

TECHNICAL SPECIFICATIONS FOR :

PROJECT:

ACCESSIBILITY RENOVATION TO BURNHAMTHORPE PUBLIC SCHOOL

CLIENT:

PEEL DISTRICT SCHOOL BOARD

PROJECT No.:

26105

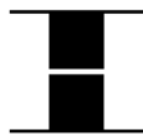
DATE:

MAY 29, 2026

BINDER:

B MECHANICAL

ARCHITECT:



HOSSACK
ARCHITECTURE

105 - 1939 IRONOAK WAY
OAKVILLE, ONTARIO, L6H 3V8
Tel (905) 815-8284 Fax (905) 815-8290

CONSULTANTS & ENGINEERS :



300 York Boulevard, Hamilton, ON L8R 3K8 905-333-9119



23 LESMILL ROAD, UNIT 410,
TORONTO, ON M3B 3P6

SET NUMBER

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MECHANICAL (DIVISIONS 21, 22 & 23)

Section 21 00 00	Mechanical Supplementary Bid Form
Section 22 00 00	Plumbing and Drainage
Section 23 00 10	Mechanical General Requirements
Section 23 00 20	Heating and Air Conditioning
Section 23 00 30	Systems Testing and Balancing
Section 23 00 40	Air Handling and Distribution
Section 23 08 00	Mechanical Commissioning

CONTROLS (DIVISION 25)

Section 25 00 00	Automatic Temperature Controls
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INSTRUCTIONS TO BIDDERS

Complete the Mechanical Supplementary Bid Form in its entirety for perusal and acceptance by the Owner. Submit completed form to the Consultant named hereunder within forty-eight (48) hours of Mechanical Tender closing. Do not submit to Bid Depository.

PROJECT:

BURNHAMTHORPE PUBLIC SCHOOL

ELEVATOR & ACCESSIBLE WASHROOM RENOVATION

3465 GOLDEN ORCHARD DR., MISSISSAUGA, ONT.

TENDER NO.

FOR THE PEEL DISTRICT SCHOOL BOARD

ENGINEER:

**Rybka Ellard Willson Inc.
23 Lesmill Road
Unit 410
Toronto, Ontario
M3B 3P6
(905) 940-3100 - PHONE
(905) 940-2139 - FAX**

FROM: (Contractor's Name, Phone & Fax)

_____	_____
_____	_____

Further to our Bid dated _____, 20_____.

1. SUBCONTRACTORS

I/We enclose herewith a List of Subcontractors to the Mechanical Building Services which is an integral part of the Bid. We agree that the Subcontractors shall not be changed without good reason and permission for same must be obtained from the Owner.

<u>Section of Work</u>	<u>Name</u>
Piping (HVAC)	_____
Sheet Metal	_____
Insulation	_____
Plumbing & Drainage	_____
Others	_____

2. MANUFACTURERS AND SUPPLIERS:

(Refer to Section 23 00 10, Article 2.1 "Standards of Materials".)

I/We enclose herewith a list of Manufacturers and Suppliers to the Mechanical Building Services which is an integral part of the Bid. We hereby agree that the Owner may select from any substitutes that we have offered in our Bid. Our Bid Price is based on the equipment/manufacturers indicated hereunder and we hereby agree that we will not alter the indicated equipment/manufacturers unless specifically authorized by the Owner.

ITEM	BASE BID BASIS OF DESIGN	ACCEPTABLE ALTERNATE
Pipe Hangers	Grinnell	Crane, Flamco, Unistrut
Unions	Crane	Grinnell, Dart
Expansion Joints	Flexonics	Amtrol, Hydroflex, Tube Turn
Gate, Globe & Ball Valves	Crane	Jenkins, Kitz, Toyo/R+W,
Check Valves	Crane	Jenkins, Kitz, Toyo/R+W
Plug Valves	DeZurik	Kitz
Circuit Balancing Valves	Tour and Andersson	
Butterfly Valves	Crane	Jenkins, Centerline, Kitz, Mueller, Apollo, Challenger
Thermal Insulation	Fiberglas Canada	Manson, Knaufl, Johns-Manville
Strainers	Sarco	Crane, McAvity, Morrison Brass, Braukmann, Mueller
Automatic Air Vents	Sarco	Amtrol, S. A. Armstrong, Braukmann, Terice
Gauges, Thermometers	Weiss	Ashcroft, Terice, Weksler, Winters, Wika

2. MANUFACTURERS AND SUPPLIERS (CONT'D)

ITEM	BASE BID BASIS OF DESIGN	ACCEPTABLE ALTERNATE
Finned Tube Radiation and Convectors	Engineered Air	Rosemex, Trane Sterling, Sigma, Slantfin, Rittling
Hot Water Unit Heaters and Cabinet Heaters	Engineered Air	Rosemex, Trane Sterling, Rittling, Sigma, Airtherm
Energy Recovery Ventilator (ERV)	Oxygen 8 (HTS)	Venmar, Cook, Mitsubishi Engineered Air
Fire Dampers	Nailor	Ruskin, Potoroff, Ventex, Controlled Air,
Smoke Dampers, Combination Fire/Smoke Dampers	Nailor	Ruskin, Potoroff,
Air Terminal Devices (Diffusers, Registers Grilles)	Nailor	Titus, Carnes, Tuttle & Bailey, E. H. Price, Krueger
Ceiling & Wall Mounted Air Conditioners	Daikin	Mitsubishi, LG
Variable Refrigerant Flow Condensing Units	Daikin	Mitsubishi, LG
Misc. Fans	Cook	Carnes, Greenheck, Penn, Jenn-Air, Acme, Twin City
Air Filters	Farr	Cambridge, Airguard, Vibron, A.A.F., Integrated Air
Filter Gauges	Dwyer	Airflow Developments (Canada) Ltd.
Dampers (except low leakage)	Tamco Series 1000	-
Low Leakage Dampers	Tamco Series 9000	Alumavent 3965-BF, Ruskin
Electric Duct Heater	Oxygen 8 (HTS)	Indeeco, Ouellet Chromalox

2. MANUFACTURERS AND SUPPLIERS (CONT'D)

ITEM	BASE BID BASIS OF DESIGN	ACCEPTABLE ALTERNATE
Electrical Starters, Disconnects, MCC's Alternator Panels	Moeller Electric	Allen-Bradley, Square 'D', Eaton (Cutler-Hammer)
Noise and Vibration Control	Vibro-Acoustics	Korfund-Sampson, Vibron, VAW, J.P. Environmental, E. H. Price
Duct Access Doors	Ruskin	Nailor
Fire Extinguisher Cabinets	National Fire Equipment	Wilson & Cousins
Fire Extinguishers	National Fire Equipment	Wilson & Cousins,
Roof Drains, Cleanouts. Drainage Specialties	Zurn	Watts, Smith, Mifab
Stainless Steel Sinks	Franke Commercial	Arch. Metal
Sink Trim	Chicago Faucets	Delta/Cambridge Brass, American Standard, Moen Commercial, Zurn
Plumbing Fixtures	American Standard	Kohler, Zurn, Eljer
Flush Valve	Sloan	Delta/Cambridge Brass, Moen, Zurn
Basin Electronic Trim	Sloan	Delta/Cambridge Brass, Moen, Zurn
Washfountain	Acorn	Bradley

3. LABOUR RATES:

I/We enclose herewith Labour Rates which are an integral part of the Bid. Labour rates are in effect for the duration of this Project's construction period. The Owner is not obligated to accept any labour rates indicated.

1. Labour Rates

Labour at the following rates shall be applied for additions or deletions to the work not covered by unit prices. The prices consist of salary, all agreed local union benefits. The rate quoted represents the net cost to the Contractor, exclusive of overhead and profit.

Plumbing & Drainage Trade		\$ _____	Per Hour
HVAC Piping Trade		\$ _____	Per Hour
Insulation Trade		\$ _____	Per Hour
Sheet Metal Trade:	Shop	\$ _____	Per Hour
	Field	\$ _____	Per Hour
Balancing Trade		\$ _____	Per Hour
Controls Trade		\$ _____	Per Hour

TENDER SIGNING

This Tender is executed under seal at _____

This _____ day of _____ 20____

Name of Firm _____

Address _____

FOR INDIVIDUAL OR PARTNERSHIP:

SIGNED, SEALED AND DELIVERED BY

(Bidder - please print) _____ (SEAL)
(Signature of Bidder)

in the presence of:

(Witness - signature)

Name _____

Address _____

Occupation: _____

FOR LIMITED COMPANY:

The Corporate Seal of _____ (Seal)
(Bidder - please print)

was hereunto affixed in the presence of:

(Authorized Signing Officer) Title

(Authorized Signing Officer) Title

Note: If the Tender is by a joint venture, add additional forms of execution for each member of the joint venture in the appropriate form of forms as above.

I N D E X

<u>ARTICLE NO.</u>	<u>DESCRIPTION</u>
<u>PART 1:</u>	
<u>GENERAL</u>	
1.1	General Requirements
1.2	Scope of Work
1.3	Approvals, Codes and Standards
1.4	Schematic Diagrams
1.5	Shop Drawings
1.6	Quality Assurance
1.7	Acceptable Products and Manufacturers
<u>PART 2:</u>	
<u>PRODUCTS AND MATERIALS</u>	
2.1	Valves
2.2	Piping Specialties
2.3	Pipes and Fittings
2.4	Cleanouts
2.5	Floor Drains
2.6	Plumbing Fixtures
2.7	Fire Protection Systems
<u>PART 3:</u>	
<u>EXECUTION</u>	
3.1	Piping Systems
3.2	Piping Specialties
3.3	Water Meters
3.4	Service Connections
3.5	Valves
3.6	Tests
3.7	Declaration of Completion
3.8	Drainage Products
3.9	Plumbing Fixtures
3.10	Fire Protection Systems
3.11	Video Inspection (Sanitary Drains)
3.12	Maintaining of Services

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

- .1 Section 21 00 00 (Mechanical Supplementary Bid Form) and Section 23 00 10 (Mechanical General Requirements) shall form part of this Section of the Specifications.

1.2 SCOPE OF WORK

- .1 The supply and installation of equipment and work specified in Section 22 00 00, and shown on the drawings.
- .2 Visit site to determine existing conditions prior to submitting a tender price.
- .3 Phasing of construction to meet the construction schedule. Review phasing of construction prior to submitting a tender price.
- .4 Locating and connecting to existing services.
- .5 Maintaining of existing services in operation during the construction period.
- .6 Saw cutting and core drilling of existing concrete floors and walls.
- .7 Demolition of existing, as shown on the drawing.

1.3 APPROVALS, CODES AND STANDARDS

- .1 Work shall comply with the applicable codes and standards including requirements of the Authorities, and shall include:-
- Building Code, and all codes and standards referenced herein.
 - Plumbing Code.
 - Applicable N.F.P.A. Codes.
 - Local by-laws and requirements.

1.4 SCHEMATIC DIAGRAMS

- .1 Provide schematic drawings using proper drafting techniques, to show all sanitary/waste drainage and vent piping for each system, as required by Authorities, for all permit applications and approvals.
- .2 Submit schematic drawings, as shop drawings immediately after the award of Contract.

1.5 SHOP DRAWINGS

- .1 Shop drawings are required for the following items. Refer to Article 1.7 of Section 23 00 10. Note: The shop drawings must be reviewed and stamped "Reviewed" by the Contractor prior to submission for review to the Consultant.

- .1 Drain and Vent Schematic (as required).
- .2 Drainage Specialties.
- .3 Plumbing Fixtures.
- .4 Flush Valves
- .5 Plumbing Trim.
- .6 Toilet Seats
- .7 Valves.
- .8 Pipe Specialties.
- .9 Fire Extinguisher Cabinets.
- .10 Fire Extinguishers.

1.6 QUALITY ASSURANCE

- .1 All works executed by this Section shall be performed only by skilled tradesmen, duly licensed and accepted, and by persons regularly employed in the installations of plumbing and drainage systems.

1.7 ACCEPTABLE PRODUCTS AND MANUFACTURERS

- .1 Refer to Article 2.1 of Section 23 00 10 for specific requirements.
- .2 Refer to Tender Form for listings of acceptance manufacturers.

PART 2 - PRODUCTS AND MATERIALS

2.1 VALVES

- .1 Unless noted otherwise, valves shall be line size.
- .2 Valves for low pressure systems shall have a minimum rating of 860 kPa (125 psig) saturated steam and 1375 kPa (200 psig) water up to 65°C (150°F). Valves shall be rated for the specified services and pressures.
- .3 Except for specialty valves, all valves shall be of one manufacturer; shall bear the manufacturer's name and the pressure rating cast or stamped on the body. All valves shall have non-asbestos packing.
- .4 Valve operators shall have sufficient neck extension to clear pipe insulation.
- .5 Before the date of Substantial Completion, turn over two sets of lockshield valve keys for each size of lockshield valve installed.

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- .6 Metals used in bronze valves shall conform to ASTM B62 standard.
- .7 The iron in iron valves shall conform to ASTM A-126 standard, Class "B" or "C".
- .8 Valves 75mm (3") and smaller shall be bronze with solder joint of screwed ends. Larger valves shall be cast iron body, bronze trim, flanged ends.
- .9 Gate, Globe and Check Valves
- .1 Gate and globe valves shall be designed to allow repacking under pressure when fully open; shall have rising stems unless specified otherwise or unless space is not available. Obtain written instructions to use valves with non-rising stems.
- .2 Unless noted otherwise, provide gate and globe valves with handwheels.
- .3 Gate valves 75mm (3") and smaller have solid wedge disc, screwed or union bonnet.
- .4 Globe valves 75mm (3") and smaller have union bonnet, replaceable composition disc.
- .5 Check valves 75mm (3") and smaller for other than pump discharge or pipes with pulsating flow, are regrindable seat swing check with screw-in cap.
- .10 Ball Valves
- .1 Ball valves are large bore, quarter-turn lever operated with stop, bubble-tight shut-off, bronze body, double-seated hard chrome-plated bronze ball, resilient seats, blow-out proof stem. Seal and "O" ring material shall be Teflon.
- .2 Balancing valves shall be ball type complete with memory stops. Memory stops shall be adjustable and shall not lose position on shut-off.
- .3 Drain valves shall be ball type complete with anti-condensation caps and chain.
- .11 Stop Valves
- .1 Stops shall be compression type valves with rough brass body, screw-on bonnet, solder ends, composition disc.
Basis of Design: Emco.
No. 10120 - stop valve, as specified above.
No. 10190 - stop and drain valve, with drain port and screw-on cap.
No. 10140 - partition stop with access sleeve, heavy chrome plated escutcheon, remote screwdriver operator.
- .12 Hose Bibbs
- .1 Hose Bibb #1:
Exterior hose bibbs shall be non-freeze wall hydrant for 19mm (3/4") pipe size, and complete with polished nickel-bronze, deep box; removable key; integral backflow preventer. Select lengths to suit construction.
Basis of Design: Zurn 1320-VB.

2.2 PIPING SPECIALTIES

.1 Flexible Connectors and Joints

- .1 Provide flexible hose connectors and expansion joints where specified or noted.
- .2 Hose connectors shall be selected for continuous flexing service at the specified system temperatures and pressures.
- .3 Expansion joints shall be selected for continuous service at the specified system temperatures and pressures.
- .4 Provide a written guarantee from the manufacturer, on materials for a period of four (4) years beyond the first year's labour and material guarantee.

.2 Unions and Flanges

- .1 Unions in copper water piping shall be wrought copper solder joint type, for pipes up to 50mm (2") diameter and brass ground joint unions for pipes 63mm (2½") and over.
- .2 Flanges in galvanized water piping 75mm (3") diameter and larger, shall be minimum 150 lb. galvanized steel, threaded ends. Where slip-on or welding neck type welded flanges are used, piping shall be galvanized after fabrication.

.3 Joints and Couplings

- .1 Caulking ferrules shall be cast brass or copper cold drawn seamless tube, not less than 100mm (4") long.
- .2 Mechanical joint (MJ) pipes shall be provided with rubber gaskets held in place by stainless steel bands and clamps.
- .3 Use copper-to-copper streamline or solder brass fittings and couplings for joints between copper to copper piping.
- .4 Use IPS adapters to connect solder joint copper pipe to threaded pipe.

.4 Water Hammer Arrestors

- .1 Water hammer arrestors shall have welded or soldered casings and shall contain a cushion of gas or air and be designed to withstand and control water hammer.
- .2 Water hammer arrestors shall be manufactured, tested and certified in accordance with the Plumbing and Drainage Institute Standard WH201, by ASSE.
- .3 Arrestors shall have PDI rating as follows:-

W.H.A. - A 1-11 Fixture Units - use Model A
- .4 Products as manufactured by the following will be considered as meeting these requirements.
Basis of Design: Precision Plumbing Products.

2.3 PIPES AND FITTINGS

- .1 Provide pipes and fittings as required and specified, approved by Authorities, for system as indicated.
- .2 All piping and fittings provided by this Section shall be approved by all Authorities and regulations, and shall bear all necessary labels and markings. Do not install any pipe or fittings that do not meet the Plumbing Code requirements.
- .3 All piping and fittings shall be suitable for the services as noted and at the specified pressure ratings. Maximum system working pressures in pressurized systems shall be 860 kPa (125 psig) W.O.G. up to 82 degrees C. (180 degrees F.).
- .4 Sanitary Systems
 - .1 Sanitary Drains (Suspended):
 - Sizes up to and including 50mm (2") shall be DWV copper tubing with wrought copper solder fittings.
 - Sizes 75mm (3") and over shall be DWV copper tubing with wrought copper solder fittings, or factory coated Class 4000 cast iron mechanical joint pipe and fittings or Iplex XFR pipe and fittings.
 - .2 Sanitary Drains (Underground, Buried):
 - Sizes up to and including 38mm (1½") shall be type 'L' copper tubing with wrought copper solder fittings, or DWV PVC solvent weld pipe and fittings.
 - Sizes 50mm (2") to 150mm (6") shall be factory coated Class 4000 cast iron 'MJ' pipes and fittings, or CSA approved PVC-SDR35 pipe, hub and spigot push-on type fittings with self-locking gaskets, or DWV PVC solvent weld pipe and fittings.
- .5 Vent Systems
 - .1 Vent Pipes (Suspended):
 - Sizes up to and including 50mm (2") shall be DWV copper tubing with wrought copper solder fittings.
 - Sizes 75mm (3") and over shall be either DWV copper tubing with wrought copper solder fittings; Class 4000 factory coated cast iron mechanical joint pipe and fittings; or galvanized steel piping with galvanized recessed drainage fittings, or Iplex XFR pipe and fittings.
 - Vent terminations through the roof shall be cast iron.
 - Vent stack flashing shall be equal to Thaler Model SJ-26.
 - .2 Vent Pipes (Underground, Buried):
 - Sizes up to and including 50mm (2") shall be type 'L' copper tubing with wrought copper solder fittings, or DWV PVC solvent weld pipe and fittings.
 - Sizes 75mm (3") and over shall be Class 4000 coated cast iron mechanical joint pipe fittings or DWV PVC solvent weld pipe and fittings.

.6 Water Services

.1 Water Piping (Suspended):

- All sizes shall be Type 'L' hard temper copper tubing with wrought copper solder fittings.

2.4 CLEANOUTS

- .1 Cleanouts shall be provided for all underground drains; in all straight runs of sewers; on all exposed or accessible traps (except water closet traps); further to all points on the system where specified or shown; where necessary before interruption of general line of flow; and as required by Code and Authority.
- .2 Cleanouts shall be full size of pipe up to 100mm (4"), and not less than 100mm (4") for larger pipes.
- .3 All cleanouts shall be manufactured from C.S.A. approved extra heavy duty coated cast iron materials.
- .4 Unless indicated otherwise, in order to prevent oxidization, nickel bronze tops and covers shall have a fusion bonded clear powder epoxy coating.
- .5 Unfinished Concrete: Coated cast iron body with integral anchoring flange, 13mm (½") thick round heavy duty adjustable nickel secured cover, complete with all gaskets, sealing rings, secondary plugs, and accessories. Cleanouts in mechanical rooms and membrane areas shall have flashing clamp devices.
Zurn ZNX-1612-DC-SP
- .6 Vinyl Tile: Coated cast iron body with integral anchoring flange, 13mm (½") thick round, heavy duty adjustable polished nickel bronze secured cover with shallow tile recess, complete with all gaskets, sealing rings, secondary plugs and accessories. Cleanouts in membrane areas shall have flashing clamp devices.
Zurn ZN-1628-DC-SP
- .7 Terrazzo or Ceramic Tile: Coated cast iron body with integral anchoring flange, polished nickel bronze heavy duty square adjustable secured cover and with polished nickel bronze finishing frame, complete with all gaskets, sealing rings, secondary plugs and accessories. Cleanouts in membrane areas shall have flashing clamp devices.
Zurn ZN-1612-T-DC-SP
- .8 Line Type: Cast iron with bolted on secured removable cover with gasket and round stainless steel access cover secure to cleanout.
Zurn Z-1616-W/ZSS-1460-9

2.5 FLOOR DRAINS

- .1 Floor drains shall be provided in all areas so indicated and as specified.
- .2 Floor drains shall be manufactured from C.S.A. approved extra heavy duty, coated, cast iron materials.

- .3 Floor drains shall be equipped with deep seal traps, primers, vents, etc. as required by Code and Authority and as specified.
- .4 Unless indicated otherwise, floor drains installed in concrete slabs shall have baked on epoxy coating.
- .5 Floor Drain FD #1: Washrooms and finished areas: `coated' cast iron body, double drainage flange, weepholes, adjustable full 100mm (4") throat with secured nickel bronze 125mm (5") strainer, and baked epoxy body. Provide membrane clamp in waterproofed areas, Zurn #ZXN-415-A-DC.
- .6 Floor Drain FD #2: Combination drains, `coated' cast iron combination funnel floor drain, with double drainage flange, weepholes with adjustable secured nickel-bronze combination 9" x 4" elongated funnel strainer with full opening, and baked epoxy body. Provide membrane clamp in waterproofed areas. Zurn #ZN-415-BF-DC.
- .7 Electronic Trap Seal Primers:
 - .1 Supply and install a P.P.P. Inc. automatic trap priming system to serve all building floor drains. The electronic trap priming system shall be PPP model #SMP-500-115V as supplied by S.M.S. Ltd., Pickering, Ontario.
 - .2 This Section shall provide and install a minimum 20mm (3/4") valved cold water supply to the electronic trap priming unit in the location shown/noted on the drawing.
 - .3 Note: For every 20 ft. of trap make-up water line, the priming units must be a minimum of 1 ft. above floor level.

2.6 PLUMBING FIXTURES

- .1 Plumbing fixtures shall be heavy duty, first grade CSA approved type, with uniform colours and quality throughout the project.
- .2 Fixtures shall be designed to sit flush and true to the adjacent architectural finishes.
- .3 Plumbing fixtures for the barrier free shall be supplied complete with all accessories and features as required by the Standards for Barrier Free Accessibility.
- .4 Obtain rough-in dimensions for fixtures from the Board prior to doing any rough-in.
- .5 Basis of Design fixtures shall be as specified below.
- .6 Drain/waste outlets shall be complete with tailpieces, companion flanges, gaskets, pipe fittings, and couplings to provide liquid tight connections. Where necessary to provide true vertical and perpendicular alignment of fixtures and piping, connections shall be adjustable.
- .7 Except as specified or noted otherwise, fasteners, piping, escutcheons, flanges, couplings, traps, stands, ring stays, valves, spuds, supplies, stops, vacuum breakers, etc., exposed in finished areas shall be heavily chrome plated (Symbol c.p.).
- .8 All clamps, bolts, nuts, flanges and fastening devices shall be fabricated of non-corroding materials such as brass, bronze, galvanized steel, zinc coated steel, nickel-plated steel, or stainless steel.

