipment and below floors. Waterproof and fire stop all penetrations.

26.0 COMMUNICATION WIRING

- 26.1 Communication wiring shall be low-voltage Class 2 wiring and shall comply with Article 25 (Electrical Work).
- 26.2 Install communication wiring in separate raceways and enclosures from other Class 2 wiring.

- 26.3 During installation do not exceed maximum cable pulling, tension, or bend radius specified by the cable manufacturer.
- 26.4 Verify entire network's integrity following cable installation using appropriate tests for each cable.
- 26.5 Install lightning arrestor according to manufacturer's recommendations between cable and ground where a cable enters or exits a building.
- 26.6 Each run of communication wiring shall be a continuous length without splices when that length is commercially available. Runs longer than commercially available lengths shall have as few splices as possible using commercially available lengths.
- 26.7 Label communication wiring to indicate origination and destination.
- 26.8 Ground coaxial cable according to OEC regulations article on "Communications Circuits, Cable, and Protector Grounding."

27.0 LOCKABLE PANELS

- 27.1 Indoor control panels shall be fully enclosed NEMA 1 construction with hinged door key-lock latch and removable sub-panels. A common key shall open each control panel and sub-panel.
- 27.2 Prewire internal and face-mounted device connections with color-coded stranded conductors tie-wrapped or neatly installed in plastic troughs. Field connection terminals shall be UL listed for 600 V service, individually identified per control and interlock drawings, with adequate clearance for field wiring.
- 27.3 Each local panel shall have a control power source power switch (on-off) with overcurrent protection.

28.0 WARNING LABELS

- 28.1 All Controller panels Affix permanent warning labels to equipment that can be automatically started by the control system.
1. Labels shall use white lettering (12-point type or larger) on a red background.
 2. Warning labels shall read as follows.

CAUTION

This equipment is operating under automatic control and may start or stop at any time without warning. Switch disconnect to "Off" position before servicing.

- B. Affix permanent warning labels to motor starters and control panels that are connected to multiple power sources utilizing separate disconnects.

1. Labels shall use white lettering (12-point type or larger) on a red background.
2. Warning labels shall read as follows.

CAUTION

This equipment is fed from more than one power source with separate disconnects. Disconnect all power sources before servicing.

29.0 IDENTIFICATION OF HARDWARE AND WIRING

- 29.1 Label wiring and cabling, including that within factory-fabricated panels, with control system address or termination number at each end within 5 cm (2 in.) of termination.
- 29.2 Permanently label or code each point of field terminal strips to show instrument or item served.
- 29.3 Label control panels with minimum 1 cm (½ in.) letters on laminated plastic nameplates.
- 29.4 Label each control component with a permanent label. Label plug-in components such that label remains stationary during component replacement (lamacoids).
- 29.5 Label room sensors related to terminal boxes or valves with nameplates (lamacoids).
- 29.6 Manufacturers' nameplates and UL or CSA labels shall be visible and legible after equipment is installed.
- 29.7 Label identifiers shall match record documents.
- 29.8 Insert laminated points list in the control panel

30.0 PRELIMINARY DESIGN REVIEW

- 30.1 The BAS contractor shall submit a preliminary design document for review. This document shall contain the following information:
 - 30.1.1 Provide a description of the proposed system along with a system architecture diagram with the intention of showing the contractors solution to meet this specification.
 - 30.1.2 Provide product data sheets and a technical description of BC, AAC, ASC hardware required to meet specifications listed herein.
 - 30.1.3 Provide product brochures and a technical description of the Server, Operator Workstation, and Building Control Unit (BC) software required to meet this specification. Provide a description of software programs included.
 - 30.1.4 Open Protocols - For all hardware Building Controllers, Advanced Application Controllers (AAC) and Advanced Specific Controllers (ASC), provide BACnet Interoperability Building Blocks BIBBs certification. Provide complete description and documentation of any proprietary services and/or objects where used in the system.
 - 30.1.5 Provide a description and samples of Operator Workstation graphics and reports.
 - 30.1.6 Provide an overview of the BAS contractor's local/branch organization, local staff, recent related project experience with references, and local service capabilities.
 - 30.1.7 Provide information on the BAS contractors project team including project organization, project manager, project engineer, programmers, project team resumes, and location of staff.