- .9 Water Closet - Ref. 'A' (Barrier Free)
Bowl: American Standard 'Madera' elongated 16 ½ (419mm) high, #3463.001, vitreous china floor mounted elongated syphon jet action bowl, 1.3 gals (4.8l) flush, 1-1/2" (38mm) back spud, floor flange, flange bolts, bolt caps and gasket.
Flush Valve: Delta Teck Commercial model #1600T6202ARI-48 (back inlet) rough-in infrared electronic activated concealed flush valve system, stainless steel cover with integral sensor, manual override, solenoid operating valve. Provide trim kit #1600T6202ATR-48. Coordinate sensor mounting location with seat cover and barrier free grab bars. Provide Delta #RP32508 hardwire transformer.
Seat: Centoco #820STS, elongated heavy duty solid plastic open front with cover, check hinges and chromated steel posts, washers and nuts.
Installation: To meet Code requirements for Barrier Free access.
- .10 Lavatory - Ref. 'B' (Barrier Free)
Basin: American Standard #0955.001EC "Murro", centre hole only, vitreous china, wall hung lavatory, drilled to accommodate concealed arm supports and with #0062.000EC semi-china pedestal.
Trim: Delta Teck Commercial #1500T3328TR, hard wired infrared electronic hardwired system, one piece integral sensor and rigid spout, mixing valve and components assembled in 10"x10" recessed metal box with 12" x 12" stainless steel cover model #ELAVT0008ARI. Provide Delta #RP32508 hardwire transformer.
Drain: McGuire #155WC drain, C.P. offset open grid, C.P. 'P' trap, 17 gauge (1.5mm), 1.1/4" (32mm) and escutcheon.
Supply: McGuire #H165LKN3RB supply, C.P. polished, short rigid horizontal with V.P. loose key angle stop, escutcheon and braided flexible riser.
Carrier: Zurn ZX-1231 concealed fixture carrier with arms.
Note: Installation shall meet the O.B.C. requirements for the Handicapped. Insulate supplies and drain as required by Code.
- .11 Counter Sink - Ref. 'C' (Single Bowl- Classroom)
Sink: Franke Commercial LBS-6808-1C, single hole stainless steel single bowl sink, for counter installation, back ledge, self rimming, 3.1/2" crumb cup strainer, 1.1/2" tailpiece. Overall size 508mm x 521mm x 200mm (20" x 20.1/2" x 8" deep).
Trim: Delta #27C634 (single temperature supply) deck mounted with gooseneck spout with vandal resistant aerator and blade handle
Trap: 1.1/2" cast brass 'P' trap with cleanout and pencil trap as detailed on drawings.
Supplies: Rough brass stop on all water supplies located below sink in millwork.
Installation: Note: Install Symmons #4-10B mechanical mixing valve with in-line check stops on hot and cold supplies to provide tempered water to the faucet. supplies
- .12 Counter Sink - Ref.'C1' (Single Bowl – Health)
Sink: Franke Commercial LBS-6808-3/3, S.S., 3 holes - 8" (203mm) centres, 20" x 20.1/2" x 8" (508mm x 521mm x 200mm) deep back ledge, stainless steel, single compartment, self-rimming, counter mounted, with crumb cup strainer, sound deadening pads and neoprene rim gasket.
Trim: Delta #28C6943 gooseneck spout with vandal resistant aerator and level handles.
Trap: 'P' 1.1/2" (38mm) with cleanout, union and escutcheon.
Supplies: Connect with flexible tubes and 1/2" (12.7mm) rough stops on supply piping below sink in millwork.
- .13 Counter Sink - Ref.'C2' (Single Bowl, Kitchen)
Sink: Franke Commercial LBS-6808-3/3, 3 holes - 8" (203mm) centres, S.S., 20" x 20.1/2" x 8" (508mm x 521mm x 200mm) deep back ledge, stainless steel, single compartment, self-rimming, counter mounted, with crumb cup strainer, sound deadening pads and neoprene rim gasket.

Trim: Delta/Cambridge Brass Teck #26T2133 Faucet, C.P. 8" (203mm) C.C. deck mounted, with cast brass body, swing spout with vandal proof 1.84 GPM (8L) flow aerator and cast metal lever handles.

Supplies: Connect with flexible tubes and 1/2" (12.7mm) rough stops on supply piping.

.14 Shower Ref. 'D' (Barrier Free)

Shower Encloser: Shall be constructed by another Division.

Trim: Symmons #4-5000VT-T24-WT safety mix visu-temp pressure-balancing mixing valve with integral thermometer FS hand spray unit with flexible hose, chrome plated 24" heavy duty wall mounted shower glide with adjustable glide, wall connection and in-line vacuum breaker.

Floor Drain: 3" floor drain FD #1. (Note: prime shower floor drain).

Trap: Adjustable 3" cast iron 'P' trap.

Note: For barrier-free application the installation shall meet the O.B.C. requirements for the Handicapped. Refer to Architectural drawings for location of controls and installation details. Maximum water temperature at shower shall be set at 49°C (120°). Submit written confirmation of setting to the local Authority and the Consultant.

.15 Automatic Clothes Washer - Ref. 'E'

Automatic clothes washer is supplied by another Section. This Section shall provide 1/2" (15mm) hot and cold water valved hose end connections and 2" (50mm) standing waste with 'P' trap.

Equal to Oatey Reversible Metal Washing Machine outlet box #38995 with water hammer arrestors.

Note: Outlet box shall be located at side of washer for access. Confirm location before rough-in.

2.7 FIRE PROTECTION SYSTEMS

.1 Provide portable fire extinguishers complete with wall mounting brackets or extinguisher cabinets as shown on the drawings.

.2 Fire Extinguisher Cabinets

.1 Fire Extinguisher Cabinets shall be fully recessed, adjustable flush mounted type, (approximately 24" x 10" x 6" deep). Cabinet constructed of 22 gauge steel tub and 16 gauge steel door and trim with return frame, a full length semi-concealed piano hinge, corbin catch and 6mm (1/4") thick Plexiglass window. Fire extinguisher shall be F.Ex. #2.
Basis of Design: National Fire Equipment Model CE-950-3.

.2 All fire extinguisher cabinets shall be complete with portable fire extinguisher type F. Ex. #2.

.3 Fire Extinguishers

.1 Fire Extinguisher F. Ex. #1 shall be ULC approved multi-purpose dry chemical portable fire extinguisher 5 lb., having a rating of 3A,10BC.
(Basis of Design: National Fire Equipment Model ABC-050WWD).

.2 Fire Extinguisher F. Ex. #2 shall be ULC approved multi-purpose dry chemical portable fire extinguisher 10 lb. having a rating of 6A:80BC.
(Basis of Design: National Fire Equipment Model ABC-100WWD).

PART 3 - EXECUTION

3.1 PIPING SYSTEMS

- .1 Piping shall be installed in strict accordance with all applicable codes, standards and manufacturers recommendation.
- .2 Piping shall be installed in such a manner so that the strain and weight of the piping is not taken by connections to the equipment and apparatus.
- .3 Keep all openings in pipes plugged and capped during installation to keep out dirt and debris.
- .4 Piping shall be placed and installed so that there will be no interference with the installation of equipment, piping of other trades, electrical equipment, light fixtures, ductwork etc.
- .5 Piping shall be installed to ensure noiseless circulation.
- .6 No pipe shall be cut with a cutting torch where the cut could be made with pipe cutters.
- .7 Install all pipes to maintain clearances for servicing, inspection, repair and replacement.
- .8 Provide service connections to all outlets and equipment specified and shown. Unless otherwise noted, this Section shall include all adapters, fittings, couplings, etc, to make final connections.
- .9 All materials shall be new, clean and free of all rust, contaminants, defects and corrosion.
- .10 Used piping shall not be accepted on this Project.
- .11 Welding
 - .1 Where welding or cutting with a torch, every precaution shall be taken to prevent fire. Welding or torch cutting operators shall have a fully charged minimum 4.5 kg. (10 lb.) CO2 fire extinguisher with them whenever welding or cutting in the building. Wooden structures shall be protected.
- .12 Drains, Waste and Vent Piping
 - .1 Buried pipes installed in trenches shall be installed on Class `B' bedding on solid stable soil where possible. Where solid stable soil is unobtainable, the pipes shall be installed on concrete bed, solid concrete blocks, concrete piers or other approved beddings, all supplied and installed by this Section to the satisfaction of local Authority.
 - .2 All necessary pipe beddings shall be the full responsibility of this Section and shall be to local Authority standards and approval.
 - .3 Suspended piping shall be supported as required by other Sections, and shall be in accordance with all Codes.
 - .4 All drainage piping shall be graded in accordance with all Codes, not less than 1% for pipe 100mm (4") and larger, and 2% for pipe 75mm (3") and smaller.
 - .5 Turns shall be made with `Y' and `1/8' bends and shall include a cleanout. Where space does not permit these fittings to be installed, long radius bends may be used.

- .6 Do not use double "wye" or double "tee wye" fittings on sanitary headers serving more than one lavatory or sink unit. Provide each unit with a separate waste connection to the header. Pipe size shall be 38mm (1½ up to "tee wye" connection for fixture trap. Provide a continuous waste and vent piping arrangement.
- .7 Vents shall be provided to conform to the requirements of the Code and the Local Authority.
- .8 Vent terminations through roof shall be min. 100mm (4") and shall be extended a minimum 300mm (1'-0") above the finished roof level. Flashing cone required for vents passing through the roof shall be provided by this Section, to be flashed into the roofing membrane by the Roofing Section. This Section shall provide the counterflashing.

.13 Water Piping

- .1 Pitch water lines 25mm (1") in 8.0m (25'-0") and install piping so that the systems can be drained at low points. Provide drain valves, consisting of 19mm (¾") hose bibbs complete with cap and chain at all low points and where necessary for complete drainage of the system.
- .2 Hot water piping shall be kept at least 150mm (6") away from cold water piping.
- .3 Provide a gate valve on each side of each piece of equipment and control valve; for each hot and/or cold water riser; in all hot and cold water branch lines to each group of plumbing fixtures.
- .4 Remove working parts of any valve during soldering operations.

.14 Joints and Fittings

- .1 Approved fittings shall be use for all connections. Job made fittings or reducers will not be accepted.
- .2 Joints, couplings, and fittings between different types of pipe or materials and between service connections shall be as recommended by the pipe manufacturer.
- .3 On screwed piping, all joints shall be made up metal to metal with approved joint compound applied to the thread. All pipe shall be reamed before installation. No hemp, wick or packing will be permitted in making up screwed joints.
- .4 Inside of copper fittings and outside of copper pipe shall be thoroughly cleaned with steel wool and emery paper and coated with flux before soldering any copper piping.
- .5 Solders for use with copper piping shall be selected for the service. All solders must be approved and shall meet the Code and local Authority requirements:-
 - Englehard Industries Silvabright 100 approved lead free solder as distributed by S.M.S. Ltd. for pressure piping to maximum 1375 kPa (200 psig).
 - Silver solder ("Silfoss") for pressure piping to maximum 2050 kPa (300 psig).
 - 50-50 tin lead solder for drain waste and vent lines.

- .6 Use copper-to-copper streamline solder brass fittings for joints in copper pipes. Use IPS adapters for connecting copper pipe to threaded pipe.
- .7 Ductile iron water piping shall be installed complete with bonding and static straps.
- .8 Other types of piping and materials shall have joints and fittings as described under other articles of various sub-sections.

.15 Unions and Flanges

- .1 Provide di-electric unions, bushings and couplings at all connections between piping of dissimilar metals. Fittings or couplings with neoprene gaskets to prevent metal-to-metal contact are also acceptable.
- .2 Provide adequate numbers of unions and flanges to facilitate maintenance and dismounting of each fixture, piece of equipment and apparatus which could at any time require dismounting or removal.
- .3 Install unions or flanges on the equipment side of shut-off and balancing valves.
- .4 Flanges shall be assembled using American Standard heavy machine bolts. Threaded steel rod will not be accepted for this purpose, regardless of strength.
- .5 Use flanged type unions on all galvanized pipings over 75mm (3").

.16 Pipe Expansion

- .1 This Section shall make adequate provisions for expansion and contraction of the piping systems. Unless specified or noted otherwise, use expansion loops.
- .2 All piping crossing a building expansion joint shall be equipped with an expansion loop.
- .3 All domestic hot water and hot water recirculation piping shall be provided with expansion loops as shown.
- .4 Provide minimum of two pipe guides on each side of each expansion loop. Provide hangers for each guide as recommended by the manufacturer. Pipe guides shall be insulated to prevent metallic contact.
- .5 Provide anchors for water piping, secured to the building structure at approximately maximum 30 meter (100 ft.) intervals, on straight horizontal runs and on risers. Expansion joints shall be located at a point midway between each set of anchors.

3.2 PIPING SPECIALTIES

.1 Water Hammer Arrestors

- .1 Provide and install water hammer arrestors complete with shut-off valves on both hot and cold water piping systems. Install in an upright position, at all of the following locations:-
 - All quick closing valves.

- Solenoid valves.
 - Groups of plumbing fixtures.
 - Each isolated plumbing fixture.
 - Remote water outlet locations.
 - At the top of each water riser.
- .2 Size and location, together with recommended installation shall be in accordance with the PDI standard.
- .3 Provide access panel at each concealed location.

3.3 WATER METERS

- .1 Existing water meter is located in existing Meter Room and is to remain.

3.4 SERVICE CONNECTIONS

- .1 This Section shall be responsible for co-ordinating the exact location of the existing services. Verify exact location, size and elevation of existing service prior to commencing work.
- .2 This Section shall make all connections to the existing services and site services terminations.
- .3 Flush and chlorinate the water service connections and mains as required by local and Provincial Health Departments. Provide all necessary test certificates.

3.5 VALVES

- .1 Do not install a valve in any application for which it is not suited.
- .2 Provide gate valves on upstream and downstream side of each piece of equipment, pressure regulating valves, pump/circulator, pumping unit, etc. to facilitate removal without draining the system.
- .3 Provide a balancing valve (globe type) on each piece of equipment which requires flow balancing, e.g. domestic water heaters.

3.6 TESTS

- .1 Perform all drainage tests as required by Authorities, and include for standard ball tests water/air tests. Arrange for and pay all fees for all tests required.
- .2 After all drain, soil, waste, vents and water piping have been placed in position, and all branches installed, but before fixtures, equipment, etc. have been set and connected, test the tightness of all joints and the soundness of all pipes. When instructed perform tests in the presence of the Engineer.
- .1 Soil, Waste, Drain and Vent Piping:
All openings and pipe ends throughout the work shall be securely closed by means of approved plugs, and the entire piping system, including soil stacks, wastes, branches to

plumbing fixtures and all horizontal drains and mains shall be filled with water up to the top of the highest opening, and the water shall stand at this level for not less than 2 hours.

- .2 Where it is not feasible or possible to test the entire system at one time, it may be done in parts.
- .3 All piping that is to be built into walls or furred-in must be properly tested before it is enclosed. Another test shall be made after the fixtures are set and connected. This test shall consist of turning the water into all pipes, fixtures and traps in order to detect any imperfect workmanship or materials.
- .4 At the completion of the job, carry out smoke and ball tests in accordance with the Plumbing Code and where requested by the Authority and by the Consultant.

.3 Water Lines:

- .1 Leakage Tests - All domestic water piping shall be tested at minimum 1035 kPa (150 p.s.i.) for leaks after roughing-in and before piping is enclosed in pipe spaces or buried in trenches.
- .2 Pressures shall be maintained for minimum 2 hours or as required by the Authority.
- .3 The water service piping shall be flushed and disinfected to Code and local Authority requirements. Submit test results to the Authority and the Consultant. Note: the potable water system shall not be put into operation until clearance has been given by the Authority.
- .4 Tests shall be repeated until satisfactory to the local Inspector and the Consultant.
- .5 Provide written notice of all tests in time to allow the Authority, the Consultant or his representative to be present when the tests are conducted.

3.7 DECLARATION OF COMPLETION

- .1 This Section shall 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. Two (2) copies of the signed declaration shall be provided before the final certificate is released by the Consultant.
 - .1 Water and sanitary sewer connections to existing services have been completed.
 - .2 Drainage and water systems tests performed and test certificates submitted.
 - .3 Plumbing inspections made and necessary certificates forwarded to the Consultant.
 - .4 Plumbing fixtures cleaned and trim polished.
 - .5 Valves tagged and valve chart mounted.
 - .6 Piping runs identified.
 - .7 Operating and maintenance instruction manuals presented for approval to the Consultant.

- .8 On site operating instruction given to Owner's representative as follows:-
Name: _____ Date: _____
- .9 Record "As-Built" Drawings turned over to the Consultant, (see Section 23 00 10).
- .10 Water systems chlorinated to local authority requirements, flushed out, strainers cleaned and ready for normal service.
- .11 Water systems checked for expansion and for water hammer.
- .12 Plumbing fixtures installed, tested and water volume adjusted.
- .13 Fire protection system including fire extinguisher cabinets, extinguishers, accessories installed, tested and approved.
- .14 Video inspection of underground storm and sanitary drain lines completed and video/report handed over to the Consultant.

3.8 DRAINAGE PRODUCTS

.1 Cleanouts

- .1 Cleanouts shall be installed on all storm and sanitary/waste drainage piping in the following locations:-
- Building drains leaving building, on upstream side of exterior wall, using 'Y' and 'T' branches with access.
 - Changes in direction of more than 45 degrees.
 - On all straight runs, exceeding 15m (50 ft.) for pipes up to 100mm (4").
 - Ends of drainage lines.
- .2 Locate all cleanouts so as to be readily accessible, with sufficient clearances for rodding and cleaning.
- .3 No cleanouts shall be located beneath any equipment or fixtures.
- .4 Extend all cleanouts to finished floors or walls, unless exposed in an unfinished area.
- .5 Cleanouts located outside the building shall be extended to finished grade and shall be installed complete with a poured concrete collar.
- .6 Cleanouts in stacks or leaders enclosed behind drywall or plastered walls shall be provided with 400mm x 400mm (16" x 16") access panels. If wall finish is tiled use a type of cleanout that can accommodate a countersunk thread 13mm (½") machine screw extension with a round min. 175mm (7") diameter stainless steel access cover.

.2 Floor Drains

- .1 Floor drains of the required type shall be installed in locations as specified, and connected to the piping in an approved manner.

- .2 Unless specifically indicated otherwise, all floor drains must be individually trapped, primed and vented, in accordance with all Codes and Local Authority requirements.
- .3 All primer piping shall be copper tubing as specified, plastic piping or tubing will not be permitted.
- .4 Plumbing fixtures shall **NOT** be used for floor drain trap priming.

3.9 PLUMBING FIXTURES

- .1 Provide all fixtures and outlets.
- .2 Make water, drain and vent connections to each fixture and outlet, to provide a complete operational system.
- .3 Where fixtures are mounted in waterproof surfaces, provide gaskets and sealants for a neat, smooth, watertight installation, i.e. counter lavatories shall have rim gaskets; floor sinks shall be caulked in place.
- .4 Caulking and sealants shall be approved for the application.
- .5 Colour of grout and sealants shall be as selected by the Architect.
- .6 Roughing-in shall be securely laid out. No offsets will be accepted. Fixtures shall be installed plumb and perpendicular to Architectural finishes.
- .7 Each fixture shall be fastened securely in place using floor supports, wall hanger, carriers, and deck clamps.
- .8 Fixtures complete with valves, trim, supplies, waste, traps, exposed piping and accessories shall remain rigid during use and shall stay permanently in place.

3.10 FIRE PROTECTION SYSTEMS

.1 Fire Extinguishers

- .1 Provide fire extinguishers where noted and where required by Authorities.
- .2 Other types of extinguishers shall be as shown and noted.
- .3 Provide wall hung fire extinguishers complete with wall mounting hanger, brackets, fasteners.

.2 Fire Extinguisher Cabinets

- .1 Provide fire extinguisher cabinets complete where noted and as detailed on the Architectural drawings.

3.11 VIDEO INSPECTION (SANITARY DRAINS)

- .1 This Section shall perform a video camera inspection of the new sanitary sewers and existing sanitary drain lines that are being connected to, and 100ft beyond. All costs associated with the video camera inspection shall be included in the Tender Price.
- .2 The video camera inspection shall be carried out after installation and backfill but prior to the pouring of the floor slabs. Co-ordinate schedule with the General Contractor. Sections of the systems can be video inspected to accommodate the floor pouring schedule.
- .3 Submit two (2) copies of the video and written inspection report to the Consultant for review, and repair piping installation as required and as directed by the Consultant and the Local Authority.

3.12 MAINTAINING OF SERVICES

- .1 Section shall be advised that all existing water and drainage systems, etc. must be maintained and retained in full free flow operation during the normal hours of the School.
- .2 Existing water and drainage systems shall only be shut-down to permit installation of new works, and/or modifications to existing, during the overnight hours or weekend hours, when the School is not normally opened.
- .3 All shut-down of the existing systems to permit new installations or tie-ins, shall be co-ordinated with and through the Contractor, the Project Manager and Owner's representative. Do not shut systems down until given approval to do so.
- .4 This Section shall include in his tender for any and all premium and overtime work, labour and equipment, as required to perform the necessary work required by the above items.
- .5 This Section shall prepare a schedule of work and present it to the Owner for review and approval.

END OF SECTION 22 00 00

I N D E X

<u>ARTICLE NO.</u>	<u>DESCRIPTION</u>
<u>PART 1:</u>	<u>GENERAL</u>
1.1	General Provisions and Requirements
1.2	Permits, Fees and Inspections
1.3	Discrepancies and Omissions
1.4	Shop Drawings
1.5	As-Built and Record Drawings
1.6	Additional Work
1.7	Insurance
1.8	Guarantees and Certificates
1.9	Definitions and Interpretations
1.10	Cutting and Patching
<u>PART 2:</u>	<u>PRODUCTS</u>
2.1	Standards of Materials
2.2	Pipe Hangers
2.3	Electric Motors, Starters and Wiring
2.4	Access Panels
2.5	Vibration Control Equipment
2.6	High Efficiency Motors
<u>PART 3:</u>	<u>EXECUTION</u>
3.1	Existing Conditions and Other Trades
3.2	Drayage, Hoisting and Scaffolding
3.3	Cutting and Patching
3.4	Tags, Charts, Identifications & Data Book
3.5	Instructions
3.6	Cleaning and Protection
3.7	Standard of Workmanship
3.8	Painting
3.9	Co-ordination
3.10	Pipe Hangers
3.11	Inserts
3.12	Equipment Supports
3.13	Pipe Anchors
3.14	Sleeves and Escutcheons
3.15	Electric Motors, Starters and Wiring
3.16	Access Panels
3.17	Insulation
3.18	Installation of Underground Pipes
3.19	Excavation and Backfill
3.20	Concrete
3.21	Commissioning
3.22	Schedule for Completion
3.23	Inspection and Testing
3.24	Demolition

PART 1 - GENERAL

1.1 GENERAL PROVISIONS AND REQUIREMENTS

- .1 The Procurement and Contracting Requirements (Division 00) and General Requirements (Division 01) Specifications apply to the Mechanical Divisions of the work.
- .2 Conform in full accordance with applicable Codes, regulations, by-laws ordinances, designated insurance underwriters, and all Authorities having jurisdiction. In case of conflict with the Contract Documents, the Codes, by-laws and ordinances, etc. shall take precedence.
- .3 Include all labour, products and services necessary for complete work, tested and ready for operation.

1.2 PERMITS, FEES AND INSPECTIONS

- .1 Give all necessary notices, obtain all permits including all air and noise pollution permits and pay for all fees, taxes and other costs in connection with the work.
- .2 File all necessary drawings, prepare all documents and obtain all necessary approvals of all regulatory bodies have jurisdiction. Obtain all required Certificates of Inspection for the work and submit to the Consultant. Correct installed work as directed by the local Authorized Inspector of the Regulatory Body without cost to the Owner.

1.3 DISCREPANCIES AND OMISSIONS

- .1 These specifications are an integral part of the drawings which accompany them and neither the drawings nor specifications are used alone. Items omitted from one but indicated in the other are considered as properly and sufficiently specified and provided by Mechanical Divisions, as applicable.
- .2 Request clarification from the Consultant prior to the close of the tenders should discrepancies or omissions in the contract documents be evident, or should there be doubt as to the intent thereof. The Consultant is not responsible for any verbal instructions, but will issue formal written addenda.

1.4 SHOP DRAWINGS

- .1 Submit prints of shop drawings for review in sufficient quantities to satisfy contractual requirements, Where shop drawings consist of printed catalogue sheets, submit at least ten (10) copies. Shop drawings pertain to each particular item as specified; show project and component name, item reference number, certified physical and performance data; and clearly indicate all applicable parts and accessories. Affix Contractor's "Approved" stamp on all copies of all shop drawings prior to their submittal to the Consultant for review. Approval stamp shows name of firm, date the approval was made and the checker's signature or initials. Should the above requirements not be adhered to, shop drawings submitted will be returned for proper resubmittal.

- .2 Submittals that are formatted for 11" x 17" (279 x 432mm) sheets or smaller may be submitted by email, provided the total number of pages, for the entire submission, does not exceed 15. Submittals must be submitted in the same size and scale as they were originally prepared. Drawings may not be reduced in size for email transmission. If acceptable to the individual reviewers, larger format submittals and larger volume submittals may be reviewed by email submission.
- .3 The Contractor shall subsequently print and submit full sized, red line copies of such reviewed documents to each reviewer. Submissions must be in PDF format and must be high quality documents, preferably generated by computer from the original documents (rather than scans of printed documents). If digital submissions are of insufficient quality, hard copies will be required. Emailed documents shall be reviewed and stamped digitally by the Contractor, or accompanied by a separate sheet from the Contractor listing the project name, documents reviewed and bearing the Contractor's review stamp, along with copies of any revisions made. Email submission is only used as a convenient means of distributing drawings, in lieu of sending hard copies by courier. Reviewed drawings must still be printed for job site files, record copies, etc. All site copies shall be red line prints or colour prints.
- .4 Shop drawing review by the Consultant is for the sole purpose of ascertaining conformance with general design concept. This review means that the Consultant does not approve the detail design inherent in the shop drawings, responsibility for which remains with the Contractor submitting same, and such review shall not relieve the Contractor of his responsibility for errors or omission in the shop drawings or of his responsibility for meeting all requirements of the Contract Documents. The Contractor is responsible for dimensions to be confirmed and correlated at the job site, for information that pertains solely to fabrication processes or to techniques of construction and installation and for co-ordination of the work of all subtrades.

1.5 AS-BUILT AND RECORD DRAWINGS

- .1 Provide all as-built drawings (hard copies) and record drawings (electronic files).
- .2 Request one (1) additional set of white prints and clearly mark as the construction progresses, any and all changes in ductwork, piping and equipment sizes and locations. Show As-Built inverts and dimensions for underground piping, from two convenient reference points. Make as-built drawings available for inspection at the site at all times.
- .3 Upon completion of the project, and before final payment is made, transfer all of the construction information from the construction drawings to a clean set of white prints, using proper drafting techniques and instruments. Include the following statement on each drawing, "As-Built Drawing as prepared by (NAME OF COMPANY), complete with a signature of a signing officer of the company. Submit for review. Complete all corrections required and resubmit drawings. One set of as-built drawings is required prior to substantial performance.
- .4 The Consultant will prepare Record Drawings and shall be reimbursed for costs by the General Contractor through the Cash Allowance included in the Contract.

1.6 ADDITIONAL WORK

- .1 The right is reserved to make changes to the Drawings and Specifications after the Contract is awarded. Submit detailed breakdown of costs with quotations for review. When costs are approved a Change Order will be issued covering the work.

- .2 Written orders signed by the Consultant must accompany claims for additional compensation on account of extra labour and materials.
- .3 For work performed by a Mechanical Division's own forces, a markup of 15% for additions unless otherwise stipulated in the General Requirements, Division 01.
- .4 For work performed by a Sub-Contractor of a Mechanical Division, a markup of 5% for additions unless otherwise stipulated in the General Requirements, Division 01.

1.7 INSURANCE

- .1 In addition to the insurance specified in the General Requirements, Division 01, maintain insurance to fully protect both the Owner and all mechanical trades from all claims under the Worker's Compensation Act, etc.

1.8 GUARANTEES AND CERTIFICATES

- .1 A "Substantial Completion Certificate" will be issued by the Consultant as soon as the work is complete and ready for its intended use and purpose. This certificate is a legal document with regard to lien period, final payment including holdback and guarantee period for all mechanical trades and systems and equipment except as noted herein.
- .2 The guarantee period for all systems and equipment starts on the issue date of the Substantial Completion Certificate and extends for a period of one year unless specified otherwise. All systems are to be operated, tested and balanced before issuance of the Substantial Completion Certificate. Assign all warranties to the Owner and provide extended warranties on refrigeration compressors, etc. as applicable.
- .3 All repairs to systems required during the guarantee period shall be performed by the Mechanical Division at no cost to the Owner.

1.9 DEFINITIONS AND INTERPRETATIONS

- .1 The term "provide" means, to include labour, materials, and services necessary to supply and install items of work referenced.
- .2 The term "instructions" or "as instructed" or "where instructed" means, as instructed by the Consultant including supplementary instruction notices; job site instruction notices; job site instructions by a field representative/inspector appointed by the Consultant and including all comments made regarding submittal of shop drawings and samples for review.
- .3 The term "listed" means, that the materials or equipment are tested in accordance with applicable standards, and are approved and listed for their intended use by a testing company approved by the Authorities having jurisdiction.
- .4 The term "approved", "approvals", etc. means, approved by Authorities having jurisdiction as conforming to the requirements of the contract documents.

- .5 The term "acceptable" or "acceptance", etc. means, acceptable to the Consultant as conforming to the requirements of the contract documents.
- .6 The term "submit for review" or "submit notice", etc. means, submit to the Consultant.
- .7 The term "subject to review" means, work or materials laid out for review by the Consultant. Obtain instruction from the Consultant before proceeding with the work. Submit further information, shop drawings, samples, etc. as specified and/or as may be reasonably requested by the Consultant.
- .8 The term "accessible" used alone means, readily accessible by a person using tools as required without cutting or breaking out materials.
- .9 The term "noted" means, notes on the drawings, the detail drawings and on the schedules.
- .10 The term "Contractor" means, the General Contractor or the Contract Manager as applicable for the project.
- .11 The term "exposed" means, within the line of sight of any person standing or sitting in the occupied space, unless defined otherwise in the following Sections of Division 15.
- .12 The term "concealed" means, not exposed.
- .13 The term "Mechanical" means Division 21 (Fire Suppression), Division 22 (Plumbing), Division 23 (Heating, Ventilating and Air Conditioning) and Division 25 (Controls).

1.10 CUTTING AND PATCHING

- .1 For new work or where new work connects with existing and where existing work is altered, do all cutting and patching of building finishes. All work shall be performed by qualified tradesmen.
- .2 Provide the location and dimension of required openings to the Contractor.
- .3 Obtain Consultant's acceptance of location and methods before cutting, boring or sleeving load-bearing markers. All work shall be performed by qualified tradesmen.
- .4 Do not endanger the work of other Divisions or property by cutting, digging or similar activity.
- .5 Do not cut or alter the work of any other Section or Division.
- .6 Should damage occur to the work of other Sections and Divisions, remedial work will be done by the trade who originally installed the work at the expense of the Sub-Contractor who caused the damage.

PART 2 - PRODUCTS

2.1 STANDARDS OF MATERIALS

- .1 Materials, fixtures, fittings, appliances and apparatus provided shall be new, CSA approved, the best of the various kinds specified, free from all defects and of uniform pattern throughout the project. All fire protection materials are ULC approved and gas burning devices are CGA approved. All materials must also comply with any requirements of the Factory Mutual.

- .2 Where a manufacturer's name or a product name is mentioned, it is for the purpose of establishing a standard of quality, performance, serviceability, appearance and capacity. Products and materials on which the design was based will be identified as the "Basis of Design" products and materials.
- .3 Refer to the Mechanical Supplementary Information Form (Section 23 00 01) and comply with the instructions indicated thereon. The Tender shall be based only on the "Basis of Design", or "Acceptable Alternate" product or material. Other "Substitute" products proposed must be shown separately in the Tender complete with the associated change in tender price for acceptance by the Owner.
- .4 Indicate (circle) only one manufacturer for each product listed on the Mechanical Supplementary Information Form on which the tender price is based. Where there is no indication of one name for each item, or where more than one name is indicated, the "Basis of Design" product, material or methods shall be provided.
- .5 The Bidder is also encouraged to offer products and materials by manufacturers not indicated in the Specification. These shall not be included in the tender sum, but shall be shown separately in the Tender as substitutes complete with changes in price.
- .6 The Consultant reserves the right to accept or reject any substitutes without explanation.
- .7 Assume full responsibility for ensuring that when providing acceptable alternative or substitute items, all space, weight, connections, power and wiring requirements, etc. are considered. All costs incurred for additional components, changes to service, structural or space requirements, layouts and plans, etc. that may be necessary to accommodate the alternative or substitute items shall be borne by the Mechanical Divisions.
- .8 Ensure that items are suitable for operating at specified pressures and corresponding temperature where working pressure or pressure ratings are specified or shown on the drawings for valves, piping, fittings, equipment, pump schedules, etc.

2.2 PIPE HANGERS

- .1 Provide adjustable wrought iron clevis type and/or adjustable ring with threaded suspension rods, pipe hangers for horizontal pipes.
- .2 Provide extension split pipe clamps, rod threaded and sized to allow for pipe movement for vertical piping up to 63mm (2.1/2 inches) diameter. For vertical piping 75mm (3 inches) diameter and larger pipe supports consist of riser clamps or U-bolts fastened to structural steel channels or angles as necessary for the complete support.
- .3 On copper piping, provide copper plated or epoxy type hangers or provide separation of the dissimilar metals with approved dielectric materials. Insulating tape is not acceptable.
- .4 On insulated piping, provide hangers external to the insulation. Provide pipe saddles for insulation protection which allows the weight of the pipe to bear directly on the insulation saddle rather than on the insulation.
- .5 Refer to drawings or elsewhere in these specifications for special application pipe hangers as applicable.

- .6 All horizontal pipes over 150mm (6") in diameter shall have hangers supported from at least two joists.

2.3 ELECTRIC MOTORS, STARTERS AND WIRING

- .1 All electrical equipment supplied must be CSA and CEMA approved with motors manufactured in Canada with local service depots. Motor ratings scheduled or specified are output power ratings and are minimum power ratings acceptable with maximum motor speed of 1800 RPM, unless otherwise noted.
- .2 Provide all electrical equipment for single point power connection, with compatible terminations, connections and plates for the line and load side for the type and size wiring specified in Electrical Division specification or shown on the electrical drawings.
- .3 Where the power characteristics required to operate an electrical device differ from that specified or schedule, provide and wire a suitable transformer to correct the voltage of the device. Submit notice of these arrangements and provide shop drawings detailing the size, weight and wiring of the transformer and its proposed location.
- .4 Motors are ball bearing type unless noted otherwise, with continuous service rating and adequate capacity to start and run up to speed within ten (10) seconds and to operate the driven device under all conditions of load and service without overloading. Include a conduit terminal box in an approved location on each motor. Provide for all motors of 40 HP and larger, thermistors embedded in the windings of each phase for over temperature protection.
- .5 All motor starters are of one manufacturer, and all are supplied by Section 23 00 20 regardless of which mechanical Section supplied the motor.
- .6 Refer to schedules and starter legend for type required. Combination magnetic starters are complete with built-in disconnect switch; over-current protection relays in all three phases; fused control circuit; control transformer (24 volt unless indicated otherwise); hand-off-auto selector switch; running pilot light; reset button; sufficient auxiliary contacts to complete the control and interlocking sequences described in these specifications with minimum two NO and two NC contacts.
- .7 Provide prewired starter mounted control relays compatible with thermistors in the motors where applicable. Include a pilot light to indicate when the sensing device has operated and separately identified reset button.
- .8 All electrical equipment (except motors) installed in sprinklered rooms are of sprinkler proof construction as defined by Code.
- .9 Armoured (BX) control cable may be used for thermostat wiring but must conform to flame and smoke developed classification required by Authorities. Provide a minimum of 14 gauge control wiring for 50 volts and above. Provide a minimum of 18 gauge control wiring for less than 50 volts.
- .10 All magnetic motor starters are complete with moulded case circuit breakers. Fuses protecting other motor circuits are Form I Class 'J' time delay. Other fuses up to 600A are Form I Class 'J'.
- .11 Motor control centres are indoor type sprinkler proof, Class I Type B and consist of vertical sections

fabricated of code gauge steel, shaped and reinforced to form a continuous rigid, free standing, closed, complete dead front assembly. All starters are designed for front access. Each section is Type B construction with all units and individual line and control leads brought out to terminal boards suitably located in each starter. All terminal boards have at least 20% spare capacity. The design and construction of the Sections is as follows:

- The main horizontal bus is copper and rated as indicated on the drawings.
- The vertical busses in each section are copper and rated a minimum of 300 amperes.
- Bus work and supports are suitably braced to safely withstand the stresses due to maximum short circuit of 50,000 amperes RMS.
- A continuous ground bus.
- Necessary rails, blank covers and hardware, where spaces are indicated for future starters.
- Full height barrier to isolate the starter compartments from the vertical bus and a full height wiring trough with cable supports for unit wiring.
- Starters are capable of being removed from a section for maintenance without the need of disconnection the power supply to the entire motor control centre, or each specific section.
- Terminal blocks are isolated to permit working on any section within the motor control centre with the remainder of the control centre being left alive.

The design and construction of the starter units is such that the connections are free floating, self-aligning construction which enable positive silver contact at all times. Unless otherwise noted, starters are combination magnetic type complete as described above.

- .12 Provide multi-speed starters with a prewired time delay relay within the starter enclosure which will lock out the low speed for an adjustable time interval of 0-180 seconds on a transfer from high to low speed. Where multi-speed starters are controlled from an external source (control system) provide a Hand-Off-Auto (HOA) switch, and a Slow-Off-Fast switch wired through the "auto" position of the HOA switch. Provide also a mechanical interlock between the slow speed and fast speed contactors to prevent simultaneous operation.
- .13 Where starters are required to be reversing type provide a cover mounted reversing switch and include both mechanical and electrical interlocks to prevent reversing during operation.

2.4 ACCESS PANELS

- .1 Supply access panels for installation through Architectural finishes where they are required by arrangement of otherwise inaccessible equipment provided under Mechanical Divisions, such as valves, cocks, drains, air vents, dampers etc. Access panels installed in fire rated walls, partitions or ceilings bear a fire resistance rating equal to the materials in which they are installed. Supply concealed type frame and door panels for locations in tiled or plaster finishes, for matching finishes to be installed in door panel.
- .2 Provide panels in a minimum size 300 x 300mm (12" x 12") for hand access and 600 x 450mm (24" x 18") only where personnel entry is required. Panels are 12 gauge bonderized steel flush type with walls or ceiling with concealed flanges and complete with anchor straps, rust resistant concealed hinges, socket head wrench or key operated locks.

2.5 VIBRATION CONTROL EQUIPMENT

- .1 All spring isolators are complete with neoprene sound pads, zinc chromate plating on all hardware, colour coded stable springs, and levelling devices selected to operate at no greater than 2/3 solid deflection. All mounts installed where exposed to high humidity conditions shall have rust resistant paint coating and neoprene coating of the spring. Provide box style mounts with limit stops where control of lateral motion is required.
- .2 Waffle pads are neoprene of minimum 12mm (½ inch) thickness or combination neoprene-steel-neoprene pads consisting of a layer of neoprene bonded to either side of a 6mm (1/4 inch) steel plate with total 13mm (1/2 inch) thickness as scheduled.
- .3 Inertia bases have full depth perimeter structural channel frames, 18 gauge metal pan bottoms and reinforcing rods welded in place. Provide gusseted brackets welded to the steel channel sides and spring supports to carry the entire base. Fill with minimum 17 mPa concrete. Total weight of the filled bases is not to be less than the weight of the equipment isolated.
- .4 Provide structural steel bases for equipment not designed for isolator point loads. All steel bases and inertia bases clear the sub-bases at least 25mm and 50mm (1 inch and 2 inches) respectively.

2.6 HIGH EFFICIENCY MOTORS

- .1 All totally enclosed fan cooled or drip proof motors 1 HP to 500 Hp inclusive provided under the Mechanical Divisions shall have a nominal full-load motor efficiency not less than the minimum specified in CSA Standard C390-M "Energy Efficiency Test Methods for Three-Phase Induction Motors".
- .2 All motors not complying with the above will be replaced by the Mechanical Divisions at no cost to the Owner or his Agents.

PART 3 - EXECUTION

3.1 EXISTING CONDITIONS AND OTHER TRADES

- .1 Visit the site to determine existing conditions affecting the work of the Mechanical Divisions and include for the complications resulting from these conditions. Examine carefully the condition of the existing wall mounted unit ventilators.
- .2 Examine the Architectural, Structural, Mechanical and Electrical Drawings and become fully familiar with the work of all other trades. Co-operate with all other trades. Particular attention shall be paid to the proximity of electrical conduit and cable to ductwork and piping. Maintain maximum clear ceiling heights throughout.

3.2 DRAYAGE, HOISTING AND SCAFFOLDING

- .1 Assume the responsibility for drayage, hoisting, warehousing and demurrage for all equipment and materials to be furnished and installed under the Mechanical Divisions. Include for the cost of dismantling and re-assembling of equipment where required to manufacturer's approval.

3.3 CUTTING AND PATCHING

- .1 Provide all cutting and patching by qualified tradesmen or have the Contractor leave openings in walls, floors, ceilings and roof as required by the Mechanical Divisions for ducts, drains, pipes, recessed fixtures, etc. Provide the Contractor with location of all recesses and all holes for ducts, pipes, etc. before concrete is poured or walls are built.
- .2 Do all drilling for hangers, rods, inserts, etc. Use approved inserts for existing conditions and slab thicknesses.
- .3 Supply the Contractor with diagrams of all equipment bases showing exact location of anchor bolts. Provide anchor bolts as required.
- .4 All flashing required for openings in walls, floors and roofs will be provided by the Contractor unless noted otherwise on the Drawings or specified as part of the mechanical equipment being installed.
- .5 For cutting and patching performed by the Mechanical Divisions, execute to make work fit properly together. Make patches invisible in final assembly.
- .6 Fit construction tightly to duct, pipes and conduits to stop air movement completely. The Section performing work that penetrates a fire, air, vapour, moisture, thermal or acoustic separation element of the building shall pack voids tightly with rock wool; seal air, vapour and moisture barriers; and caulk joints as may be required to ensure that no air movement through the penetration is possible.

3.4 TAGS, CHART, IDENTIFICATIONS AND DATA BOOK

- .1 Provide for each major piece of equipment or apparatus engraved "Textolite" nameplates securely fastened with self-tapping screws in a conspicuous place on the equipment. Names and number correspond to those used on flow diagrams and operating instruction manuals. The lettering is minimum 6mm (1/4") high.
- .2 Identify (paint in its entirety) all gas piping provided by the Mechanical Divisions in accordance with the requirements of the Gas Code. Identify all other piping installed by the Mechanical Divisions with plastic coated adhesive tape labels, marked as to contents and direction of flow. Labels are 25 x 100mm (1" x 4") and colours are to CSA standards and space at approximately 6 meters (20ft.) apart. Provide each pipe in each room with at least one label.
- .3 Prepare three copies of an operation and instruction manual in stiff cover three-ring binders including the following:
 - Title label on outside of the cover stating name and address of the project, trade(s) involved and the name and address of the Sub- Contractor.
 - Neatly typewritten index furnishing immediate information as to location in the manual of all data regarding the installation.
 - Complete typewritten index furnishing immediate information as to location in the manual of all data regarding the installation.
 - Oiling and greasing schedule for all equipment indicating frequency and type of lubricant.

- Copy of balancing report.
 - Complete nomenclature of all replaceable parts, their part numbers, and name and address of the nearest vendor.
 - Copy of all guarantees and warranties issued on the installation, showing all dates of expiration.
 - Copy of all approved "Shop Drawings".
- .4 Provide one (1) digital copy of contents of operating and maintenance manual loaded onto a USB flash drive. All contents in digital copy shall be in Portable Document Format (PDF), and enhanced with bookmarks and internal document links. Each PDF file name shall match that indicated in the hard-copy binder.
- .5 Supply and attach to each valve installed, except draining cocks and stops at fixtures, a brass tag of 25mm (1") diameter with black numbers embossed thereon. Attach tags to the valves with a brass chain. Co-ordinate the numbering with all Sections to prevent duplication.
- .6 Prepare a chart of each system showing the equipment, the location and the numbers and purpose of each valve. Prepare a chart showing number and location of each air vent. Provide one copy of each chart in each data book as mentioned herein and install another copy of each chart framed and glazed where instructed.
- .7 Where the work is an extension of existing work, the equipment and valve tagging will follow the existing system sequentially. Co-ordinate with the Owner regarding the starting point and sequence number in accordance with sequences shown on the drawings.

3.5 INSTRUCTIONS

- .1 Provide the services of a competent Consultant to instruct personnel designated by the Owner in the proper operation and maintenance of all equipment provided by the Mechanical Divisions. Period of instruction shall be of sufficient duration to allow the Owner's designated personnel to become competent in the operation of the equipment. In addition, provide specialized instructions given by the respective manufacturers as required and as described under the appropriate articles of this Specification.

3.6 CLEANING AND PROTECTION

- .1 Protect equipment properly from dirt and damage during the construction period. Where damage occurs repair and touch up with the manufacturer's paint. On completion of the work remove all waste materials and leave the work in a clean and perfect condition.

3.7 STANDARD OF WORKMANSHIP

- .1 Only top quality workmanship using qualified tradesmen will be accepted. Work throughout shall present a neat and clean appearance on completion in a condition to receive paint.

3.8 PAINTING

- .1 The Painting Section of the Contract provides all finished painting of ducts, piping (except gas piping), equipment and fittings. Paint all gas piping in colour complying with the requirements of the local Gas Company.
- .2 Supply all equipment, etc. with manufacturer's standard prime coat as a minimum unless fabricated of non-corrosive materials.
- .3 Supply all steel piping with standard factory oil coat. Paint all field welds with zinc rich primer.

3.9 CO-ORDINATION

- .1 Mechanical Divisions are responsible for co-ordinating the work herein to suit project phasing schedule.
- .2 Co-ordinate all work with the work of any other Section or Division to avoid conflicts. Be responsible for modifying installed work of Mechanical Divisions to accommodate space conflicts.

3.10 PIPE HANGERS

- .1 Provide pipe hangers and their supports for all piping installed.
- .2 Provide protection to prevent crushing of insulation where hangers are external to the insulation. Use insulating saddles manufactured for this purpose. Size hangers to accommodate saddles and insulation.
- .3 Space support points for all piping as follows:

.1 Steel Pipe:

<u>Nominal Pipe Size</u>	<u>Distance Between Supports</u>
Up to 32mm (1.1/2")	2.4 meters (8 ft.)
38mm to 65mm (2.1/2")	3.0 meters (10 ft.)
75mm (3") and larger	3.6 meters (12 ft.)

.2 Copper Tubing:

<u>Nominal Pipe Size</u>	<u>Distance Between Supports</u>
Up to 16mm (5/8")	1.8 meters (6 ft.)
20mm to 25mm (1")	2.4 meters (8 ft.)
32mm to 50mm (2")	3.0 meters (10 ft.)
65mm (2.1/2")and larger	3.6 meters (12 ft.)