31.0 DRAWING REQUIREMENTS

- 31.1.1 Within 45 days of award of contract and before start of construction, submit 3 hard copies and 1 soft copy of manufacturers information and shop drawings. Soft copy to be in AutoCAD or VISIO and WordPerfect or Word formats (latest versions) structured using menu format for easy loading and retrieval on the OWS.
- 31.1.2 Manufacturer's Data: Provide in completely coordinated and indexed package to assure full compliance with the contract requirements. Piecemeal submittal of data is not acceptable and such submittals will be returned without review. Information shall be submitted for all material and equipment the contractor proposes to furnish under terms of this contract work. Arrange the

submittals in the same sequence as these specifications and reference at the upper right-hand corner the particular specification provision for which each submittal is intended. Submittals for each manufactured item shall be manufacturer's descriptive literature (equipment specification), equipment drawings, diagrams, performance and characteristic curves, and catalog cuts, and shall include the manufacturer's name, trade name, catalog model or number, nameplate data, size layout dimension, capacity, specification reference, applicable specification references, and all other information necessary to establish contract compliance.

31.1.3 Shop drawings: Provide in completely coordinated and indexed package:

31.1.3.1Wiring and piping diagrams.

31.1.3.2Control schematics with narrative description and control descriptive logic fully showing and describing operation and/or manual procedures available to operating personnel to achieve proper operation of the building, including under complete failure of the BAS.

31.1.3.3Shop drawings for each input/output point showing all information associated with each particular point including sensing element type and location; details of associated field wiring schematics and schedules; point address; software and programming details (CDL's) associated with each point; and manufacturer's recommended installation instructions and procedures for each type of sensor and/or transmitter.

31.1.3.4Detailed system architecture showing all points associated with each controller, controller locations, and describing the **spare points capacity** at each controller and BAS LAN.

31.1.3.5Each BC shall contain a minimum of 20% spare resource capacity. The BC shall provide a throughput capable of transmitting all BAS LAN data connected to it within 10 seconds.

31.1.3.6Each AAC and ASC shall have a minimum of 10% spare capacity for each point type for future point connection. Provide all processors, power supplies and communication controllers complete so that the implementation of a point only requires the addition of the appropriate point input/output termination module and wiring. As a minimum, provide one of each type of point available on the controller.

31.1.3.7Specification sheets for each item including manufacturers descriptive literature, drawings, diagrams, performance and characteristic curves, manufacturer and model number, size, layout, dimensions, capacity, etc

31.1.3.8Colour graphic displays detailing hierarchical structure of facility, including floor plans, with multi-level penetration to equipment level.

32.0 START-UP AND CHECKOUT

City's BAS Project Manager shall be present during the Start-Up and Checkout- FOR FACILITIES MANAGEMENT PROJECTS ONLY, FOR OTHER DIVISIONS THIS IS OPTIONAL

32.1 This work shall include field testing and adjustment of the complete BAS, and on-site final operational acceptance test of the complete operational BAS. The Engineer shall be advised at least 14 days in advance of the dates of all tests and may attend at his discretion. If the Engineer witnesses the test, such tests shall be subject to his approval prior to the release of equipment. If the Engineer elects not to witness the tests, the contractor shall provide performance certification. Acceptance of tests by the Engineer and Project Manager shall not relieve the contractor of responsibility for the complete system meeting the requirements of these specifications after installation.

32.2 Static testing:

32.2.1 Static testing shall include point-by-point testing of the entire system and completion of Component Test Sheets. The contractor shall forward proposed Test Sheets at the shop drawing review stage. These Component Test Sheets shall be completed during the contractor's own testing and verification procedure that is done prior to the request for a final inspection. The completed Component Test Sheets shall then be returned to the Engineer for review and approval. The Engineer may repeat a random sampling of at least 50% of the tests during the Engineers commissioning procedure to corroborate their accuracy. The Contractor shall be on site with test equipment during this verification process. The test procedures shall include the following.