- .3 PVC Pipe:
- All Sizes
- 1.2 meters (4 ft.) centres or 1/2 lay length of pipe, whichever is less.
 - Every length of pipe exceeding 0.3 meters (1 ft.) is supported at least once.
- .4 Space all pipe hangers such that there is a hanger within 0.3 meters (1 ft.) of every bend and that the maximum spacing does not exceed the limits indicated below.
- .5 Hangers for galvanized iron pipe are spaced at maximum of 2.4 meters (8 ft.) for pipe up to 150mm (6 inches) in size, and at maximum of 3.6 meters (12 ft.) for pipe 200mm (8 inches) and larger.
- .6 Hangers for cast iron pipe are spaced at maximum of 1.5 meters (5 ft.) and at not more than 0.9 meters (3 ft.) where the pipe has mechanical joints and the length of pipe between fittings is 0.3 meters (12 inches) or less.
- .7 Vertical lines are supported at each length and at the top and bottom of each riser and at each floor level.
- .8 Do not suspend hangers from the metal roof deck or other mechanical or electrical system components.
- .9 Obtain approval from the Structural Consultant for all hangers suspended from open web steel roof joist construction.

3.11 INSERTS

- .1 Use only factory made, threaded or toggle type inserts as required for supports and anchors, properly sized for the load to be supported. Provide factory made expansion shields where inserts cannot be placed, but only where prior written instructions are obtained, and only for light weights.

3.12 EQUIPMENT SUPPORTS

- .1 Provide structurally sound supports for the installation of equipment provided by Mechanical Divisions except where supports by other Sections are specifically indicated on the drawings. When instructed, submit the designs of the supports for review. Where equipment is not designed for the points loads imposed by supports or vibration isolation, provide structural steel bases to evenly distribute the loads on the equipment.
- .2 Provide metal shims necessary for leveling all base mounted equipment and provide expanding grout under the entire base to give even support and weight distribution.

3.13 PIPE ANCHORS

- .1 Anchor piping at all points where necessary, using substantial structural steel angles, channels, or plates secured to the building structure. Do not anchor pipes to open web joists. Install piping so that it is free to expand and contract without imposing undue stresses on any branch connection, or the building structure. Allow for expansion of building where indicated on the Architectural or Structural Drawings, in all piping and ductwork crossing building expansion joints. Utilize expansion compensators or expansion loops where required to allow for pipe expansion or contraction.

3.14 SLEEVES AND ESCUTCHEONS

- .1 Provide standard weight steel pipe for sleeves passing through masonry or concrete walls and floors; 22 gauge galvanized steel for sleeves through partition walls; and minimum 75mm (3 inch) high concrete curbs for ducts or groups of pipes passing through floors. Ten (10) U.S. gauge angle iron frames around openings suitably waterproofed will be acceptable in lieu of concrete curbs.
- .2 Provide chrome plated escutcheons of one piece construction complete with set screws on exposed pipes in finished and unfinished areas where building surfaces are penetrated.
- .3 Supply to the Contractor all necessary frames for building into walls and partitions for grille outlets or passage of ducts. Provide also detailed information for location of same.
- .4 Caulk annular space between pipes and sleeves with ULC listed thermo-fibre fire-proof type insulation or Tremco Fyre-Sil fire stop sealant complying with CAN4-S115 and finished to provide fire rating required for walls and floors.
- .5 Extend sleeves passing through roof decks or floors not less than 75mm (3 inches) above finished roof or floor level and thoroughly caulk and seal. Water-proofing membranes will be flashed to sleeves by the Contractor.

3.15 ELECTRIC MOTORS, STARTERS AND WIRING

- .1 Provide electric motors complete with drives, guards and starters for all motorized equipment.
- .2 Include pilot lights, relay, transformers and other electrical devices required for the proper operation and control of the equipment.
- .3 Remote disconnect switches where required by Code are provided by the Electrical Division, unless noted otherwise. Fuses for fusible disconnects and starters for mechanical equipment are supplied by Mechanical Divisions as specified regardless of who supplied the disconnect or starter. Co-ordinate the fuses with the starter or disconnect fuse clips to ensure compatibility.
- .4 Unless specified otherwise in other Sections of Mechanical Divisions, the following principle shall apply to electric wiring:
 - All starters; electric heaters (except duct heaters); and heating cable; power wiring both line and load side of all starters; and all line voltage thermostats will be installed and wired by the Electrical Division.
 - All control wiring including wiring between thermistors and relays and interlocking wiring shall be provided by Mechanical Divisions. No wiring shall be exposed. Make all Mechanical Division power wiring conform with the requirements of Electrical Division Specifications.
 - Install all wiring by the Mechanical Divisions except as defined below in EMT conduit. Where acceptable to Authorities, armoured (BX) control cable may be used in lieu of EMT and wiring in concealed accessible areas only. Length of armoured cable shall not exceed

3m (10 ft.). Armoured control cable must be attached to the structure with suitable clips at a maximum of 1m (3 ft.) on centre. Do not attach to ductwork or other conduit. Where wiring is exposed to outdoor conditions, or poured into concrete floor, install in rigid galvanized steel conduit with threaded and gasketed weather-proof fittings.

3.16 ACCESS PANELS

- .1 Provide approved access panels to maintain access to all services, valves etc. Access panels in insulated surfaces must be of the double wall insulated type.

3.17 INSULATION

- .1 Apply insulation in a workmanlike manner by Journeymen skilled in this trade employed by acceptable contractors normally doing this type of work. Apply insulation to piping and equipment only after all tests have been successfully made.
- .2 All insulation, unless specifically excepted hereinafter has composite (insulation, jacket or facing and adhesive used to adhere the facing or jacket to the insulation) fire and smoke hazard ratings as tested by procedure complying with ASTM E-84, ULC C723, ULI 723, NFPA 255 or CAN4-S102, 2-79 requirements, not exceeding a Flame Spread Rating of 25; Smoke Developed Rated of 50; and a Fuel Contribution Rating of 50.
- .3 Pipe insulation is UL approved, 88kg/m³ (5.5lb/cu.ft.) density moulded sectional glass fibre complete with vinyl coated foil-kraft laminated vapour barrier jacket reinforced with an open mesh fibreglass scrim fabric. Thermal conductivity: 0.0335 W/m-°C at 24°C (0.232 BTU-in/hr. ft²-°F at 75°F) mean temperature. Re-cover all externally insulated piping exterior to the building with 0.5mm thick corrugated aluminum secured in place, with side longitudinal joints (facing down to shed water) and all joints lapped 100mm and sealed watertight with suitable waterproof coatings and joint sealers. Provide 3M Ventureclad 1579 Series to cover the Armaflex on the exposed refrigeration piping
- .4 Refrigerant piping is UL approved, tubular foamed plastic of closed cell structure, having a thermal conductivity of 0.039 W/m-°C (0.27 Btu-in/sq.ft.-hr-°F). Comply to requirements of local authorities and obtain approval for same before using. If disallowed use standard glass fibre insulation.
- .5 Concealed rectangular duct and all circular duct insulation is UL approved, 25mm (1") thick minimum, 16 kg/m³ (1 lb/cu. ft.) density glass fibre faced flexible blanket type with foil faced laminated vapour barrier jacket reinforced with an open mesh fibreglass scrim fabric. Thermal conductivity: 0.0409 W/m-°C at 24°C (0.283 BTU-in/hr. ft²-°F at 75°F) mean temperature.
- .6 Exposed rectangular duct insulation is UL approved 75 kg/m³ (4.5 lb/cu. ft.) density glass fibre faced rigid type with foil faced laminated vapour barrier jacket reinforced with an open mesh fibreglass scrim fabric. Insulation thickness is minimum 25mm (1), except for fresh air (outside air) which is minimum 38mm (1.1/2") thick and ductwork exterior to building which is minimum 50mm (2") thick. Thermal conductivity: 0.0337 W/m-°C at 24°C (0.234 BTU-in/hr. ft²-°F at 75°F) mean temperature.
- .7 Acoustic rectangular duct insulation is UL approved 25mm (1") thick, 72 kg/m³ (4.5 lb/cu. ft.) density glass fibre rigid type with membrane reinforced neoprene coating on one side. Plenums have 50mm (2") thick insulation.

- .8 Heating tanks, equipment and breeching insulation is UL approved 38mm (1.1/2") thick, glass fibre rigid type having a 112 kg/m³ (7 lb/ft. 3) density. Thermal conductivity: 0.0303 W/m-°C at 24°C (0.2103 BTU-in/hr. ft²-°F at 75°F) mean temperature.
9. Cold tanks and equipment can be as above in 75mm (3") thickness, or if approved for use by the local authorities, can also be Armaflex FR flexible elastomeric sheet having a thermal conductivity of 0.0412 W/m-°C (0.286 Btu-in/hr. ft²- °F) at 32.2 °C (90 °F) and 96 kg/m³ (6 lb/ft 3) density.
- .10 Insulate the following ductwork and components externally unless otherwise noted:
- All non-tempered fresh air (outside air) ductwork from the fresh air fan to the terminal outlet.
 - All supply air ducts (including silencers and acoustically lined ducts) in mechanical/service rooms, in non-conditioned spaces, and as follows:
 - Constant volume systems: From air handler or rooftop unit up to flexible branch ducts serving individual diffusers, except circular exposed ductwork external to mechanical/service rooms. Note that flexible branch ducts are pre-insulated.
 - Variable air volume systems: From air handler or rooftop unit up to flexible branch ducts serving individual diffusers, except circular exposed ductwork external to mechanical/service rooms, acoustically lined ducts and VAV and fan-powered VAV boxes. Note that flexible branch ducts are pre-insulated.
 - All outside air ductwork, mixing plenum, filter plenum, coil plenums up to fan section.
 - Fan sections or fans on outside air or air conditioning system not factory insulated.
 - Relief or exhaust air ducts or plenums at least 1524mm (5 ft.) inside of outside wall or roof or discharge damper, whichever is the greater.
 - Under damper motor support brackets.
 - All ductwork external to the building, except where noted otherwise.
- .11 Insulate the following ductwork and components internally unless otherwise noted:
- All ductwork and plenums shown on the Drawings as acoustically lined.
 - Plenums and duct access doors and panels on insulated ducts and plenums.
- .12 Insulate the following piping and/or fittings unless otherwise noted:
- All hot water heating piping and fittings throughout.
 - Equipment drain piping and condensate drains.
 - All metal piping for 1.5 meters (5 feet) from the outside wall or roof as a minimum (see also rainwater leaders below).
 - Domestic cold water including water meter body.
 - Domestic hot and tempered water supply and recirculation.
 - Horizontal sanitary and rainwater leaders above grade including rainwater hoppers, upturn and downturn fittings, couplings, etc.
 - All refrigerant piping complete.
 - All trace heated piping.
 - Install manufacturer's moulded insulation package for circuit balancing valves (CBVs) installed on insulated piping. Co-ordinate with piping trades to include moulded insulation with purchase of CBVs.
- .13 Do not insulate the following piping and/or fittings unless otherwise noted:
- Piping used exclusively for fire protection.
 - Soil stacks, vents, etc. except as noted above.
 - Unions.
 - Flexible connections or expansion joints unless noted on the drawings.
 - Check valve covers.
 - Strainer legs and bucket covers.

- .14 As applicable, insulate the following tanks, breeching and equipment unless otherwise insulated or noted:
- Domestic hot water tank.
 - Boiler stacks and breeching within the building.
 - Plate exchangers.
 - Products of combustion exhausts - including mufflers.
- .15 Do not insulate the following equipment unless otherwise noted:
- Expansion tanks.
 - Boilers.
 - Pumps (other than above).
 - Equipment nameplates or capacity plates.
 - Type 'B' or "All Fuel" factory insulated vents.
 - Products of combustion exhausts outside building except where required for personnel protection.
- .16 Unless otherwise specified re-cover all insulated exposed piping and externally insulated ductwork, tanks, breeching and equipment in finished areas and mechanical rooms with 0.271 kg/m² (8 ounce per square yard) ULC labelled thermo canvas, secure with 2 coats of fire retardant lagging adhesive. No further re-covering or finishes are required on concealed ductwork unless otherwise specified. Re-cover all internal or externally insulated ductwork exterior to the building with Venture-Clad 5-ply, stucco embossed texture, acrylic jacketing as manufactured by Venture Tape. Re-cover all externally insulated piping exterior to the building with 0.5mm thick corrugated aluminum secured in place, with side longitudinal joints (facing down to shed water) and all joints lapped 100mm and sealed watertight with suitable waterproof coatings and joint sealers.
- .17 Provide removable, internally insulated covers for manholes, removable heads, tops of split case pumps, etc. Construct covers of 1.27mm (18 gauge) aluminum, internally lined with acoustic insulation as specified elsewhere for ductwork. Provide suitable hardware as required to attach covers securely to the equipment.
- .18 Apply rigid thermal or acoustic insulation to duct and/or plenum with edges tightly butted together. Secure insulation with 2.769mm (12 gauge) galvanized pins and clips spot welded on 30.48cm (12") centres each way. Apply insulation with vapour barrier to the warm side. Where mechanical fasteners penetrate vapour barrier, and at all corners and joints, apply vapour tape or vapour barrier strips adhered with Bakelite 230-06 vapour barrier adhesive. On acoustic insulation provide metal nosing (channel or Z profile) on upstream edges of liner duct sections at fan discharge, any point where lined duct is preceded by unlined duct and at each lined duct joint to eliminate the possibility of uplift. Metal nosing is securely installed over entire traverse liner edges facing the airstream and extends minimum 50mm (2") along the leading edge of duct liner. All edges not requiring metal nosing are coated. All minor damage to the airstream surface shall be repaired by coating damaged area with approved adhesive or coating designed for duct liner application. Duct liner with major damage shall be replaced. Where duct air velocity exceeds 7.62 m/s (1,500 fpm) provide 13mm x 13mm (1/2" x 1/2") galvanized expanded metal mesh on the first 3m (10 feet) of duct liner off of the discharge of a fan secured with the mechanical fasteners.

- .19 For flexible insulation on rectangular ducts 762mm (30") or more in width, apply mechanical fasteners to bottom surface at approximately 45.7cm (18") centres. At joints and where mechanical fasteners penetrate the vapour barrier apply vapour barrier tape or cover with heavy coating of vapour barrier adhesive.
- .20 Hold pipe covering without integral jacket in place with insulation fastenings at not less than 305mm (12") centres. Hold pipe covering with integral jacket in place by stapling the flap on 76mm (3") centres. Apply pipe covering with integral vapour barrier jacket to piping and hold in place by securing the jacket flap. Seal all flaps and butt strips with Bakelite 230-60 vapour barrier coating adhesive and lap sealer. Insulate fittings, valves and strainers with sections of the pipe covering mitred to fit tightly, or insulation cement, or with tightly placed flexible insulation covered with reinforcing membrane stapled in place. Apply hard coat finishing cement over insulating cement. Leave drains, blow-off plugs and caps uncovered. Insulate flanges with oversized pipe covering or mitred blocks to the thickness of the adjacent pipe covering. Terminate insulation 76mm (3") from fittings to provide working clearance and bevel insulation at 45 degree angle.
- .21 Pipe insulation conforms to the following table, as applicable:

<u>Application</u>	<u>Pipe Size</u>	<u>Insulation</u>
Chilled water supply, brine, refrigerant piping (T ≥ 4.5°C)	Up to 50mm (2") 65mm - 200mm (2.1/2"-8") 250mm (10") and larger	25mm (1") 38mm (1.1/2") 50mm (2")
Chilled water supply, brine, refrigerant piping (T < 4.5°C)	Up to 25mm (1") 32mm - 200mm (1.1/4"-8") 250mm (10") and greater	25mm (1") 38mm (1.1/2") 50mm (2")
Chilled water return	All sizes	25mm (1")
Heating water and glycol supply and return	Up to 32mm (1.1/4") 40mm (1.1/2") and greater	38mm (1.1/2") 50mm (2")
Domestic cold water	All sizes	25mm (1")
Domestic hot and recirc. water	Up to 32mm (1.1/4") 40mm (1.1/2") and greater	25mm (1") 38mm (1.1/2")
Condensate drains	All sizes	12mm (1/2")
Horizontal storm and sanitary	All sizes	12mm (1/2")

<u>Application</u>	<u>Pipe Size</u>	<u>Insulation</u>
Piping electrically traced	Up to 90mm (3.1/2") 100mm (4") and larger	50mm (2") 65mm (2.1/2")
Steam ($T \leq 121^{\circ}\text{C}$) and condensate	Up to 90mm (3.1/2") 100mm (4") and greater	65mm (2.1/2") 75mm (3")
Steam ($T > 121^{\circ}\text{C}$) and condensate	Up to 20mm (3/4") 25mm - 32mm (1"-1.1/4") 40mm (1.1/2") and greater	75mm (3") 100mm (4") 115mm (4.1/2")

3.18 INSTALLATION OF UNDERGROUND PIPES

- .1 Install pipes in trenches on Class 'B' bedding on solid stable soil. Extend Class 'B' bedding to 305mm (1'-0") above piping and finish with approved material above. Where solid stable soil bed is unobtainable, install pipes on concrete bed, solid concrete block, concrete piers or other approved bedding provided by Mechanical Divisions, to the satisfaction of local Authorities.

3.19 EXCAVATION AND BACKFILL

- .1 Provide all excavation and backfill in strict accordance with the requirements of the Authorities having jurisdiction. In the existing building areas which are to remain, the excavation shall include all necessary saw cutting of floors and walls.
- .2 Grade excavation by hand at the trench bottom to fit the lower 1/3 segment of the pipe and to ensure even bearing along the barrels; prepared so that no portion of the pipe bears directly on rock or other hard surface, kept dry at all times; protected from freezing and damage by weather; deep enough to remove all silt, etc. and to provide for an adequate bedding.
- .3 Where excavation is carried to depth greater than shown, replace the extra excavation with 10.3 MPa (1500 psi) concrete at no extra cost. Where excavation is necessary in close proximity to and below any footing level, backfill shall be 20.6 MPa (3000 psi) concrete up to the level of the top of the highest adjacent footing.
- .4 Do not commence backfilling until the work is reviewed, accepted and approved. Backfill all pipe trenches under pavement and under the building with sand and granular materials.
- .5 Backfill trenches with granular materials applied in 150mm (6 inch) deep layers, and compacted to not less than 97% Modified Proctor and brought up to the spring line of all buried piping from a trench depth which has been cleared of silt. Fill the remainder of trench depth to within 0.3 meters (1 foot) of finished elevation with sand applied in 150mm (6 inch) layers and compacted to 97% Modified Proctor. Addition of water is limited to that required for production of optimum moisture content, and "puddling" of backfill will not be permitted. Do not use frozen earth for backfilling nor place any backfill against frozen ground.
- .6 Where settlement occurs fill depressions to restore correct grades. Be responsible for making good any subsequent settlement to fill placed, and pay all costs involved in making good paving, floors, lawns, curbs and other surfaces damaged by such settlement.

- .7 Pile and store excavated materials under the direction of the Contractor to ensure a minimum of inconvenience to all trades. Remove and dispose of all remaining excavated material on completion of the work and the site left clear and unencumbered.

3.20 CONCRETE

- .1 Provide all concrete work for the support of all piping laid in backfilled ground and include concrete bed, solid concrete block or concrete piers to the approval of the local Inspectors. Concrete is 10.3 MPa (1500 psi) at 28 days complete with reinforcing steel as required, and complies with the Concrete Division of the Specification.
- .2 Provide all cast-in-place concrete, including concrete bases for equipment, concrete curbs for pipe/duct floor penetrations, trench drains, etc., unless otherwise noted.
- .3 Provide all precast concrete work, including catch basins, manholes, etc.

3.21 COMMISSIONING

- .1 Each trade Section of the Mechanical Division shall include for the cost of one qualified serviceman, completely familiar with the project, complete with appropriate spare parts and tools, to become part of the commissioning team for the project. The serviceman shall assist the Owner for a total of 10 hours during the commissioning process. This work will be required at or near the substantial completion phase of the project. Each Division and/or trade providing servicemen shall ensure continuity of their function by having only one such person assigned to the commissioning team. The actual performance of this work will be scheduled and coordinated by the Owner.

3.22 SCHEDULE FOR COMPLETION

- .1 All work must be substantially performed by the date as indicated in Division Zero, Bidding Requirements.

3.23 INSPECTION AND TESTING

- .1 All inspection and testing of all equipment and systems as required by Regulatory Authorities, as well as all piping and ductwork pressure testing and chemical flushing and cleaning, shall be witnessed by the Owner and the Owner's written acceptance obtained. Minimum 48 hours prior notice of such inspections and testing shall be given to the Owner.

3.24 DEMOLITION

- .1 Demolition of existing mechanical materials and/or equipment as shown on drawings is by Mechanical Divisions, as applicable. Work shall be carried out in strict accordance with applicable Provincial and Municipal By-Laws and Regulations.
- .2 Mechanical Divisions (as applicable) shall disconnect and remove all equipment designated for removal, reinstall all reused equipment, reconnect all equipment where required and disconnect and cap, or arrange for disconnecting and capping, all main services in accordance with the authorities having jurisdiction, including purging of existing natural gas piping. Active services to the existing facility shall be protected and maintained without interruption.

- .3 In each case, as applicable, the affected utility company shall be notified in advance and their approval obtained where required before commencing with the work on the main mechanical services.
- .4 All materials and/or equipment designated to be reused shall be reinstalled. All materials and/or equipment designated for salvage shall be turned over to the Owner. All other materials and/or equipment designated for removal become the property of the demolition contractor and shall promptly be removed from site. Under no circumstances shall the materials and/or equipment be sold directly from the site.
- .5 Contact the Owner prior to any demolition work. The Owner will designate in writing which equipment and/or materials are to be salvaged. Minimum 48 hour notice shall be given to the Owner.
- .6 Salvaged equipment and/or materials will be picked up by the Owner on site or as directed by the Owner. Delivery of salvaged equipment and materials to Owner's transport vehicles on site, including vehicle loading, shall be the responsibility of the demolition contractor.
- .7 Exercise extreme care during removal, transportation, storage, handling, loading, etc. of reused and salvaged equipment and/or materials.
- .8 Submit to the Consultant an itemized record, signed by both demolition contractor and Owner, of items picked up by the Owner.

END OF SECTION 23 00 10

I N D E X

<u>ARTICLE NO.</u>	<u>DESCRIPTION</u>
<u>PART 1: GENERAL</u>	
1.1	Requirement
1.2	Conformance to Architectural & Structural Layouts
<u>PART 2: PRODUCTS</u>	
2.1	Piping Systems
2.2	Piping Specialties
2.3	Valves
2.4	Modular Air-Cooled Variable Refrigerant Flow System
2.5	Refrigerant Piping
2.6	Convectors and Finned Tube Elements
2.7	Energy Recovery Ventilator (ERV)
2.8	Hot Water Unit Heaters and Cabinet Heaters
<u>PART 3: EXECUTION</u>	
3.1	Piping Installation
3.2	Hydronic Systems' Testing
3.3	Hydronic Systems' Balancing

PART 1 - GENERAL

1.1 REQUIREMENT

- .1 Sections 21 00 00 and 23 00 10 form part of this Section. Related work is specified in Sections 23 00 30, 23 00 40 and 25 00 00. Refer to same.

1.2 CONFORMANCE TO ARCHITECTURAL & STRUCTURAL LAYOUTS

- .1 Ensure that all equipment and piping can be installed in the locations indicated. Refer to Architectural and Structural Drawings and Specification to establish the existence of interferences. Make changes to the routing of piping and shifting of equipment locations to accommodate structural conditions and work of other trades at no change to the Contract Price.

PART 2 - PRODUCTS

2.1 PIPING SYSTEMS

- .1 All fabrication, welded or otherwise meets the requirements of the ASA B-31.1 code for pressure piping and the CSA 15-1951 Canadian regulation for the construction of boilers and pressure vessels. All pipe welding is done by a welder holding a certificate from the Department of Labour for the class of piping to be welded.
- .2 Class 1 Systems includes low pressure steam condensate as applicable. Piping is black steel to ASTM A-53 minimum Schedule 80. Fittings for piping 50mm and smaller are screwed ends, 1720 kPa (250 psig) cast iron. Fittings for larger piping are Schedule 80 black steel butt welding type. Flanges and accessories, unions, strainers, gate, globe and check valves are as specified herein for low pressure steam service.
- .3 Class 2 Systems includes low pressure steam less than 860 kPa (125 psig), heating water and heating glycol less than 121°C (250°F) and 1035 kPa (150 psig), chilled water and condenser water less than 66°C (150°F) and 1035 kPa (150 psig). Piping is black steel to ASTM A-53 minimum Schedule 40. Fittings for piping 50mm and smaller are screwed ends, minimum 1035 kPa (150 pound) Malleable Iron: fittings for larger piping are standard black steel butt welding type. For branch to main tap-in connections use Weldolets for sizes larger than 50mm; use Thredolets for sizes 50mm or smaller. Make flanges a minimum 1035 kPa (150 pound) standard carbon steel for sizes larger than 50mm and they may be of the welding neck or slip on welding types. Gaskets for flanged joints are 1.6mm (1/16") approved for the applicable service.
- .4 Class 3 Systems include domestic water piping above grade, cold water make-up piping and cooling tower sump filter piping, all suitable for a minimum working pressure of 1375 kPa (200 psi). Conform to applicable plumbing and building codes. Piping is type 'L' hard drawn copper tubing to ASTM B88 standard, sweat pattern, connected using 95 percent tin and 5 percent antimony solder.
- .5 Class 4 Systems include condensate drains, vents and surface drains from equipment. Piping is DWV copper pipe to ASTM A306 standard and fittings are sweat pattern copper or brass.

- .6 Class 5 Systems include refrigerant piping. Piping is type K seamless copper tubing, soft temper for 16mm (5/8") OD and smaller, hard temper for 19mm (3/4") OD and larger. Joints to be silver solder.
- .7 Mechanical grooved pipe fittings and couplings are not acceptable.

2.2 PIPING SPECIALTIES

- .1 Manual air vents are nickel-plated screwdriver operated vent cock type with 6mm (1/4") O.D. copper tubing connections to air chambers. Automatic air vents are float type, designed for minimum 860 kPa (125 psi) complete with isolating cocks. Make air eliminator fittings full line size complete with an automatic air vent. Provide automatic air vents at all high points in each closed water system and at all other points necessary to free the system from air binding. Vents installed in concealed locations are equipped with type 'L' copper drain tubing run to the nearest drain and complete with access panel for servicing.
- .2 Strainers are 'Y' type unless specified otherwise with monel or stainless steel screens having 1.5mm (1/16") perforations. Strainers 50mm (2") smaller have cast iron body with screwed end and screw-in cap. Strainers larger than 50mm (2") have iron body, flanged ends, minimum 20mm (3/4") threaded blow down connection and plug, bolt-on cover. Strainers 50mm (2") and smaller on copper lines have bronze body with screwed end and screw-in cap.
- .3 Suction guides at pump inlets are designed for direct connection to the pump; conforming to the specifications for strainers herein and have full pipeline size inlets and outlets, and tappings for gauge connections.
- .4 Unions are ground joint type, brass seat, wrought iron body.
- .5 Backflow preventers are listed; conforming to the requirements of the Plumbing and Drainage Section and are Watts No. 900 Series. Water make-up assemblies consist of pressure reducing valves with built-in strainer, check valves, pressure relief valve, pressure gauge and three valve bypass. Make assemblies minimum 20mm (3/4") size.
- .6 Pressure gauges are Bourdon type, minimum one percent accuracy throughout the entire range, complete with phosphor bronze full size Bourdon tube, forged brass socket, brass rotary movement, bronze bushings, cast aluminum case. Mount tube and movement independently from the case for shock protection. Gauges are minimum 110mm (4 1/2") dial size, black case, black ring, silver brazed joints, METRIC/IMPERIAL indication. Use liquid filled gauges for application directly on pumps. Select gauges to suit fluid working pressure and where possible the test pressure. Where test pressure falls outside safe instrument range, attach a note to this effect to the installation instructions. The normal working pressure occurs at approximately mid-scale. Install each gauge complete with 6mm petcock and provide snubbers (restrictors) in the connection where pressure surges could cause damage to the gauge. For steam services also provide a coil syphon between gauge and steam to prevent the steam from reaching the bourdon tube. Provide a gauge at the inlet and discharge of all water coils, boilers, pumps, heat exchangers and where detailed on the drawings.

- .7 Thermometers for installation in piping are minimum 225mm (9") adjustable angle type with blue/black aluminum finish, clear acrylic plastic lens, white scale with black figures, brass stems, chrome plated brass sockets and fittings, brass separable wells, combination METRIC/IMPERIAL temperature indication. Provide thermometers at the inlet and discharge of all water coils, boilers, condensers, heat exchangers, water heaters, and where detailed on the drawings.
- .8 Wells for temperature sensing will be supplied by Section 25 00 00 for installation by this trade Section. Install in piping systems as directed.

2.3 VALVES

- .1 Valves are line size having a minimum rating of 860 kPa (125 psig) saturated steam and 1375 kPa (200 psig) water. Rate valves for the specified services and pressures. Except for specialty valves, all valves are of one manufacturer; bear the manufacturer's name and the pressure rating cast or stamped on the body. All valves have non-asbestos packing. Valve operators have sufficient neck extension to clear pipe insulation. Before the date of Substantial Completion, turn over two sets of lockshield valve keys for each size of lockshield valve installed. Use metals in bronze valves conforming to ASTM B62 standard. Shut-off valves installed more than 3 meters above floors or service platforms have chain operators. Use iron in iron valves conforming to ASTM A-126 standard, Class "B" or "C".
- .2 Gate and globe valves are designed to allow repacking under pressure when fully open; have rising stems unless specified otherwise or unless space is not available. Obtain written instructions to use valves with non-rising stems. Unless noted otherwise, provide gate and globe valves with handwheels. All valves 50mm (2") and smaller are bronze with screwed ends. All larger valves are cast iron body, bronze trim, flanged ends.
- .3 Gate valves 50mm (2") and smaller have solid wedge disc, union or screw-in bonnet. Gate valves larger than 50mm (2") have O.S.&Y., solid wedge disc, bolted bonnet.
- .4 Globe valves 50mm (2") and smaller, except for steam service, have replaceable composition disc, union bonnet. Globe valves 50mm (2") and smaller for steam service have stainless steel disc and seat ring, union bonnet. Globe valves larger than 50mm (2") have O.S.&Y., bronze disc, renewable bronze seat ring, bolted bonnet.
- .5 Check valves 50mm (2") and smaller, except for pump discharge or pipes with pulsating flow, are swing type with regrindable seat and screw-in cap. Check valves larger than 50mm (2"), except for pump discharge or pipes with pulsating flow, are swing type with regrindable seat and bolted cap. Check valves for pulsating flows such as pump discharge are silent check type, bronze trim, spring loaded, globe or wafer type body, stainless steel disc, renewable composition seal for tight shut-off and non-corroding spring.
- .6 Butterfly valves are an acceptable substitute for gate valves installed in water systems which do not exceed the valve pressure and temperature ratings. Butterfly valves are not acceptable on steam services. Butterfly valves are lug type with cast iron body; floating disc; replaceable high temperature EPDM lining; bubble-tight shut-off to 1103 kPa (160 psi) when downstream piping is removed. Valves 150mm (6") and smaller have a bronze or stainless steel disc and 10 position lever handle. Valves larger than 150mm (6") have a bronze or stainless steel disc and a handwheel operator. Where the optional grooved piping system is used, grooved end butterfly valves may be used in sizes 63mm (2-1/2") through 300mm (12") in lieu of gate valves, but the valves must conform to the specifications herein.

- .7 Circuit balancing valves are globe style, equal to Tour & Andersson STA, with the following design features: flow measurements; flow balancing with vernier-type handwheel settings; positive shut-off with no-drip seat/plug type stem with Teflon disc; tamperproof hidden memory; positive shut-off metering valves for connection of portable differential pressure meter. All valves are rated at 1725 kPa (250 psi) maximum working pressure, 121 degrees C (250 degrees F) maximum operating temperature. Valves 50mm (2") and smaller have all metal parts of non-ferrous pressure die cast hard copper alloy, NPT connections, built-in 20mm (3/4") drain connection with shut-off valve and protective caps (except 50mm (2") size). Valves larger than 50mm (2") have cast iron body with hard copper alloy trim, 860 kPa (125 psi) flanged connections. All valves to be complete with minimum 4.5 R-factor insulation moulded specifically for the valve size. Install insulation on valves as part of the piping system overall insulation.
- .8 Ball valves have bronze body with screwed ends, large bore, double-seated hard-chromium plated brass ball, resilient seat, blow-out proof stem with "O" ring material designed for the service, quarter turn lever operated with stop, bubble-tight shut-off. In general ball valves are an acceptable substitute for gate valves in water systems except that gate valves shall be provided where temperature and pressure ratings of the piping system exceed valve ratings. Ball valves are not acceptable on steam services.
- .9 Plug valves are cast iron body with bronze plug, eccentric action, non-lubricated type with oil impregnated sintered metal bushings, resilient seals, quarter turn lever operated, bubble-tight shut-off.
- .10 Drain valves are ball type complete with anti-condensing cap and chain.

2.4 MODULAR AIR-COOLED VARIABLE REFRIGERANT FLOW SYSTEM

- .1 The specified mechanical system shall be a VRF (variable refrigerant flow) air conditioning system. The high efficiency modular Variable Refrigerant System shall consist of variable speed drive scroll compressor air cooled condensing units each supplying a maximum of up to fifty (50) indoor fan coil units based on a series of modular outdoor units providing 72 - 360 MBH nominal cooling capacity. The Variable Refrigerant System shall be a refrigerant two pipe configuration capable of providing cooling or heating to the designated zone. The units carry a standard ten year warranty on parts and compressors, material warranty provided by the manufacturer and labour warranty provided by the contractor. The system installation shall be supervised, tested and commissioned by Daikin trained technician, (i.e. refrigerant, piping and control integration and programming), for a complete operational system. The commissioning shall be in strict conjunction with the building automation system contractor.

.2 Air-Cooled Condensing Units

.1 General:

The Variable Refrigerant System shall consist of the outdoor unit, indoor units, and D-III controls. The outdoor unit shall be specifically used with VRF indoor and control components. The outdoor units shall be equipped with multiple circuit boards that interface to the D-III controls system and shall perform all functions necessary for operation. The outdoor unit shall have a powder coated finish. The outdoor unit shall be completely factory assembled, piped and wired. Each unit shall be thoroughly run tested at the factory without exception. Alternate product offerings shall provide the owner with written confirmation and results for the factory run test on each unit.

.2 System Performance Rating:

The system shall consist of be one (1), two (2) or three (3) modular units piped together in the field using a factory supplied multi connection piping kit. Once connected they shall operate as one unit alternating compressor run cycles to balance total compressor operation hours.

.3 Acoustic Performance:

Outdoor unit shall have a sound pressure level (SPL) rating no higher than a maximum of 64 dB (A) individually or a collective maximum sound pressure rating of 67 dB (A) when combined with other modules in a system. The sound pressure rating is as measured a horizontal distance 1 m from the unit. The individual modular unit shall have a low sound operational mode where the SPL rating is no higher than 50 dB (A) or 55 dB (A) when combined in a single system with other PUHY modules (night mode operation operation). Alternate product offerings shall provide all necessary factory or field acoustic treatment as required to achieve or exceed the above performance levels at no additional cost to the owner.

.4 System Refrigerant Pipework:

Both refrigerant lines from the outdoor unit to indoor units shall be individually insulated. The outdoor unit shall have an accumulator with refrigerant level sensors and controls. The outdoor unit shall have a high pressure safety switch, over-current protection and DC bus protection. The outdoor units shall have the ability to operate with a maximum height difference of 164 feet and can, when combined in a modular format have a total refrigerant tubing length of 3,280 feet when serving up to Qty 50 indoors units. The greatest length is not to exceed 540 feet between the outdoor unit and the indoor units without the need for line size changes or traps. The Modular Variable Speed Drive outdoor unit shall have rated performance for operation in heating mode and cooling as indicated on the technical performance data sheets. The outdoor unit shall have a high efficiency oil separator plus additional logic controls to ensure adequate oil volume in the compressor is maintained. Each condensing unit shall be provided with pre-piped isolating valves, sight glass, flexible connections.

.5 Condensing Unit Cabinet Construction:

The casing(s) shall be fabricated of galvanized steel, bonderized and finished with a powder coated baked enamel. Units cabinets shall be able to withstand 1000 hours of Salt Spray (ASTMB117 & Blister Rating:10), Acetic acid salt spray test of 500 hours (ASTM G85 & Blister Rating:10)

- .6 Variable Speed Condenser Fan:
The modular outdoor unit module shall be furnished with one direct drive, inverter driven, variable speed propeller type fan. The unit shall be manufactured and factory set for operating under 0.12 'WG external static, but capable of operation under a maximum of 0.32" W.G external static via a dipswitch setting. The fan motor shall have inherent protection, have permanently lubricated bearings, and be completely variable speed. The fan motor shall be mounted for quiet operation. The fan shall be provided with a raised guard to prevent contact with moving parts. The outdoor unit shall have vertical discharge airflow.
- .7 Refrigerant:
R410A refrigerant shall be required for modular outdoor unit system.
- .8 High Efficiency Condenser Coil:
The outdoor coil shall be manufactured from Hi-X seamless copper tubes with N-shape internal grooves mechanically bonded on the aluminum fins to an e-Pass Design. A minimum clearance of 1 3/8" shall be allowed between modular units to facilitate sufficient air flow across the wrap around condenser coils. The coil fins shall have a factory applied corrosion resistant blue-fin finish particularly effective in urban environments. The anti-corrosion hydrophilic blue coating treatment is a standard feature on all condensing units .The outdoor coil shall include four (4) circuits with two position valves for each circuit, except for the last stage. The coil shall be protected with an integral metal guard. Refrigerant flow from the outdoor unit shall be controlled by means of an inverter driven compressor.
- .9 High Efficiency Inverter Scroll Compressor:
The High Efficiency Modular Air-cooled outdoor units shall be provided complete with an inverter driven scroll hermetic compressor(s) (72 MBH one compressor single fan and 96/120/144 MBH single compressors twin fan) as manufactured and designed by the manufacturer. The compressor motor shall be of DC Brushless configuration with AUTO TUNING INVERTER control to achieve optimum compressor/motor performance levels particularly during off design conditions. Non inverter-driven compressors shall not be deemed acceptable for this application. Compressors driven by induction are not allowed in this instance. A crankcase heater(s) shall be factory mounted on the compressor(s).Each compressor shall be capable of modulation down to 11% of rated capacity. The compressor(s) shall be equipped with an internal thermal overload. The compressor shall be mounted to avoid the transmission of vibration.
- .10 Unit Electrical Characteristics
The outdoor unit electrical power shall be 208 volt, 3 phase, 60 hertz. The outdoor unit shall be controlled by integral microprocessors. The control circuit between the indoor units and the outdoor unit shall be 16VDC completed using a stranded non shielded 18-2 AWG cable to provide total integration of the system. The inrush current to the outdoor unit shall not exceed the design full load amp FLA rating for the unit. Alternate systems with solid state or constant speed scroll compressors with significant inrush current characteristic will not be acceptable for this application.

- .11 Modular Configuration:
The outdoor units shall consist of one, two or three modules each rated for the designated proportion of the total system cooling/heating capacity. Each module is furnished with a Daikin manufactured inverter driven scroll compressor and inverter driven variable speed propeller type condenser fan. Single compressor individual outdoor condensing units with capacities in excess of 144,000 Btu's are not acceptable for this application based on reduced operational life cycles and limited compressor redundancy levels. The modular outdoor unit combinations are designed so as to balance the run hours seen by each individual inverter driven scroll compressor in order to extend overall outdoor unit life cycle and reduced ongoing maintenance costs. The modules shall be installed in a side by side configuration without the need for intermediate oil balancing pipework. Alternate modular systems which require additional onsite oil balancing infrastructure between modules shall not be deemed appropriate for this application.
- .3 Variable Refrigerant Flow Indoor Units
- .1 General:
The total capacity of the indoor units shall be between 50 and 200% of the capacity of the outdoor unit. Each indoor unit will have a heat exchanger which shall be constructed from copper tubing with aluminum fins. The flow of refrigerant through the heat exchanger will be controlled by electronic proportional expansion valve. This valve will be controlled by two pipe thermistors and a return air thermistor and shall be capable of controlling the variable capacity of the indoor unit between 25% and 100%. Each indoor unit will require a 208-230 vac power supply. Control will be via the 16 VDC D-III data control signal from the outdoor unit. Different models of indoor units suit different applications. Provide variable refrigerant flow indoor units as scheduled.
- .4 Roundflow Ceiling-Recessed Cassette with Decoration Panel Indoor Unit
- .1 General:
The unit shall be a roundflow cassette style indoor unit that recesses into the ceiling with a ceiling grille. The unit shall be used with the outdoor unit module(s). The unit shall support individual control using D-III controllers.
- .2 Indoor Unit:
The indoor unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, electronic modulating linear expansion device, control circuit board and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, an auto restart function, an emergency operation function, a test run switch, and the ability to adjust airflow patterns for different ceiling heights. Indoor unit and refrigerant pipes shall be charged with dehydrated air before shipment from the factory.
- .3 Unit Cabinet:
The cabinet shall be space-saving ceiling-recessed cassette. The cabinet panel shall have provisions for a field installed filtered outside air intake. Branch ducting shall be allowed from cabinet. The unit shall have a round flow 360° air distribution. The grille vane angles shall be individually adjustable from the wired remote controller to customize the airflow pattern for the conditioned space.

- .4 Fan:
The indoor fan shall be an assembly with a variable speed direct drive DC type fan. The indoor fan shall be statically and dynamically balanced to run on a motor with permanently lubricated bearings. The indoor fan shall consist of 3 user-selectable fan speeds. The automatic fan speed mode shall allow the fan to vary between 5 speeds based on space load. The indoor unit shall have an adjustable air outlet system offering 4-way airflow, 3-way airflow, or 2-way airflow. The indoor unit shall have switches that can be set to provide optimum airflow based on ceiling height and number of outlets used. The indoor unit vanes shall have 5 fixed positions and a swing feature that shall be capable of automatically swinging the vanes up and down for uniform air distribution. The vanes shall have an Auto-Wave selectable option in the heating mode that shall randomly cycle the vanes up and down to evenly heat the space. The grille shall have an i-see sensor that will measure room temperature variations and adjust the airflow accordingly to evenly condition the space.
- .5 Filter:
Return air shall be filtered by means of a washable filter
- .6 Coil:
The indoor coil shall be of nonferrous construction with smooth plate fins on copper tubing. The tubing shall have inner grooves for high efficiency heat exchange. All tube joints shall be brazed with phos-copper or silver alloy. The coils shall be pressure tested at the factory. A condensate pan and drain shall be provided under the coil. The unit shall be provided with an integral condensate lift mechanism that will be able to raise drain water 33-1/2 inches above the condensate pan. Both refrigerant lines to the FXFQ indoor units shall be insulated. A condensate pump shall be provided integral to the unit, prewired and prepped.
- .7 Electrical:
The unit electrical power shall be 208/230 volts, 1-phase, 60 hertz
- .8 Controls:
This unit shall use controls provided by the manufacturer to perform functions necessary to operate the system. The manufacturer approved VRF installer shall provide and install a complete operational control system and shall interface with the BAS system.
- .5 Wall Mounted Indoor Unit
- .1 General:
The unit shall be a wall mounted indoor fan coil that mounts below the ceiling and shall have a modulating linear expansion device. The indoor unit shall be used with the outdoor unit. The indoor unit shall support individual control using D-III controllers.
- .2 Indoor Unit:
The indoor unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, electronic modulating linear expansion device, control circuit board and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, and an auto restart function. Indoor unit and refrigerant pipes shall be charged with dehydrated air before shipment from the factory. Condensate pump shall be field installed.

- .3 Unit Cabinet:
The cabinet shall be constructed with sound absorbing foamed polystyrene and polyethylene insulation.
- .4 Fan:
The indoor unit fan shall be direct drive cross flow with statically and dynamically balanced impeller with high and low speeds available. The unit shall have an auto-swing louver which ensures efficient air distribution, which closes automatically when the unit stops.
- .5 Filter:
Return air shall be filtered by means of a washable filter
- .6 Coil:
The indoor coil shall be of nonferrous construction with smooth plate fins on copper tubing. The tubing shall have inner grooves for high efficiency heat exchange. All tube joints shall be brazed with phos-copper or silver alloy. The coils shall be pressure tested at the factory. A condensate pan and drain shall be provided under the coil. A condensate pan and drain shall be provided under the coil. Both refrigerant lines to the indoor units shall be insulated. A condensate pump shall be provided integral to the unit, prewired and prepiped.
- .7 Electrical:
The unit electrical power shall be 208/230 volts, 1-phase, 60 hertz.
- .8 Controls:
This unit shall use controls provided by the manufacturer to perform functions necessary to operate the system. The manufacturer approved VRF installer shall provide and install a complete operational control system and shall interface with the BAS system.

2.5 REFRIGERANT PIPING

- .1 Submittals:
 - .1 Submit in shop drawing form, a schematic piping diagram for each refrigerant piping system indicating pipe size, slopes, valves, traps and piping specialties. Piping schematic must be reviewed, approved and signed by the refrigeration equipment manufacturer prior to being submitted to the consultant for review. Contractor must be one of the approved contractors of the manufacturer.
 - .2 Submit details from the equipment supplier outlining proper installation and startup.
- .2 Regulatory Compliance and Quality Assurance:
 - .1 Installing Contractor must be TSSA certified and shall register all projects sized at 5 tons or greater for air conditioning application and 3 tons or greater for refrigeration applications.
 - .2 A copy of the TSSA registration shall be submitted to the mechanical consultant of record.
 - .3 All components of a refrigeration piping system must have a Canadian Registration Number or CSA certification acceptable to TSSA.
 - .4 All systems shall display appropriate Ozone Depletion Prevention (ODP) tags prior to commissioning. Manufacturer shall not commission any system not displaying proper ODP tag.

- .5 Pressure relief valves shall be installed in pairs (two valves per refrigeration circuit) using a purpose built “Y” fitting similar or equal to Superior Products model 3155W. Relief valve assembly must be complete with an integrated ball valve. Assembly shall be supplied and installed on both the liquid and suction line, or liquid and discharge line as per drawing details. Pressure relief valves shall be individually isolated to allow for maintenance and replacement every five years as mandated by the code (refer to CSA B52 section 8.4.2). Authority Having Jurisdiction may require systems to vent pressure relief devices to outside.

- .3 Special Considerations for VRF Refrigerant Piping Systems:
 - .1 VRF refrigeration piping systems shall be installed as per the balance of this specification with the following considerations and exceptions:
 - .2 Refrigerant piping contractors must be trained and certified by VRF equipment supplier. Proof of training certification must be made available upon request.
 - .3 There shall be minimal use of refrigeration specialties (filter driers, accumulators, receivers, sight glasses, check valves, shut-off valves, flexible connectors, etc.) in the VRF piping system. Refer and follow Manufacturer’s recommendations in this regard.
 - .4 Y style piping joints and headers provided by the manufacturer shall be used to ensure proper refrigerant balance and flow for optimum system capacity and performance.
 - .5 T style joints and/or joints provided by the installing contractor, or Y joints not purchased from the manufacturer are not acceptable.
 - .6 Approved R-410a flaring block, and approved torque wrenches, both available from VRV manufacturer, shall be used for all flare connections.
 - .7 All indoor refrigerant lines shall be insulated with minimum ½” wall diameter Armaflex.
 - .8 All outdoor refrigerant lines shall be insulated with minimum ¾” wall diameter Armaflex and suitable for outdoor service. Exposed insulation shall be protected by aluminum, that is water resistant and provides shielding from solar radiation.
 - .9 Pipe clamps shall fasten around the piping insulation. Pipe clamps that compress the copper directly shall be installed a minimum of 36” away from RefNet joints, and shall be loosely tightened to allow for copper expansion.
 - .10 Contractor shall provide VRF manufacturer with all actual pipe lengths installed for calculation of refrigerant charge. Refrigerant piping contractor shall supply and charge VRF system with required quantity of R-410a prior to VRF manufacturer commissioning. Refrigerant charging shall be done in the liquid state.