32.2.1.1 Digital input component testsheet:

32.2.1.1.1 DI status shall be verified at the POT and OWS for ON and OFF status.

32.2.1.1.2 All digital alarm inputs shall be proven using actual field conditions where possible or be jumpered at the field device for testing with the approval of the Engineer.

32.2.1.2 Digital output component testsheet:

32.2.1.2.1 Status to be verified at the equipment location. Verification at the OWS shall be completed for ON and OFF status, software DISABLE indicator and OVERRIDEN indicator

32.2.1.3 Analog input component testsheet:

32.2.1.3.1 All temperature sensors shall be calibrated using a hand held meter with equal or better accuracy.

32.2.1.3.2 Selected temperature sensors chosen by the Engineer shall be verified by spraying with a cold spray or other means to ensure response and to test the low temperature alarm condition.

32.2.1.3.3 All pressure sensing devices and analog output feedback shall be verified using a device with equal or better accuracy to ensure correct calibration.

32.2.1.3.4 All humidity sensing devices must be verified using a recently calibrated device with equal or better accuracy

32.2.1.3.5 All CTs shall be set to accurately reflect motor status, including removing belts on belt driven equipment

32.2.1.3.6 All other devices shall be verified using appropriate devices of equal or better accuracy

32.2.1.3.7 Adjust span on feedback devices so that input matches the end device

32.2.2 Analog output component testsheet:

32.2.2.1 AI points shall be tested by sending a command from the PWS or OWS to incrementally stroke the field device from full CLOSED to full OPEN and measuring the signal at the field device. The increments of the test shall be no larger than 10% of the output span.

32.2.2.2 The AO feedback requirement shall also be tested by failing the field device and verifying that the alarm registers

32.2.2.3 Each output shall be exercised over the full output capability of the panel

32.2.2.4 Field device hysteresis shall be measured at a minimum of three output levels for each direction of travel. Output increments shall not exceed 2% of span for this test

33.0 STANDARDS COMPLIANCE

33.1 Where materials or equipment are specified to conform to requirements of the standards of organizations, such as the Canadian Standards Association (CSA) that use a label or listing as method of indicating compliance, proof of such conformance shall be submitted and approved, indexed and cross-referenced with the specification. The label or listing of the specified organization will be acceptable evidence. In lieu of the label or listing, the contractor shall submit a certificate from a testing organization adequately equipped and competent to perform such services, and approved by the Engineer, stating that the item has been tested in accordance with the specified organization's test methods and that the item conforms to the specified organization's standard or code. For materials whose compliance with organizational standards or specifications is not regulated by an organization using its own listing or label as proof of compliance, a certificate from the manufacturer shall be furnished to the Engineer stating that the material complies with the applicable referenced standard or specification.

34.0 FINAL ACCEPTANCE

34.1 Final acceptance shall commence only after satisfactory completion of start-up, verification of performance and the 30-day test period described earlier. When the Contractor has satisfied himself as to proper system operation he shall advise the BAS Commissioning Engineer/Consultant to establish a date for Final Acceptance. This will involve a point-by-point check of all hardware and software items including graphics and displayed data, as well as performing tasks as directed.

34.2 Supply 2-way radios and all test equipment as previously specified. Have on-site technical personnel capable of re-calibrating all field hardware and modifying software.

34.3 Test each system independently and then in unison with other related systems. Test weather sensitive systems twice- once near winter design conditions and again near summer design conditions.

34.4 Optimize operation and performance of each system. Test full-scale emergency operation and integrity of smoke management and other life safety systems.

34.5 Demonstrate to the Engineer the operation of each system including sequence of operations in regular and emergency modes, under all normal and emergency conditions, start-up, shut-down, interlocks, and lock-outs.