- .4 Pipe, Fittings and Joints:
 - .1 All copper piping shall be air conditioning / refrigerant grade ASTM B280, annealed or hard drawn as required. Soft annealed copper tubing shall not be used in sizes larger than 22 mm (7/8 inches). Joints shall be brazed except that joints on lines 22 mm (7/8 inch) and smaller may be flared. Fittings shall be cast copper alloy for flared copper tube, or wrought copper and bronze solder-joint pressure fittings. Joints and fittings for brazed joint shall be

wrought-copper or forged-brass sweat fittings. Cast sweat-type joints and fittings shall not be allowed for brazed joints. Brass or bronze adapters for brazed tubing may be used for connecting tubing to flanges and to threaded ends of valves and equipment.

- .2 Filler metal shall be type BAg-5 with AWS Type 3 flux, except Type BCuP-5 or BCuP-6 may be used for brazing copper-to-copper joints.
- .3 Brazing rods for all joints shall be 15% Lucas Milhaupt "sil-Fos".
- .5 Valves
 - .1 Valves shall be designed, manufactured, and tested specifically for refrigerant service. Valve bodies shall be of brass, bronze, steel, or ductile iron construction. Valves 25 mm (1 inch) and smaller shall have brazed or socket welded connections. Valves larger than 25 mm (1 inch) shall have butt welded end connections. Threaded end connections shall not be used, except in pilot pressure or gauge lines where maintenance disassembly is required and welded flanges cannot be used. Internal parts shall be removable for inspection or replacement without applying heat or breaking pipe connections. Valve stems exposed to the atmosphere shall be stainless steel or corrosion resistant metal plated carbon steel. Direction of flow shall be legibly and permanently indicated on the valve body. Purge, charge and receiver valves shall be of manufacturer's standard configuration.
 - .2 Refrigerant access valves and hose connections shall be in accordance with ARI 720.
 - .3 Isolation valves shall be installed at each fan coil. Isolation valves shall be bi-flow self-seating with operating pressures up to 650 PSI. Valves shall be complete with brass schrader connections located on the valve body only. Condensing unit shall come with isolation valves.
 - .4 Check Valves shall be Mueller Industries Inc. "Checkmaster" straight through type for valves 6.4mm to 16 mm (1/4" to 5/8") diameter, globe type for valves 22mm (7/8") diameter and larger, each complete with extended tubing for brazing connections, and as follows:
 - Straight through type check valves are to be complete with a machined brass gasketed body, phosphor bronze spring, and neoprene seat.
 - Globe type check valves are to be complete with a cast bronze body, forged brass cap, phosphor bronze spring, Teflon seat disc, and neoprene O-ring seal.
 - .5 Ball type valves as specified above, each in accordance with ARI 760 and be suitable for continuous duty with applied voltages 15 percent under and 5 percent over nominal rated voltage at maximum and minimum encountered pressure and temperature service conditions, direct-acting or pilot-operating type, moisture-proof, UL approved, totally encapsulated or encapsulated and metal jacketed as required. Valves shall have an operating pressure differential suitable for the refrigerant used.
- .6 Expansion Valves:
 - .1 Valve shall be the diaphragm and spring-loaded type with external equalizers, and bulb and capillary tubing. Valve shall be equipped with an external superheat adjustment along with a seal cap. Internal equalizers may be utilized where flowing refrigerant pressure drop between outlet of the valve and inlet to the evaporator coil is negligible and pressure drop across the evaporator is less than the pressure difference corresponding to 1°C (2°F) of

- saturated suction temperature at evaporator conditions. Pilot-operated valves shall have a characterized plug to provide required modulating control.
- .2 Electronic expansion valves shall be brass body, needle valve with floating needle and machined seat, stepper motor drive.
- .7 Evaporator Pressure Regulators, Direct-Acting:
- .1 Valve shall include a diaphragm/spring assembly, external pressure adjustment with seal cap, and pressure gauge port. Valve shall maintain a constant inlet pressure by balancing inlet pressure on diaphragm against an adjustable spring load. Pressure drop at system design load shall not exceed the pressure difference corresponding to a 1°C (2°F) change in saturated refrigerant temperature at evaporator operating suction temperature. Spring shall be selected for indicated maximum allowable suction pressure range.
 - .2 Refrigerant access valves and hose connections shall be in accordance with ARI 720.
- .8 Piping Accessories:
- .1 Sizes 15 mm (5/8 inch) and larger shall be the full flow, replaceable core type. Sizes 15 mm (1/2 inch) and smaller shall be the sealed type. Cores shall be of suitable desiccant that will not plug, cake, dust, channel, or break down, and shall remove water, acid, and foreign material from the refrigerant. Filter driers shall be constructed so that none of the desiccant will pass into the refrigerant lines. Minimum bursting pressure shall be 10.3 MPa (1,500 psi).
 - .2 Discharge line oil separator shall be provided in the discharge line from each compressor. Oil return line shall be connected to the compressor as recommended by the compressor manufacturer.
 - .3 Accumulators shall be provided in the suction line to protect the compressor from liquid refrigerant damage. Accumulator shall be CUL listed under the required operating pressures and must be installed as close to the compressor as possible.
 - .4 Refrigerant Moisture and Liquid Indicators shall be single or double port, ULC listed. Body shall be copper or brass with flared or soldered ends. Sight glass shall have color coded paper moisture indicator with removable element cartridge and plastic cap. Maximum working pressure shall be kPa (500 psig). Maximum working temperature shall be 93.3 Deg. C. (200 Deg. F.).
 - .5 Pressure and Vacuum Gauges shall conform to ASME B40.100 and shall be provided with throttling type needle valve or a pulsation dampener and shut-off valve. Gauge shall be a minimum of 85 mm (3-1/2 inches) in diameter with a range from 0 kPa (0 psig) to approximately 1.5 times the maximum system working pressure. Each gauge range shall be selected so that at normal operating pressure, the needle is within the middle-third of the range.
 - .6 Liquid, suction and hot gas lines shall be individually insulated. All indoor and outdoor refrigerant lines shall be insulated per manufacturer's equipment specifications. Exposed insulation shall be protected by aluminum, sheet metal, painted canvas, plastic cover, or painted with an approved UV coating that is water resistant and provides shielding from solar radiation.

- .9 Execution:
- .1 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 you of the responsibility for the proper erection of the systems of piping in every respect suitable for the work intended.
 - .2 Install all piping in the best workmanlike manner and in accordance with the best practices of the trade. Piping shall be pitched 13mm (½ inch) for every 3000mm (10 feet) of length in the direction of flow to ensure adequate oil drainage. Open ends of refrigerant lines or equipment shall be properly capped or plugged during installation to keep moisture, dirt, or other foreign material out of the system. Piping shall remain capped until installation. Equipment piping shall be in accordance with the equipment manufacturer's recommendations and the contract drawings.
 - .3 Pipe supports shall be a maximum of six feet apart. Pipe clamps shall fasten around the piping.
 - .4 Installation shall be in accordance with CSA B52 and ASME B31.5 Mechanical Refrigeration Code guidelines.
 - .5 Nitrogen purging / sweeping shall be used when brazing and welding to minimize oxidization.
 - .6 Isolation valves shall be installed where shown on the schematics.
 - .7 Piping supports and guides using steel, reinforced polytetrafluoroethylene (PTFE) or graphite slides shall be provided where required to allow longitudinal pipe movement. Lateral restraints shall be provided as required. Slide materials shall be suitable for the system operating temperatures, atmospheric conditions, and bearing loads encountered.
 - .8 Anchors shall be provided wherever necessary or indicated to localize expansion or to prevent undue strain on piping. Anchors shall consist of heavy steel collars with lugs and bolts for clamping and attaching anchor braces, unless otherwise indicated. Anchor braces shall be installed in the most effective manner to secure the desired results using turnbuckles where required. Supports, anchors, or stays shall not be attached where they will injure the structure or adjacent construction during installation or by the weight of expansion of the pipeline. Where pipe and conduit penetrations of vapor barrier sealed surfaces occur, these items shall be anchored immediately adjacent to each penetrated surface, to provide essentially zero movement within penetration seal.
 - .9 The Contractor shall, at all times during the installation and testing of the refrigeration system, take steps to prevent the release of refrigerants into the atmosphere.
 - .10 Pipe shall be cut accurately to measurements established at the jobsite, and worked into place without springing or forcing, completely clearing all windows, doors, and other openings. Pipe or tubing shall be cut square, shall have burrs removed by reaming, and shall permit free expansion and contraction without causing damage to the building structure, pipe, joints, or hangers.

- .11 Layout and install piping, valves, and fittings to facilitate easy maintenance. Do not locate any valves, couplings, or flanged/union connections directly above electrical panels, motor starters or MCC's.
- .12 Ensure that all pipe brazing is done by TSSA certified workers.
- .13 A liquid line filter dryer shall be provided on each refrigerant circuit located such that all liquid refrigerant passes through a filter dryer. Dryers shall be sized in accordance with the manufacturer's recommendations for the system in which it is installed.
- .14 A moisture indicating sight glass shall be installed in all refrigerant circuits down stream of all filter dryers and where indicated. Site glasses shall be full line size.
- .15 Refrigerant piping contractor shall supply and install all VRV low voltage control wiring (FT-6 plenum rated 18-2 stranded non-shielded wire), as per the VRV wiring schematics. VRV wiring includes all wiring: between thermostats and fan coils, between fan coils and branch selector boxes, between branch selector boxes and condensing units, and between condensing units and central controller(s).
- .16 Installing contractor shall handle all low voltage mechanical wiring in the condensing unit penthouse room, including wiring between the VRV control panel and the heat traces, gas heaters and dampers.

2.6 CONVECTORS AND FINNED TUBE ELEMENTS

- .1 Provide convectors and finned tube elements of the type, configuration and capacity as noted. Unless noted otherwise, capacities shall be based on 15.5°C. (60°F.) entering air and 60°C (140°F) average water temperatures.
- .2 Convector heating elements are copper tube with aluminum plate fins, cast iron headers, tested for water at 1380 kPa (200psi) and 149°C. (300°F.). Tube finned unit elements are 32mm (1¼") copper tube aluminum fin unless noted otherwise.
- .3 Tube finned unit elements are mounted in ball bearing, cradle type hangers designed for quiet operation with unrestricted longitudinal movement during expansion and contraction.
- .4 Enclosures and casings are minimum 16 gauge steel with factory applied baked primer coat inside and outside. Where enclosures are installed across doorways or in other locations subject to traffic the casings shall be sufficiently rigid to prevent distortion under a point load of 150 kilograms.
- .5 Enclosures for tube finned units are wall-to-wall, complete with trim strips, end panels, inside and outside corners where required. This Section shall co-operate fully with the manufacturer and take field measurements as necessary to ensure proper, neat fitting installation.
- .6 For each unit which is not thermostatically controlled, or where detailed or noted, provide a factory built, knob operated internal damper at the enclosure outlet grille unless noted otherwise. Damper is fully adjustable and stable in all positions.
- .7 Provide 300mm (12") removable enclosure/cabinet end covers for access to permit easy operation of unit valves and vents.
- .8 Hangers are supported on enclosure brackets at maximum 1.2 meter centres with elements evenly distributed within the space.

- .9 Provide expansion compensators where recommended by the manufacturer to allow for expansion and contraction.
- .10 Provide two valves for each unit. One valve is a hand operated shut-off valve and the other, a circuit balancing valve with memory stop.
- .11 Provide a manual air vent on the return water side of each unit. For each unit which is below the piping mains, provide a drain cock with chain and cap on the supply water side. Where air vents are not easily accessible, extend the vent through the unit enclosure/cabinet for screwdriver operation.

2.7 ENERGY RECOVERY VENTILATOR (ERV)

- .1 Provide heat recovery wheels of sizes and capacities noted, factory installed in the air handling units. Supply and return air tunnels are stacked or side-by-side, as shown on drawings. The manufacturer guarantees the performance of the wheel as to its total heat transfer capability and its operation. Alternate heat reclaim devices are not acceptable.
- .2 Wheels are constructed of sheet aluminum, with alternate layers corrugated, with adjacent layers glued to each other for stability. Wheels are tension wound onto a central hub. All aluminum surfaces are coated with a "Zeolite" aluminosilicate coating to provide water vapour transfer from one air stream to the other. Latent heat transfer is equal to the sensible heat transfer $\pm 6\%$ throughout the complete range of operation. The wheels are cleanable with compressed air, or warm water, without damage to the aluminum or desiccant.
- .3 Wheels are held securely together with extruded aluminum spokes extending radially from the hub to the peripheral aluminum banding. Spokes are flush mounted in the rotor media. Wheels 1800mm (72") diameter and smaller are provided in one piece construction. Larger wheels are provided in 4 or 8 piece construction. Alternatively, the smaller wheels can also be provided in 4-piece construction.
- .4 Wheels are provided with non-contact labyrinth seals around the perimeter of the wheel, and across the face, at the division between the supply and exhaust sectors. Adjustable seals are spaced not more than 1mm off the rotor surface.
- .5 The wheels are supported by two pillow block bearings which in turn are supported by a tubular steel support. The bearings are located in the shadow of the bearing support member and the division between air streams, to maximize the free area of the rotor as much as possible. The bearings are replaceable without removing the wheel from the air handling unit.
- .6 The air handling units are provided with a purge system to allow a percentage of outdoor air to be swept through the exhaust air sector to eliminate the possibility of bypassing exhaust air to the supply air stream to reduce the potential for contamination from the exhaust air and to eliminate the possibility of loss of efficiency when exhaust air bypasses to the supply stream. Ensure that the ambient pressure at the entering air side of the exhaust sector of the wheel is lower than the pressure at the leaving air side of the supply air sector. In the case of draw through fans, this will necessitate a field adjustable damper in the exhaust system upstream of the total energy wheel. Select the exhaust fan to provide the additional air for purge.
- .7 The wheels are driven by a continuous V-belt around the outer perimeter of the wheel, and connected to an AC motor fitted with a V-belt pulley. Access to the motor and drive is from the side of the unit to maximize serviceability. Wheel speed control is variable, controlled range 40:1 achieved through an AC inverter (3-phase) complete with unfused incoming power disconnect switch, keypad and LED

readout for programming and alarm annunciation, 16 bit microprocessor control logic, electronic motor overload protection and ground fault protection. The electronic control system is complete with suitable temperature sensors and is factory installed in the unit and completely wired and tested to achieve the sequence of operation indicated herein and complete with numbered terminal strips for interface with the Owner's remote BAS, as follows:

- Air handling unit interlock.
- Heat recovery wheel status (AI) – Provide current sensing relay (must be analog signal).
- Heat recovery wheel discharge air temperature reset (AO, 0-10VDC).
- Heat recovery wheel "trouble/failure" (DI).

.8 Control Sequence: ON/OFF control is from the BAS. In the ON mode, temperature sensor downstream of energy recovery wheel (ERV) on the incoming air side (DAT) varies wheel speed to maintain setpoint with override from temperature sensor downstream of ERV on the exhaust air side to maintain unit frost protection. DAT setpoint is reset from the Owner's remote BAS. System operating mode changeover (heating/economizer/cooling) is automatically achieved when required as determined via temperature sensors provided by the BAS contractor.

.9 Power wiring to unit non-fused disconnect switch is by Electrical Division. BAS control wiring, including AHU interlock, is by Section 25 00 00.

2.8 HOT WATER UNIT HEATERS AND CABINET HEATERS

.1 Provide horizontal and vertical type unit heaters and cabinet heaters with capacities as noted. Unless noted otherwise, capacities shall be based on 82.2°C/71.1°C. (180°F/160°F.) entering/leaving water and 15.5°C. (60°F.) entering air.

.2 Heater coils are copper tube with aluminum plate fins, tested for water at 1380 kPa (200 psig) and 149°C. (300°F.). Cabinet heaters have cast iron headers each with screwdriver operated manual air vent.

.3 Motors are thermally protected, permanent split capacitor, permanently lubricated, resiliently mounted type. Fan and motor speeds noted shall not be exceeded under any circumstances. Unit heater motors are totally enclosed type.

.4 Cabinet heater motors have minimum two speeds, complete with starter and integrally wired manual speed-control switch. Starter and speed control are mounted within the cabinet, outside the air stream, behind an access panel in the front face of the casing. Access panels to be metal construction and tamperproof.

.5 Casings are minimum 16 gauge steel with zinc chromate prime paint finish inside and outside. Casings for cabinet heaters are designed for recessed ceiling, recessed wall, semi-recessed or surface wall mounting as shown. Provide suitable mounting flanges.

.6 Unit heaters have fan guards on the inlet side and adjustable diffusers on the outlet side, with single deflection blades for vertical units and double deflection blades for horizontal units. Cabinet heaters have inlet and outlet grilles.

.7 Unless noted otherwise, unit heaters are controlled by single stage, 120 volt electric thermostats with key adjustable setpoints and scales in degrees C. Provide acceptable metal type guards where noted, and/or in all public areas.

- .8 Cabinet heaters will be controlled (ON/OFF) from the remote space temperature sensors via the Owner's BAS.
- .9 Suspend vertical blow unit heaters rigidly to prevent rotation on start-up.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

- .1 All piping irrespective of size is installed as neatly and inconspicuously as possible, complete with supports and guides as necessary. Install piping in such a manner so that the strain and weight of the piping is not taken by connections to the equipment and apparatus. Keep all openings in pipes plugged and capped during installation to keep out dirt and debris. Place and install piping so that there will be no interference with the installation of equipment, other piping systems, ducts, etc., to ensure noiseless circulation.
- .2 No pipe shall be cut with a cutting torch where the cut could be made with pipe cutters. When welding or cutting with a torch take every precaution to prevent fire. Ensure that welding or torch cutting operators have a fully charged minimum 4.5 kg. (10 lb.) CO2 fire extinguisher with them whenever welding or cutting in the building. Protect wooden structures with non-flammable blankets.
- .3 Use approved fittings for all connections. Job made fittings or reducers will not be accepted. Make reductions in pipe sizes on horizontal runs using eccentric reducing couplings properly installed. Use concentric reducing couplings only on vertical runs.
- .4 Provide di-electric unions, bushings and couplings at all connections between piping of dissimilar metals. Supply adequate numbers of unions and/or flanges to facilitate maintenance and dismounting of each piece of equipment and apparatus which could at any time require dismounting or removal. Assemble flanges using American Standard heavy machine bolts with hex nuts, in accordance with codes and standards specified above. Threaded steel rod will not be accepted for this purpose regardless of material strength.
- .5 On screwed piping, make up metal to metal joints with red or white lead and oil applied to the thread. Ream all pipe before installation. No hemp, wick or packing will be permitted in making up screwed joints. Thoroughly clean inside of fittings and outside of pipe with steel wool or emery paper and coat with flux before soldering any copper pipework. Remove working parts of valves during soldering.
- .6 Grade water piping at minimum 1 in 480 for proper venting and draining, and 1 in 240 for steam/condensate services. Provide hose end gate valves at all piping low points and at drains from equipment and apparatus. Provide automatic air vents at all high points on closed systems and at all other points necessary to free the system of air binding. Vents installed in concealed locations shall be equipped with type 'L' copper drain tubing run to the nearest drain and complete with access panel for servicing.
- .7 Anchor piping at all points shown on the drawings or as is necessary, using structural steel angles, channels, plates, rigidly secured to the building structure. Do not anchor piping to open web steel joists. Design calculations and layout of the anchors shall be subject to review. Make adequate allowance for expansion and contraction of all piping. No expansion joints of any kind shall be used. Provide for expansion and contraction by means of pipe anchors, guides and welded pipe loops.

- .8 Install valves used for shut-off service so that a shut-off, system side pressure is exerted against the valve seat. Ball type valves have bronze body, double-seated solid bronze or stainless steel ball, resilient set, blow-out proof stem with 'O' ring material designed for the service.
- .9 Do not install any valve for an application for which it is not suited. Provide gate valves on upstream and downstream side of equipment and control valves to facilitate removal without draining the system. Provide balancing valve on the downstream side of each piece of equipment which requires flow balancing. Do not use ball or butterfly valves on steam and condensate piping systems.
- .10 Pipe all blowdown outlets on backflow preventers to the nearest hub drain. Ensure that there is a proper air gap on the drain to conform to Plumbing Codes.

3.2 HYDRONIC SYSTEMS' TESTING

- .1 Provide all gauge ports, valves, etc., required for testing and balancing and make any changes required for the final balancing results. Co-operate with the balancing contractor to ensure satisfactory completion of his work. Provide all equipment necessary to perform the required tests.
- .2 Tests shall be performed after roughing-in and before pipes are insulated, enclosed in pipe spaces or buried in trenches. Submit notice of all tests in ample time to allow the Consultant or his representative to be present when the tests are conducted. Any components of the systems which might be damaged during tests shall be removed before the tests and reinstalled after the tests. All water piping shall be tested for minimum of six (6) hours under hydraulic pressure of 150 percent of working pressure and a minimum of 1015 kPa (150 psig). All welded joints shall be hammer tested. Refer also to Article 3.23 in Section 23 00 10.
- .3 Leaks found shall be made tight while system is still under test. If this is impossible, defective parts shall be removed and refitted. Caulking of threaded joints or welds will not be permitted. After leaks, etc. have been repaired, the tests shall be repeated as often as necessary to demonstrate acceptable results.

3.3 HYDRONIC SYSTEMS' BALANCING

- .1 This work will be carried out by Section 23 00 30, refer to same.

END OF SECTION 23 00 20

I N D E X

ARTICLE NO. **DESCRIPTION**

PART 1: **GENERAL**

1.1 Requirements

PART 2: **PRODUCTS**

Not Applicable

PART 3: **EXECUTION**

3.1 General
3.2 Hydronic Systems
3.3 Air Systems
3.4 Certified Reports

PART 1 - GENERAL

1.1 REQUIREMENTS

- .1 Work of this Section shall form part of the Mechanical contract, and shall be provided by competent and experienced Testing, Adjusting and Balancing (TAB) personnel specifically trained in the balancing of air and hydronic systems. The balancing company shall be a member in good standing of AABC or NEBB at the time of tender. Written proof of same shall be provided prior to contract award.
- .2 Test and balance all water systems to ensure that all coils, convertors, radiators, etc. are operating to design conditions.
- .3 Test and balance all air systems including air volumes and control settings under maximum system pressure drop conditions (filters at replacement condition).
- .4 Section 23 00 10 forms part of this Section. Related work is specified in Sections 23 00 20, 23 00 40 and 25 00 00. Refer to same.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.1 GENERAL

- .1 Co-ordinate with Sections 23 00 20 and 23 00 40 to ensure that all necessary devices (valves, dampers, gauge ports, pitot tube test holes, access facilities, etc.) required for proper testing and balancing are installed by respective Sections in all locations required by this Section. Notify the Consultant in writing that this co-ordination has taken place. Include in this letter any recommendations made regarding devices, locations, installation, etc. If this Section fails to co-ordinate with Sections 23 00 20 and 23 00 40, and if failure to co-ordinate results in being unable to balance the systems, any changes required shall be provided by this Section at no extra cost to the Owner.
- .2 Co-ordinate, co-operate and perform the testing and balancing, wherever applicable, in conjunction with Section 25 00 00 so that Section 25 00 00 may calibrate their instrumentation to display proper readings.
- .3 Automatic Temperature Controls Section will accommodate this Section with a loan of a system specific portable device so that this Section may adjust control signals from minimum to maximum for proper balancing and/or calibration. Alternatively, Automatic Temperature Controls Section will provide a trained technician complete with portable two-way radios to adjust control signals as instructed by this Section. Co-ordinate with Automatic Temperature Controls Section. This Section is responsible for the loss/damage of all loaned devices.
- .4 Refer to, and become familiar with, systems' sequences of operation as specified in Section 25 00 00.