34.6 Upon completion of the testing submit a report to the Engineer to summarize all testing.

35.0 DOCUMENTATION

35.1 Documentation shall consist of 4 hard copies and one soft copy for all information described below

35.2 The final documentation package shall include:

35.2.1 Hard and soft copies of all control drawings (As-Builts).

35.2.2 Manufacturer's technical data sheets for all hardware and software

35.2.3 Factory operating and maintenance manuals with any customization required

35.2.4 Soft copies of programming and front-end software and each controller's database. Hard copy output of programming is not necessary

- 35.2.5 Provide clear, concise, typewritten and soft copy descriptions of all control sequences in the working language.
- 35.2.6 Soft copy text files shall be in MS-Word.
- 35.3 Each instruction and reference manual shall be bound in hardback, 3 ring, binders or an approved equivalent shall be provided to the Engineer. Binders to be no more than 2/3 full. Each binder to contain index to full volume. One complete set of manuals shall be furnished prior to the time that the system or equipment tests are performed, and the remaining manuals shall be furnished at acceptance. The identification of each manual's contents shall be inscribed on the cover and spine. The manuals shall include the names, addresses and telephone numbers of each subcontractor installing equipment systems and of the local representatives for each item of equipment and each system. The manuals shall have a table of contents and be assembled to conform to the table of contents with the tab sheets placed before instructions covering the subject. Additionally, each manual shall contain a comprehensive index of all manuals submitted in accordance with this paragraph. Manuals and specifications shall be furnished which provide full and complete coverage of the following subjects:
- 35.4 Operational Requirements: This document shall describe in concise terms, all the functional and operational requirements for the system and its functions that have been implemented. It shall be written using common terminology for building operation staff and shall not presume knowledge of digital computers, electronics or in-depth control theory.
- 35.5 System Operation: Complete step by step procedures for operation of the system, including required actions at each operator station; operation of computer peripherals; input and output formats; and emergency, alarm and failure recovery. Step-by-step instructions for system startup, back-up equipment operation, and execution of all system functions and operating modes shall be provided.
- 35.6 Maintenance: Documentation of all maintenance procedures for all system components including inspection, periodic preventive maintenance, fault diagnosis, and repair or replacement of defective module. This shall include calibration, maintenance, and repair or replacement of all system hardware.
- 35.7 Test Procedures and Reports: The test implementation shall be recorded with a description of the test exercise script of events and documented as test procedures. A provision for the measurement or observation of results, based on the previously published test specification, forms the test reports. The procedures record and the results of these exercises shall be conveniently bound and documented together.
- 35.8 Configuration Control: Documentation of the basic system design and configuration with provisions and procedures for planning, implementing, and recording any hardware or software modifications required during the installation, test, and operating lifetime of the system. This shall include all information required to ensure necessary coordination of hardware and software changes, data link or message format/content changes, and sensor or control changes in the event system modification are required, and to fully document such new system configurations.

36.0 TRAINING

- 36.1 The Contractor shall provide the services of competent instructors who will provide instruction to designated personnel in the adjustment, operation and maintenance, including pertinent safety requirements, of the equipment and system specified. The training shall be oriented towards the system installed rather than being a general "canned" training course. Instructors shall be thoroughly familiar with all aspects of the subject matter they are to teach. The number of person-days (eight hours) of instruction furnished shall be as specified below as a minimum. A training manual shall be provided for each trainee that describes in detail the data included in each training program.
- 36.2 All equipment and material required for classroom training shall be provided by the contractor. A person-week shall be considered as 37.5 hours, 8:00 am to 12:00 noon, and 12:30 pm to 4:30 pm Monday through Friday. Provide 5 days of training as specified herein.

36.3 Training shall enable operators to accomplish the following objectives:

- 36.3.1 Proficiently operate system
- 36.3.2 Understand control system design and configuration
- 36.3.3 Create and change system graphics
- 36.3.4 Create, delete, and modify alarms, including configuring alarm reactions
- 36.3.5 Configure and run reports
- 36.3.6 Add, remove, and modify system's physical points
- 36.3.7 Create, modify, and delete application programming
- 36.3.8 Add a new controller to system
- 36.3.9 Download firmware and advanced applications programming to a controller
- 36.3.10 Configure and calibrate I/O points
- 36.3.11 Maintain software and prepare backups
- 36.3.12 Understand DDC system components
- 36.3.13 Understand system operation, including DDC system control and optimizing routines (algorithms)
- 36.3.14 Operate workstation and peripherals
- 36.3.15 Log on and off system
- 36.3.16 Access graphics, point reports, and logs
- 36.3.17 Adjust and change system setpoints, time schedules, and holiday schedules
- 36.3.18 Recognize common HVAC system malfunctions by observing system graphics, trend graphs, and other system tools
- 36.3.19 Access data from DDC controllers
- 36.3.20 Add new users and understand password security procedures