3.2 HYDRONIC SYSTEMS

- .1 All piping is pressure tested by Section 23 00 20.
- .2 Prior to the final inspection of the building or project, adjust all hydronic systems as necessary to provide the design flow rates for each part. Adjust system to provide the design pressure drops and flows through the heat transfer elements prior to the thermal testing. Perform balancing by measurement of temperature differential only in conjunction with the air balancing. Affect system balancing with automatic control valves fully open to the heat transfer elements. Affect adjustment of water distribution systems by means of balancing cocks, valves and fittings. Do not use service or shut-off valves for balancing.
- .3 Calibrate all gauges, thermometers, thermostats, etc., before conducting tests. Use only calibrated test gauges for pump adjustment; the use of pressure gauges installed with the system will not be accepted. Where calibrated venturi tubes, or other metering fittings and pressure gauges are installed in the piping system, use them in conjunction with the portable type flow meters to determine the flow rates for system balance. Where flow metering devices are not installed, base flow balance on the temperature difference across the various heat transfer elements in the system.
- .4 At the time of final inspection, re-check in the presence of the appointed Field Representative random selections of data recorded in the Certified Reports. Points or areas for re-check shall be as instructed on site.

3.3 AIR SYSTEMS

- .1 Ductwork is pressure tested by Section 23 00 40. This Section shall inspect the ductwork for undue restrictions, incorrect fittings, duct leakage, type and fastening method of duct insulation, mixing plenum arrangements, baffles and other related work. Inspect ductwork, outlets, dampers, etc. for excessive noise and/or vibration. Submit notice of all such problems.
- .2 Locate pitot tube test holes and ensure that insulated capped pitot tube fittings are provided.
- .3 Adjust inlets, outlets, grilles, registers and diffusers to ensure capacities within 10% of design up to and including 70 L/s (150 cfm) and within 5% of design for capacities greater than 70 L/s (150 cfm).
- .4 Set pattern controllers to eliminate objectional air motion and sound levels.
- .5 Check branch, zone and total capacity readings by pitot tube traverse as proof of individual location readings. Test duct static pressure at same location readings. Test duct supply and return system air flow and pressure capacities for both maximum outside and maximum return conditions. Record mixing plenum pressure for both. In case of V.A.V. units, test as above for both maximum and minimum volumes.
- .6 Test air mixing plenums to ensure proper air mixing and that air stratification does not exist. Perform such tests when outdoor air temperatures are below 0C. (32F.). Provide temperature readings on a grid basis of five (5) positions horizontally and vertically. Submit notice immediately of all stratification problems.
- .7 Check fans and record results of pressure, temperature and R.P.M. and make note of pulley and belt adjustments positions. Test filter and coil pressure drops noting whether wet or dry coil. Perform test with clean filters.
- .8 Test motor voltage and amperage for each phase; record excessive vibration, noise or heat; record horsepower, voltage, frame size and amperage. For starters, record rating of fuses or circuit

breakers; size and rating of thermal overload elements.

- .9 At the time of final inspection, re-check in the presence of the appointed Field Representative random selections of data recorded in the Certified Reports. Points or areas of re-check shall be as instructed on site.

3.4 CERTIFIED REPORTS

- .1 Prepare a Certified Report for each system with headings (or identification) the same as those on drawings and specifications.
- .2 Include the following information in the report:
- Name of project, location and date.
 - Names of Mechanical Contractor, Consultant and Report Evaluator.
 - Description of test methods and list of equipment used in testing.
 - Name of building equipment manufacturers and equipment identification.
 - Evaluation of fan capacities.
 - Electrical characteristics and readings.
 - Evaluation of air outlets.
 - Stratification test readings.
 - Schematics for description of the systems showing design requirements, quantities achieved through tests and locations of all pitot tube test openings.
 - Evaluation of heat exchange elements.
 - For Motors: manufacturer, size, horsepower, voltage, amperage (nameplate and final operating) current characteristics, starter and heater size, RPM (design and final equipment operating).
 - For Pumps: manufacturer, model, impeller size, flow (design and final operating), total head (design and final operating), discharge and suction pressures, brake horsepower.
 - Methods used to determine flows.
 - Evaluation of V.A.V. boxes, by-pass boxes, etc.
 - All other pertinent data relating to the testing and balancing.
- .3 Report shall be certified by a qualified Consultant or Technician who is versed in the field of air and water balancing. Include types, serial numbers and dates of calibration of all instruments used.
- .4 Submit three (3) copies of bound Certified Report. Provide reports complete with index page and indexing tabs, and cover identification at front. In case of 3-ring binder, provide side identification in addition to the above.

END OF SECTION 23 00 30

I N D E X

<u>ARTICLE NO.</u>	<u>DESCRIPTION</u>
<u>PART 1: GENERAL</u>	
1.1	Requirements
1.2	Conformance to Architectural and Structural Layouts
1.3	Ductwork
<u>PART 2: PRODUCTS</u>	
2.1	Ductwork
2.2	Ductwork Access Panels
2.3	Dampers
2.4	Intake and Exhaust Ventilators
2.5	Diffusers, Registers & Grilles
2.6	Fans
2.7	Air Filters, Frames and Gauges
2.8	Noise Control Devices
2.9	Louvres and Blank-Off Panels
<u>PART 3: EXECUTION</u>	
3.1	Ductwork Fabrication Methods
3.2	Exhaust Hoods and Ducts
3.3	Plenums and Casings
3.4	Anti-Stratification Devices
3.5	Air System Testing and Running-In
3.6	Air System Testing and Balancing
3.7	Fire Protection and Smoke Control

PART 1 - GENERAL

1.1 REQUIREMENT

- .1 Sections 21 00 00 and 23 00 10 form part of this Section. Related work is specified in Sections 23 00 20, 23 00 30 and 25 00 00. Refer to same.

1.2 CONFORMANCE TO ARCHITECTURAL AND STRUCTURAL LAYOUTS

- .1 Do not fabricate ductwork without confirmation that diffuser, register and grille locations are in accordance with Architectural reflected ceiling plans. Make changes to duct sizes and locations as required to accommodate structural conditions and work of other trades at no change to the Contract Price.
- .2 Where Underwriters Laboratory rated floor/ceiling assemblies, or roof/ceiling assemblies are utilized, the requirements of the tested assembly supersedes all other requirements. It is the responsibility of this Division to establish the existence of such an assembly by reference to Architectural and Structural Drawings and Specifications.

1.3 DUCTWORK

- .1 Comply with NFPA standards for exhaust ductwork and hoods which are used in applications resulting in airborne grease entrainment.
- .2 Clean ductwork internally prior to issue of the Certificate of Completion.
- .3 Plenums and casings include all outside air intakes, discharges, recirculating plenums, division plates, connections between components, built-up air handling units, etc.
- .4 All supply air ductwork from air handling unit fan discharge to first reheat coil shall be constructed to SMACNA 750 Pa (3" wg) duct construction class. All other supply air ductwork upstream of reheat coils shall be constructed to SMACNA 500 Pa (2" wg) duct construction class. For all other constant volume systems, all supply air ductwork installed in mechanical rooms shall be constructed to SMACNA 500 Pa (2" wg) duct construction class.
- .5 All supply air ductwork downstream of reheat coils shall be constructed to SMACNA 250 Pa (1" wg) duct construction class.
- .6 All return air ductwork and all exhaust air ductwork installed in mechanical rooms shall be constructed to SMACNA 500 Pa (2" wg) duct construction class. All other return air ductwork and all other exhaust air ductwork shall be constructed to SMACNA 250 Pa (1" wg) duct construction class.
- .7 Tie rods shall not be used in lieu of external duct reinforcement except where specifically mandated by SMACNA duct construction standards.
- .8 This Section shall provide a schedule of proposed duct construction, meeting SMACNA standards, to be used on the project. Schedule shall include panel width, gauge, transverse connector, reinforcement, longitudinal seam, sealing class and sealing compound. Submit schedule prior to performing any duct fabrication/installation.

PART 2 - PRODUCTS

2.1 DUCTWORK

- .1 Galvanized sheet metal used to fabricate ductwork conforms to ASTM A-446, with designated Z275 coating to meet the ASTM Specifications. Construct aluminum ductwork, where required, of aluminum sheets one gauge heavier than if the duct were to be made from galvanized steel. Make stainless steel ducts of no. 316 Atlas mill finish stainless steel using one gauge lighter material than if the ducts were to be made from galvanized steel.
- .2 Turning vanes are double wall construction with correct air foil pattern fabricated by Duro-Dyne or other Acceptable Manufacturers. Provide a turning vane in each slot on vane rail.
- .3 Duct sealants (sealers) and duct tapes are water resistant, compatible with mating materials meeting U.L.C. flame resistance requirements.
- .4 Rivets, screws and other fasteners are the same material as ductwork except use zinc or cadmium plated fasteners with galvanized sheets.
- .5 Sizes shown on the drawings for internally lined ductwork are clear inside dimensions.
- .6 Bolted duct connecting systems such as Ductmate or Nexus couplings joining methods may be used. Caulk joints and corners of joints as for standard SMACNA seal Class B.
- .7 Use galvanized ductwork for all systems, except as follows, as applicable:
 - Fume hood and acid/solvent cabinet exhaust ductwork: stainless steel.
 - Gymnasium change room exhaust ductwork: aluminum with horizontal runs sloped to drain at point of inlet.
 - Kitchen dishwasher exhaust ductwork: stainless steel, or stainless steel where ductwork is exposed and aluminum elsewhere, with horizontal runs sloped to drain at point of inlet.
 - Kitchen cooking hood exhaust ductwork: refer to "Exhaust Hoods and Ducts" Article in this Section.
- .8 Aluminum and stainless steel ductwork is watertight, externally all welded construction.
- .9 All flexible ductwork for all supply air systems is thermal type, pre-insulated and factory-wrapped with vapour barrier jacket.

2.2 DUCTWORK ACCESS PANELS

- .1 Provide access panels as specified and noted and where required for periodic servicing of equipment, control elements, etc. including; upstream and downstream of all duct and plenum mounted cooling coils and heating coils; at all air filters; at all fire dampers and fusible links unless noted; at all backdraft dampers; and at motorized dampers for access to linkage and actuator.
- .2 Access panels are rectangular, 457mm (18") long and the width of the duct in ducts up to and including 305mm (12 inches) in width. In ducts and plenums 330mm (13 inches) to 610mm (24 inches), size of access panels are 305mm x 457mm (12 x 18 inches) or larger where required for easy access. In ducts and plenums 635mm (25 inches) and larger, size of access panels are 610mm x 610mm (24 x 24 inches) or larger as indicated on the drawings. Fabricate panels of

same material as duct and of metal gauge suitable for the application and size of panels. Hinge panels larger than 450mm x 450mm (18 x 18 inches) to galvanized steel mounting frame and provide sash locks to give tight closure on neoprene gasket. All hardware is made of corrosion resistant material including attaching bolts.

- .3 Provide access panels on thermally insulated ducts of double panel construction with insulation as specified for adjacent ducts sandwiched between panels. Depth of access door stand-off matches the thickness of thermal insulation finish with minimum 25mm (1") face for termination of thermal insulation.

2.3 DAMPERS

- .1 Provide deflecting or splitter dampers where shown on the drawings and where required for balancing the system. Fabricate dampers of minimum 22 gauge galvanized steel or same gauge as duct in which damper is installed. Hinge damper at the air leaving edge and construct damper so that the entering edge presents a round nose to the air flow. Make the length of the splitter at least 1½ times the width of the smaller branch duct but in no case less than 300mm (12 inches). Attach a minimum 6mm (¼ inch) diameter galvanized steel push rod hinged to the splitter near the air entering edge and passing through a locking clamp on the side of the duct which is accessible for adjustment. Make all hardware of corrosion resistant materials including attaching bolts and hinges.
- .2 Provide manual opposed multi-blade control dampers in ductwork where shown and where required for balancing the system. Construct dampers of minimum 18 gauge galvanized steel or 4 standard gauges heavier than the gauge of duct in which damper is installed, whichever is the thicker. Fit dampers snugly into the duct so that they may be used as shut-off dampers. The two edges at right angles to the shaft shall be bent 90 degrees or beaded to make the damper more rigid. Provide extra bracing wherever necessary. Fit each damper with a locking type quadrant handle pointing in the direction of air-flow with damper open and at right angles with damper closed using proper manufactured hardware. Where dampers are installed on insulated ducts, mount quadrant on sheet metal standoffs built out to beyond insulation thickness.
- .3 Construct all fire dampers and rate in accordance with U.L.C. Standards with U.L.C. label. Protect all openings in fire rated ceilings or rated ceiling assemblies for diffusers, registers and grilles by fire stop flaps or ceiling fire stops approved, tested and listed the by U.L.C. Fire dampers are interlocking blade type unless specifically noted otherwise. For square and rectangular ducts with the height dimensions up to and including 305mm (12 inch) damper blades are out of the airstream. For larger ducts dampers in the airstream are acceptable. Install fire dampers in walls and floor slabs in duct extension sleeves with perimeter angles and breakaway fittings. Install all fire dampers and fire stop flaps in accordance with local Authorities and all codes being applied by such Authorities. All fire dampers shall be installed with damper blades in closed position. Prior to air balancing, all fire damper blades shall be set open by the installing trade in the presence of Board's representative.
- .4 All motorized dampers are supplied, complete with operators, by Section 25 00 00 for installation by this trade Section. All two position control dampers are parallel neoprene edging. All dampers installed at fresh air inlets or at exhaust air outlets from the building are approved "low leakage" type with inflatable type seal applied to the blade edges to provide leakage in the fully closed position not exceeding 20.3 L/s per square meter (4 CFM per square foot) of damper area at 1500 Pa (6 inches W.C.) of differential pressure across the damper. Frames are formed channels of not less than 13 gauge galvanized steel. Blades are Extruded aluminum airfoil section not exceeding 205mm (8 inch) in width and 1220mm (48 inch) in length. Shaft bearings are nylon with Teflon coated thrust

bearings provided at the ends of each blade. Use spring stainless steel or multi-fin neoprene seals on blade side edges. Make dampers suitable for operation with the temperature limit of 93°C to -40°C. All dampers are flanged to ductwork. Insert type dampers and inaccessible intermediate bell cranks on multiple damper section are unacceptable. Low leakage dampers shall be Tamco Series 9000.

- .5 Size damper operators to operate dampers under all system conditions. Areas described below represent the maximum acceptable area of damper to be operated from one operator.
- | | |
|---|-------------------------|
| Standard Dampers/Electric Operator | 2.8 Sq. M. (30 Sq. Ft.) |
| Low Leakage Dampers/Electric Operator | 1.9 Sq. M. (20 Sq. Ft.) |
| Standard Damper/Pneumatic Operator | 2.8 Sq. M. (30 Sq. Ft.) |
| Low Leakage Damper/Pneumatic Operator | 1.9 sq. M. (20 Sq. Ft.) |
| Low Leakage Damper/Pneumatic Operator with Pilot Positioner | 2.8 Sq. M. (30 Sq. Ft.) |
- .6 In the event of power failure, all equipment fails safe and all dampers return to their normal position. Locate damper operators outside the air stream and provide sheet metal standoffs on insulated ducts.
- .7 Smoke Dampers (SD): Dampers shall meet the requirements of NFPA 80, 90A, 92, 101 and 105. Dampers are classified by Underwriter's Laboratories and labeled as a 1.5 hour or 3 hour (as required) fire damper under UL 555 and as a Class 1 smoke damper under UL 555S at an elevated temperature of 121°C (250°F) for use in dynamic or static Smoke Control Systems. Dampers are tested under UL 555 and UL 555S by UL to a minimum velocity/pressure rating of 10 m/s @ 1 kPa (2000 ft/min @ 4" w.g.).
- Dampers are opposed blade configuration with an interlocking blade design that provides complete flame and smoke seal under fire conditions at an elevated temperature of 1093°C (2000°F) when in the closed position.
 - Frames are 1.6mm (16ga) galvanized steel hat channel with mitered corners reinforced with die-formed corner gussets for strength. Blades are 2mm (14ga) equivalent galvanized steel formed double-skin airfoil design on 140mm (5.1/2") centers. Blade axles are 13mm (1/2") diameter plated steel, double bolted at each end of blade to ensure positive locking connection. Bearings are self-lubricating oilite bronze type. Blade linkage is zero-maintenance, concealed in frame, out of airstream. Jamb seals are compression type stainless steel.
 - Dampers are complete with factory installed sleeves, length dependent on wall thickness, minimum 406mm (16"). Wall thickness shall be field verified by contractor. Factory sleeves are caulked to UL requirements and are 1.0mm (20ga) through 2134mm (84") wide and 1.2mm (18ga) above 2134mm (84") wide.
 - Dampers are complete with suitable factory-installed, externally mounted electric actuators. Actuators are fast-acting, 2-position, spring return, direct-coupled, 120VAC complete with auxiliary switch which "makes" on damper closed position and momentary test switch for local push-button testing/inspection for proper operation.
 - Actuator assembly is suitably factory-wired and terminated at a junction box ready for single point power connection in the field by Electrical Division.
 - Smoke detectors are provided by the Electrical Division, including all wiring.
- .8 Combination Fire/Smoke Dampers (F/SD): Combination dampers are smoke dampers (as specified herein) complete with a UL Classified heat responsive device that will cause the damper to close in a controlled manner, and lock in a closed position by means of an over center/knee lock linkage, when the duct temperature reaches the maximum degradation temperature of the

damper/actuator assembly as required by UL 555S. Closure devices that cause instantaneous closure are not acceptable.

2.4 INTAKE AND EXHAUST VENTILATORS

- .1 Provide air intake and exhaust roof ventilators of throat size and height as scheduled on the drawings.
- .2 Ventilators shall be extruded aluminum, complete with birdscreen, anti-condensate coating and 450 high prefabricated insulated aluminum curb.

2.5 DIFFUSERS, REGISTERS & GRILLES

- .1 Grilles and registers are extruded aluminum type and diffusers are either steel or aluminum. Diffusers, registers and grilles have baked enamel factory applied finish, unless specified or noted otherwise with colour as selected by the Consultant. Frames shall have mitred corners designed for the surface of application. Use concealed mountings on diffusers, registers or grilles where physically possible. Where fastenings are visible, install with oval head cadmium plated screws in countersunk holes.
- .2 Provide diffusers, registers and grilles with gaskets to prevent air leakage. Provide supply diffusers and registers and exhaust registers with opposed blade dampers, except where volume extractors are used (see Drawings and Schedules). Return diffusers; return grilles; and supply grilles only where so designated; do not require opposed blade dampers.
- .3 On linear diffuser installations involving more than one length of diffuser, provide alignment strips to ensure that the diffusers represent a neat straight line when installed. Provide blank-off baffles or throw reducing vanes where specific directions of throw or length of throw is detailed on the drawings. Provide airflow straightening grids behind all supply diffusers. Perforated supply diffusers have curved louvre pattern controllers.
- .4 Door grilles when supplied by this Division are complete with adjustable frames on both sides of door to suit any door width. Door grilles are all steel construction and installed by the Architectural Division.

2.6 FANS

- .1 Provide fans complete with drives and motors, capacities as noted. Construct fans in conformance to AMCA with certified ratings based on tests performed in accordance with AMCA Bulletins 210, 211A and 300, unless noted otherwise. Note carefully the installation of each fan as shown on the drawings and allow for the 'system effects' in the selection and application of fans. Submit for each fan before fabrication, certified acoustical and fan curve performance data rated at the actual speeds required, showing static pressure, total pressure, fan power, and mechanical efficiency and sound power level plotted against air flow. Do not exceed fan speeds specified, noted and calculable, from the scheduled data, by more than five percent (5%) by alternate or substitute manufacturers. Fans operating beyond this limit will not be accepted.
- .2 Provide fan motors of at least the size specified or noted, and larger when necessary to accelerate the fan to operating speed from a dead start within ten (10) seconds. Refer to "Electric Motors, Starters and Wiring" article in Section 23 00 10. Electrical Division will provide power wiring for fans and will wire firestats unless noted otherwise. Refer to Section 25 00 00 and co-ordinate the firestat wiring requirement.

- .3 Provide all fans exposed to the weather with a heavy gauge vented housing that completely protects the fan and motor. Treat casings, except those constructed of aluminum with corrosion resistant paint. Provide all casings with suitable access for motor bearing and belt servicing. Provide discharge openings of fans discharging to outdoor air with aluminum or galvanized steel 12mm (½ inch) mesh birdscreen. Unless another closure is specified or noted, provide a gravity activated backdraft damper for each exhaust fan. Dampers have neoprene or felt blade edge seals. Provide fans with exposed inlets or outlets with protective screens, guards or grilles. Statically and dynamically balance fan assemblies to provide vibration-free operation. Operate fans at not more than 75% of their first critical speed. Provide scroll dampers as necessary to ensure stable air flow at all operating conditions. Unless noted otherwise fans with 3-phase motors are belt driven. Provide variable pitch sheaves on fans with 3-phase motors up to and including 7.5 HP (5.6 KW), and multiple belt fixed pitch drives on fans with larger motors. For each fan with fixed pitch drive, include for the supply and installation of one extra drive package of a size to be determined after air balancing has been completed. Where indicated, single-phase fans have EC motors specifically designed for fan applications (AC induction motors are not acceptable). EC motors are permanently lubricated with heavy-duty ball bearings to match the fan load and prewired to the specific voltage and phase. Internal motor circuitry converts AC power supplied to the fan to DC power to operate the motor. Motor speed is controllable down to 20% of full speed (80% turndown). Speed is controlled by either a motor-mounted potentiometer dial, or remote mounted controller. Remote controllers are factory installed/wired within fan enclosure. Motors are minimum 85% efficient at all speeds.
- .4 Provide bearings with a minimum life expectancy of 60,000 hours. Shaft sizes 32mm (1½ inch) and smaller are permanently lubricated anti-friction type. Larger shaft sizes have horizontally split pillow block grease lubricated, regreasable bearings. Fans other than roof ventilators are complete with flexible connections on inlet and outlet ductwork, suspension clips, mounting legs, and where noted, fan platform, etc.
- .5 Duct blowers mounted in ceiling spaces include internal acoustic lining and filter section where air is being recirculated to the occupied space.
- .6 Inlet vanes (vortex dampers) where required operate from a positive peripheral control mechanism located out of the air stream and supported at both ends in bronze bearings. On double inlet fans inlet vanes are interconnected to operate in unison. Positively position the control mechanism through a pneumatic or electric operator as specified or noted. Provide external grease lubrication for bearings. Provide extended tubing and grease fittings where standard fittings are not readily accessible.
- .7 Propeller type fans are multi-blade design with steel or aluminum wheel; drive package; resilient motor mounts; totally enclosed air over motor; inlet venturi; mounting frame; blade guards.
- .8 Axial type fans are complete with heavy gauge steel casing, belt fairing, removable cap to permit access to sheave and bearings, adjustable motor base and motor, heavy gauge belt guard over exposed portion of belt with tachometer openings and standard steel wheel with airfoil blade section mounted on a steel shaft equipped with shaft seal. Provide heavy gauge steel inlet and outlet cones with 7 degree cone angles and/or fan inlet bell where shown on the drawings. Equip axial fans with heavy plate support legs where installed on slab and heavy duty suspension clips where suspended. Where noted provide fans with hinged doors to provide complete access to internal parts of fan for cleaning and maintenance. Direct drive, adjustable pitch type fans are acceptable in lieu of belt drive specified above. Include guide vanes on all vane axial type fans. Provide variable pitch-in-motion fans where noted. Provide thrust restraining springs for all axial fans.