37.0 WARRANTY

- 37.1 Provide warranty certificates showing the name of the firm giving the warranty, dated from the issuance of the Certificate of Substantial Performance and acknowledged on specific equipment and systems.
- 37.2 Include these certificates with the Operation and Maintenance Manual in the appropriate sections.
- 37.3 Contractor shall give a minimum two-year warranty for parts and labor on all equipment and materials installed and shall select materials and equipment where the Manufacturer gives the same warranty arrangements. Warranty shall commence on the date of the Engineers issuance of the Certificate of Substantial Completion.
- 37.4 Provide a warranty as indicated in 38.0 - Maintenance/Service.

- 37.5 The Contractor shall agree to make good at his own expense any equipment that fails to operate due to poor workmanship, manufacturing defect or improper installation. Any repairs shall be made at the convenience of the Engineer during normal working hours, unless deemed an emergency.
- 37.6 Provide upgrades to all software or all panel firmware issued during the warranty period at no charge to Owner.

38.0 MAINTENANCE/SERVICE

*BAS contractor to show the price of service contract as separate line item.
Applicable to New System Installations OR Major overhaul of existing BAS system/s*

- 38.1 Provide warranty in accordance with the warranty section of this specification. In addition provide scheduled maintenance and service during the warranty period on all control system apparatus including but not limited to valves, dampers, linkages, control panels, interfaces, direct digital control systems, OWS, Server, BC, AAC, ASC, Software and application programs.
- 38.2 Scheduled preventive maintenance inspections will provide those services required to maintain the system at maximum performance and reliability levels and may include the following:
- 38.3 Analyze, adjust, calibrate the applicable temperature sensors, humidity sensors, diagnostic LEDs, printers, power supplies, work stations, controllers, modems, input/output points, communication cabling, transmitters, transducers, UPS for the BAS system.
- 38.4 Conduct inspections and thorough preventive maintenance routine on each piece of covered equipment. In addition, make tests and adjustments to ensure efficient and reliable operation of other major components.
- 38.5 Examine, clean and calibrate as required sensors, thermostats, humidity controls, temperature controls, pressure controls, relays, damper actuators, instrumentation and accessories directly pertaining to the Building Automation System.
- 38.6 Check and confirm control system sequence of operation to insure optimum system efficiency and economy.
- 38.7 A log of each loop tested and each control sequence verified shall be reviewed with the owner.
- 38.8 All components of the Pneumatics Control System will be serviced according to manufacturer's recommendations during each year of the contract. This will include (but not be limited to) all lubricant changes, filter changes, adjustments, calibrations and cleaning.
- 38.9 The system includes, but is not limited to, the air compressor, air receiver, pressure reducing valves, air dryers and all sensors, controllers, transducers, damper and valve operators, thermostats, pilot positioners, electro-pneumatic switches, linkages and any other pneumatic and electronic devices used to maintain the environmental comfort in the building.
- 38.10 The Contractor will provide preventative maintenance and diagnostic inspections to all electronic system components on a frequency established by manufacturer's recommendations, component age and condition and discussion with the Supervisor of Operations responsible for the site.
- 38.11 Provide a fully trained BAS service technician and a Pneumatic fitter (Required for Pneumatic/DDC system) a minimum of one day per month (8 hours for DDC technician and 8 hours for pneumatic fitter) during the warranty period to provide the preventive maintenance and service described above. Provide

written reports to the owner outlining the work performed. Allow for 12 annual visits of one day each (24 days total for 2 years) during the warranty period to provide required service. (This may change in accordance with the size of the project).

- 38.12 Provide emergency service for parts and labor on an as needed basis. Response to an emergency call shall be 2 hours maximum on Mon.-Fri. including on holidays and weekends.
- 38.13 Provide remote service diagnostic monitoring from the local office. At the request of the owner, a service diagnostic call will be made to troubleshoot and resolve (if possible) any reported system complaints.
- 38.14 Provide a price for a three-year service agreement based on the above requirements to come in to effect upon the completion of the warranty period. Show this price as OPTION: Service Agreement.