- .9 In-line centrifugal fans are complete with box type or tubular steel casing (see schedule), belt fairing, removable cap for drive and bearing access, adjustable motor base and motor, belt guard with tachometer opening, an in-line air foil centrifugal wheel mounted on a steel shaft equipped with shaft seal. Provide inlet and outlet cones with 7 degree cone angles and/or fan inlet bell where detailed or scheduled. Include support legs where floor mounted and suspension clips where suspended. Where noted or detailed include hinged doors to provide access to all internal parts of the fan for cleaning and maintenance.
- .10 Centrifugal fans have fan wheels constructed of heavy gauge steel with spun or die formed shroud, inspection openings with pressure tight, quick opening cover plates in housing scroll where fan wheel diameters are over 560mm. Fan wheels have non-overloading horsepower characteristics unless otherwise noted. Utility sets have motors mounted on an integral frame with the fan. Cabinet fans are mounted in an integral steel housing as detailed and shall include double width, double inlet fans. Arrangement 3 fans include single inlet, single width fans.
- .11 Roof mounted spun aluminum fans are centrifugal type, having low contour, spun aluminum, weatherproof housing and curb caps. Units have adequate structural members to support fan wheels, motor and bearings, and vibration isolators to prevent transmission of vibration to the housing. Motors are located outside of air stream. Where noted, provide housing hood with heavy duty corrosion resistant hinged and friction catches, to permit convenient access to motor, etc. for servicing and lubrication. Construct fan wheels of aluminum with non-overloading horsepower characteristics. Provide each fan with weatherproof, non-fused listed safety type disconnect switch located under the housing, adjacent to the motor. Factory wire the motor through the switch in flexible metal conduit. Where noted, provide each fan with prefabricated insulated roof curb a minimum of 450mm (18 inches) high, complete with nailing strip, cant and flashing pan. Secure roof exhaust fans to curbs with fastening devices as recommended by manufacturer.
- .12 Ceiling mounted fans have centrifugal fan wheel, resiliently mounted motor, 12mm thick acoustic insulation on inside of sheet metal housing, inlet grille, backdraft damper and terminal box in housing. Provide speed controller where scheduled or noted.
- .13 Each cabinet type fan consists of a double inlet centrifugal fan installed in a housing having access panels on both sides. Fans are resiliently mounted. Mount fan motor inside the cabinet on the blower with a hinged bolt for belt adjustment. Acoustically line the casing throughout. Provide filter section capable of accepting 25mm thick disposable filters. Where scheduled or detailed provide a silent closing, tightly sealing backdraft damper.
- .14 Ceiling ("Casablanca") fans are UL listed with matching UL listed solid state controls. Motors have built-in thermal overload protection. Fans are complete with: perfectly balanced motor and blades; permanently sealed and greased bearings; corrosion resistant, durable epoxy enamel paint finish; 20mm (13/16") diameter steel downrod of suitable length; safety cable secondary support assembly factory connected to motor shaft; with rated breaking strength complying with CSA-C22.2; totally enclosed fan guard (where indicated); solid state motor speed control; mounting hardware. Fan performance shall be AMCA certified.
- .15 Install dampers for exhaust fans as close as possible to the point of discharge from the building. Insulate exhaust ductwork inside the building for a distance of 1.5 meters (5 feet) upstream from the damper or for the Code required distance, whichever is greater. Secure roof exhaust fans to curbs with fastening devices as recommended by the manufacturer.

2.7 AIR FILTERS, FRAMES AND GAUGES

- .1 Provide air filters, frames and gauges of sizes, types and capacities noted. Filter material is non-combustible and carries a ULC Class II label. Unless noted otherwise, efficiencies specified and noted are as measured by the ASHRAE Standard 52-76. Filter approach velocities shall not exceed 2.5 m/s (500 FPM).
- .2 Construct frames, supports and all fitments of non-corroding materials such as galvanized steel, stainless steel, bronze, etc. Fabricate support frames so that they may be bolted or rivetted together to form filter banks. Provide frames complete with gaskets and seals to prevent air bypass. Design and install filters and frames for upstream, downstream, or side loading service access as noted. Lock matching frames for side loading filters together with aligned locking devices.
- .3 Filters are replaceable media type supported by a metal grid on downstream side and enclosed in a heavy duty chipboard frame. Media is minimum 50mm (2 inch) pleated non-woven cotton and synthetic fabric with nominal efficiency of 25%-30% and average arrestance of 90%-92%. Media support grid is welded wire bonded to media to eliminate media oscillation and pull-away. Wire grid has an effective area not less than 96%. Enclosing frame is a rigid, heavy-duty, high wet-strength board with diagonal support members bonded to each pleat on both sides of media for pleat stability. Inside periphery of enclosing frame is bonded to filter pack to eliminate air bypass. Filters are Farr 30/30, or equal.
- .4 Each filter is complete with a universal metal holding frame. Holding frames are designed to accommodate standard size filters, minimum 16 ga construction with a minimum in-line depth of 68mm (2.7"), complete with full perimeter polyurethane foam gaskets, suitable filter retainer clips and automatic filter centering devices. Holding frames are Farr Type 8, or equal.
- .5 Provide filter gauges for each filter bank. Gauges are Dwyer #MS-111-LCD magnesense loop-powered differential pressure transmitters with a 4-20 mA output. On indoor units, transmitters are mounted on unit exterior and are complete with LCD display and terminals for remote BAS monitoring of filter status (analog signal). On outdoor units, gauges are mounted in a readily accessible location inside units and are without digital display.
- .6 No air conditioning, heating or ventilating unit, or transfer fan shall operate without filters in place. Replace temporary or trial usage filters with clean filter media for the opening of the building.

2.8 NOISE CONTROL DEVICES

- .1 Provide noise control devices as specified and noted which includes silencers, acoustic panels and acoustic plenum enclosures.
- .2 Acoustic insertion losses are minimum acceptable and pressure drops are maximum allowable. Submit copies of certified performance data for each noise control device, signed by an acceptable, independent, AMCA rated, test laboratory such as Riverbanks Laboratories. Acceptable noise (NC) levels are defined as follows:-

Office & Classroom Areas	35
Library Area	35
Lobby & Corridor Areas	40
Service Areas & Fan Rooms	60

- .3 Where alternate and substitute materials and equipment is provided, this Division shall recalculate the silencer insertions losses based on the actual sound data necessary to meet the specified noise criteria. Submit these calculations with the shop drawings.
- .4 Engage the services of the noise control equipment manufacturer to inspect the installation, assess the operation of the attenuation equipment and submit a written report. The report includes:
 - .1 An analysis of all areas not meeting the specified performance, complete with corrective proposals.
 - .2 Noise measurements taken over the complete audible frequency range in occupied zones adjacent to silencer installations; adjacent to, above and below equipment/fan/service rooms.
 - .3 Readings plotted on IC curves, substantiating that acceptable noise levels exist in the occupied zones.
- .5 Where vibration control equipment and noise control devices (silencers) are supplied by the same manufacturer, the isolation and attenuation reports specified, may be combined.
- .6 Fabricate sound attenuators in accordance with ASHRAE and SMACNA Standards for the ductwork application. Construct silencers of galvanized steel as described for "Ductwork". Prime coat after fabrication where galvanizing is not possible. Acoustic media is formaldehyde-free, pre-compressed glass fibre. Reinforce the media with a glass fibre cloth where velocities exceed 22.9 m/s (4500 FPM). Provide integral silencer enclosures where required to eliminate break-in/break-out noise transmission.
- .7 Crosstalk silencers are constructed of galvanized steel with acoustic quality glass fibre blanket protected by perforated galvanized metal liner.
- .8 Install guide vanes up and downstream of silencers where excessive turbulence occurs and as necessary to achieve the design pressure drop.

2.9 LOUVRES AND BLANK-OFF PANELS

- .1 Colour of louvers provided by this Division shall have custom colour as selected by the Architect. Provide prefinished aluminum, high performance drainable louvers complete with birdscreens. Heads, sills, jambs and mullions are one-piece 6063-T52 aluminum alloy structural members with fasteners of same material as fabricated items. Frames are 3mm (0.125") thick channel type, blades are 2mm (0.081") thick. Screens are 13mm (1/2") mesh expanded aluminum secured within a 2mm extruded aluminum frame. Louvres are equal to McGill DSP-635, 153mm (6") wide with minimum 50% free area on a 1219mm x 1219mm (48"x48") test size, tested in accordance with AMCA 511 Standard to 4.83 m/s (950 FPM) air intake face velocity at not water penetration, maximum 30 Pa (0.12") pressure drop at 4.83 m/s (950 FPM) air intake rate. All louvers are complete with vertical stiffeners spaced to meet required loads.
- .2 Supply and install where indicated on the drawings, insulated blank-offs as manufactured by Construction Specialties Inc. Panel to be fabricated with a urethane (or styrofoam) core, faced on both sides with .81mm (0.32") thick stucco embossed aluminum sheet 5005-H134. Panel perimeter frame to be 6063 T52 extruded aluminum sections 2.03mm (.080") thick. Panel frame to be mitred

at corners. The assembled 50.8mm (2") thick panel to have a U factor of less than .06 watts per sq. meter deg. C. (10 BTU per hour/sq.ft. deg. F.). Closed cell PVC perimeter compression gaskets 3.17mm x 25.4mm (1/8" x 1") to ensure tight closure of panel to louvre. Blank-off panels shall be painted black on the outside (louvre side).

PART 3 - EXECUTION

3.1 DUCTWORK FABRICATION METHODS

- .1 Ductwork fabrication, supporting and sealing methods shall be in accordance with methods described in the Equipment Volume of the ASHRAE handbook latest edition or current edition of Duct Manual and Sheet Metal Construction for Ventilating and Air Conditioning Systems, published by SMACNA where methods in these volumes are not at variance with the requirements of any Authority have jurisdiction, and do not conflict with those shown and specified herein.
- .2 Construct duct transitions with a maximum gradient of 1 in 4 for low velocity and 1 in 7 for medium and high velocity ductwork. Limit duct transitions on the upstream side of equipment or coils to 30 degrees and on the leaving side of equipment or coils to 45 degree inclined angle.
- .3 Support vertical ducts passing through floors on angles secured to duct and bearing on the floor. Protect floor openings by 75mm (3 inch) high water stop all around.
- .4 Paint visible internal portions of ductwork at grilles, registers and diffusers flat black by this Division.
- .5 Seal joints and seams in outdoor air intake ducts and plenums watertight. Provide suitable drain connection at low points. Slope ductwork and plenum towards drain connections. Weatherproof all ductwork including access panels and flexible duct connections located outdoors.
- .6 Do not suspend duct hangers including wires and rods from the steel roof deck nor from other mechanical or electrical components. Support hangers from structural bearings such as beams, top chords of steel joists or structural concrete slabs. Where structural bearings do not exist, provide angle or channel iron from nearest structural bearings to support hangers.
- .7 Internally insulate all ductwork and plenums to the extent specified or noted on the drawings. Refer to the "Insulation" Article in Section 23 00 10 for duct liner requirements.
- .8 Caulk joints and corners of joints on all supply ductwork with high velocity duct sealer on the interior of the duct during erection to ensure air tightness.
- .9 Make pitot tube openings in ductwork of supply, return, relief and exhaust systems as required by Section 23 00 30. Provide openings before and after all fans and at each branch take-off, at each floor, etc. Provide acceptable devices for closing of pitot openings.
- .10 Use Listed and Labelled flexible connections at the inlets and outlets of all air handling equipment except curb mounted roof exhausters and ceiling exhaust fans.
- .11 Where vibration occurs in the ductwork while the system is in operation, provide and install such additional members as is necessary to overcome this vibration.
- .12 Make changes in direction of horizontal ducts with elbows having a throat radius not less than 3/4 of the width of the duct. Make changes of direction from horizontal to vertical duct with elbows having

a throat radius equal to the depth of the duct. Where available space limits the throat radius, use the largest possible radius complete with long radius turning vanes to maintain a loss co-efficient no greater than 0.25 according to SMACNA Standards.

- .13 Construct round ducts of helically wound galvanized steel strips with spiral lock seam.
- .14 Use flexible ductwork of corrugated aluminum construction with minimum average wall thickness of 0.15mm (6 mil inch) and minimum positive and negative pressure rating of 4000 Pa (16 inch W.G.) for high pressure ductwork applications. Thermal flexible ducts have cores factory-wrapped with 25mm (1") thick flexible fiberglass insulation covered with a flame retardant scrim foil mylar vapour barrier. Length of flexible duct connecting branch ducts to air terminal and diffuser shall not exceed 3 meters (10 feet) and is continuous with no intermediate joints. Provide 0.6 meters (2 feet) slack over the length shown on the drawings. Connect flexible ducts to other ductwork or units by airtight slip joints with a minimum of 3 screws and secure joints by at least three wraps of pressure sensitive vapour seal adhesive tape with mastic duct sealant. Support flexible ducts by hangers every 1.5 meters (5 feet) such that duct or insulation cannot be damaged by vibration or other motion. Do not lay ducts across lighting fixture or hot surface or make abrupt changes in direction.
- .15 Install fire dampers without strain or distortion of any part and ensure that all parts move freely without binding or rattling.
- .16 The position of air outlets shown on the drawings is approximate only. Check the location of outlets and make adjustments in position as is necessary to conform with Architectural features, acoustic tile pattern, brick or block courses, etc. and with the outlets required by other trades, without additional charge.

3.2 EXHAUST HOODS AND DUCTS

- .1 Where exhaust hoods are detailed on the drawings as the work of this Division, fabricate from 18 gauge stainless steel in compliance with N.F.P.A. Standards.
- .2 Provide grease filters and frames in a readily accessible rack for hoods which are used in applications resulting in airborne grease entrainment. Grease filters shall be listed.
- .3 Fabricate exhaust ducts from all cooking exhaust hoods of galvanized steel constructed in accordance with N.F.P.A. Standards. Use 16 U.S. gauge minimum thickness unless heavier gauge is required by local building ordinances. All seams and joints have a liquid-tight smooth continuous external weld. Provide a grease tight access door at each change in direction. Make doors sufficiently large to permit inspection and cleaning and installed not less than 35mm (1½ inch) from the bottom of the duct. Paint all external welds with corrosion resistant zinc rich paint after assembly.
- .4 Where shown on drawings, kitchen grease exhaust duct shall be wrapped with a ULC Listed, non-combustible, flexible fireproof blanket, fully encapsulated in a foil scrim. The wrap material shall be applied directly onto the installed ductwork strictly in accordance with the manufacturer's instructions. Wrap thickness shall be that required to maintain the integrity of the kitchen wall fire resistance rating. All hangers, support rods, concrete anchors and fire stopping of duct penetrations shall be in accordance with ULC Listing and the manufacturer's instructions. Assembly shall have a "zero clearance" rating complying with the NFPA-96 Standard. Acceptable products: 3M FireMaster Duct Wrap, or equal.

3.3 PLENUMS AND CASINGS

- .1 Fabricate plenums and casings from minimum 16 gauge galvanized steel suitably reinforced with angles so that after insulation is applied no sagging or buckling will occur.
- .2 Join both sidewall and top panels by 38mm (1½ inch) high standing seams, bolted on 300mm (12 inch) centres.
- .3 Place standing seams on outside of casings and supplementary reinforcing angles, where required, on the inside of casing parallel to air flow. Bolt or rivet inside angles to casing wall, on approximately 300mm (12 inch) centres, adjacent to standing seams.
- .4 To ensure airtight structure, insert an approved gasketing material between each companion flange and compress the material tightly using joint fasteners on approximately 150mm (6 inch) centres.
- .5 Where panels join masonry or concrete construction, bolt panels on 150mm (6 inch) centres to 38 x 38 x 3mm (1½ x 1½ x 1/8 inch) angles; securely fasten to the masonry; seal airtight using an approved caulking compound.
- .6 Provide sleeves, metal collars, escutcheons, flanges, etc. around all penetrations including electrical conduit; seal airtight using an approved caulking compound.
- .7 Fabricate access doors using double wall construction of 22 gauge galvanized iron. If the casing is to be insulated, install insulation equal to any thickness to that specified for the casing between the two panels of the door. Fit plenum doors suitable for operation from either side with rigid hinges and fire resistant gaskets and a minimum of two catches. Provide an access door to all equipment contained within the plenum which requires service or maintenance.
- .8 On insulated plenums, mount metal collars around all openings to allow a neat finish for the insulating materials.

3.4 ANTI-STRATIFICATION DEVICES

- .1 Install adequate baffling plates as indicated on plans or as required in all mixing chambers in order to prevent stratification of the air.

3.5 AIR SYSTEM TESTING AND RUNNING-IN

- .1 Provide all equipment necessary to perform the required tests. Test all air systems for leakage in accordance with SMACNA procedures. Calibrated orifices shall be used to measure all leakage airflow rates. All ductwork shall be pressure tested at minimum 500 Pa (2" WG). For any system, total leakage at the test pressure shall not exceed 5% of respective fan design air flow rate. For all variable air volume (VAV) systems, test all supply air ductwork from air handler to VAV or fan-powered VAV boxes, including runout ducts to VAV or fan-powered VAV boxes and associated fire dampers. For constant volume (CV) systems, test all supply air ductwork from air handler to air terminals, including fire dampers, reheat coils, etc. excluding air terminals. In cases of by-pass boxes on CV systems, test all supply air ductwork from air handler to by-pass boxes, including runout ducts to by-pass boxes and associated fire dampers. Repair all leaks and repeat test.

Pressurize with small blower. Test system as a whole, or in parts, provided that all ductwork is accessible for inspection at the time of test.

- .2 Tests shall be performed before ducts are insulated or enclosed. Submit notice of all tests in ample time to allow the Consultant or his representative to be present when the tests are conducted. Refer also to Article 3.23 in Section 23 00 10.
- .3 Any components of the systems which might be damaged during tests shall be removed before the tests and reinstalled after the tests.
- .4 Provide all test holes (including prefabricated insulated capped test hole fittings), dampers, access facilities, etc. as required for air balancing and make any changes required for the final balancing results. Co-operate with the balancing contractor to ensure satisfactory completion of his work. Provide test holes prior to application of thermal insulation. Test ports are Duro-Dyne IP-2 for insulated ducts, and IP-1 for non-insulated ducts.
- .5 Start-up and run-in and test the complete heating, ventilating and air conditioning system.

3.6 AIR SYSTEM TESTING AND BALANCING

- .1 This work will be carried out by Section 23 00 30, refer to same.

3.7 FIRE PROTECTION AND SMOKE CONTROL

- .1 Provide for fire protection and smoke control as noted hereafter.
- .2 Electrical Division provides smoke detectors in air handlers in accordance with NFPA 90A and wires same including the relays. Mechanical Division provides the relays for shut-down of the air handler on actuation of the corresponding smoke detector. Co-ordinate with Electrical Division for the location of these detectors.
- .3 Provide sufficient ductwork off of the air handling units, whether shown on the drawings or not, to install the smoke detectors. Co-ordinate with the Electrical Division.
- .4 Supply to the Contractor for installation in architectural finishes, suitable sized access doors where they are required by location of otherwise inaccessible firestats and smoke detectors.

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PART 1 – GENERAL

1.1 GENERAL REQUIREMENTS

- .1 Conform to the Mechanical General Conditions, Section 23 00 10.
- .2 Provide labour and tools/equipment to conduct the commissioning process as outlined in this specification section.
- .3 The Mechanical contractor shall coordinate with the commissioning agent and comply with the commissioning agent's requirements.

PART 2 – PRODUCTS

2.1 MATERIALS

- .1 The Mechanical Contractor and manufacturers shall provide all instrumentation and equipment necessary to conduct the tests specified. The Mechanical Contractor shall advise the Consultants of instrumentation to be used and the dates the instruments were calibrated.

PART 3 – EXECUTION

3.1 THE COMMISSIONING PROCESS

- .1 The commissioning process consists of:
 - Shop Drawings and Record Drawings
 - Installation inspection and equipment verification
 - Plumbing and drainage system testing
 - Testing of piping systems
 - Flushing and cleaning of piping systems
 - Independent contractor testing and balancing of water systems
 - Testing of air systems
 - Independent contractor testing and balancing of air systems
 - Testing of equipment and systems
 - Commissioning Consultant performance testing
 - Commissioning meetings and reporting
 - Operating and maintenance manuals
 - Operator Training
 - System Demonstration and turnover
 - Testing forms
 - Warranties

3.2 SHOP DRAWINGS AND RECORD DRAWINGS

- .1 Conform to Section 23 00 10 for requirements for shop drawings and record drawings.

3.3 INSTALLATION INSPECTION AND EQUIPMENT VERIFICATION

- .1 Co-ordinate with the Consultant who will inspect the mechanical installation.
- .2 Complete the equipment verification forms for each piece of equipment. The forms shall be included in the operating and maintenance manual. The equipment data shall include:
 - Manufacturers name, address and telephone number
 - Distributors name, address and telephone number
 - Make, model number and serial number
 - Pumps - RPM, impeller sizes, rated flow
 - Fans - belt type and size, sheave type and size
 - Electrical - volts, amps, fuse size, overload size
 - Any other special characteristics.

3.4 PLUMBING AND DRAINAGE SYSTEM TESTING

- .1 The plumbing and drainage system shall be tested in accordance with the Plumbing Code under the Ontario Water Resources Act and specification Section 22 00 00.
- .2 Notify the Plumbing Inspector when systems are available for testing. Document all tests performed and arrange for the Plumbing Inspector to sign for tests completed. The forms shall be forwarded to the Consultant.

3.5 TESTING OF PIPING SYSTEMS

- .1 Test all piping systems in accordance with all applicable Codes and specification Sections 22 00 00 and 23 00 20.
- .2 All tests for the systems shall be performed in the presence of the Consultant or Commissioning Consultant. Complete the testing forms and forward to the Consultant.

3.6 FLUSHING AND CLEANING OF PIPING SYSTEMS

- .1 Conform to specification Section 23 00 20.
- .2 Prior to the start of flushing and cleaning, notify the Consultant or the Commissioning Consultant, to review flushing procedures.
- .3 The testing of the piping systems, by the chemical treatment supplier shall be witnessed by the Consultant or the Commissioning Consultant. Complete the testing forms and forward to the Consultant.

3.7 INDEPENDENT CONTRACTORS TESTING AND BALANCING OF WATER SYSTEMS

- .1 Conform to the specification Section 23 00 30.
- .2 The Independent Contractor shall be hired by and report to the Commissioning Consultant.

3.8 TESTING OF AIR SYSTEMS

- .1 Conform to the specification Section 23 00 40.
- .2 All supply air ductwork shall be pressure tested from the air handling equipment to the terminal device.
- .3 All tests shall be performed in the presence of the Consultant or the Commissioning Consultant. Complete the testing forms and forward to the Consultant.

3.9 INDEPENDENT CONTRACTORS TESTING AND BALANCING OF AIR SYSTEMS

- .1 Conform to specification Section 23 00 30.
- .2 The Independent Contractor shall be hired by and report to the Commissioning Consultant.

3.10 TESTING OF EQUIPMENT AND SYSTEMS

.1 General

- .1 The Mechanical Contractor shall, with the services of the manufacturer's technicians, test the equipment and associated systems. The technician shall record the results of the tests on the testing forms. The Consultant or the Commissioning Consultant shall witness the tests. When the tests have been completed satisfactorily the technician and witnessing authority shall sign the forms. A copy of the forms shall be forwarded to the Consultant. The original shall be inserted into the operating and maintenance manual.
- .2 Should equipment or systems fail a test, the test shall be repeated after repairs or adjustments have been made. The additional tests shall be witnessed.
- .3 Tests, which have not been witnessed, shall not be accepted and shall be repeated.
- .4 The equipment and systems to be tested shall include:
 - DX Cooling (if applicable)
 - Boilers and Pumps
 - Packaged Air Handling Units
 - Life Safety and Fire Protection Systems
 - Humidification Systems
 - Water Treatment Systems
 - Building Automation Systems (BAS)
 - Noise and Vibration
 - Specialty Equipment

3.11 COMMISSIONING MEETINGS AND REPORTING

- .1 The Mechanical Contractor shall include in the schedule for all tests and equipment start-up tests in the construction schedule.

- .2 The commissioning process and results shall be reviewed during the regular construction meetings. Separate commissioning meetings may be scheduled at the discretion of the Architect.
- .3 All testing forms and reports associated with the mechanical systems shall be directed to the Consultant with copies to the Architect, Commissioning Consultant and The School Board.
- .4 The forms and reports to be issued shall include:
 - Shop drawings, issued and accepted
 - Equipment verification forms
 - Testing forms
 - Reports resulting from tests
 - Testing schedule

3.12 OPERATING AND MAINTENANCE MANUAL

- .1 Conform to Section 23 00 10 for requirements for the O&M Manuals.

3.13 OPERATOR TRAINING

- .1 Conform to this section and any pertinent sections of the mechanical specification for the requirements of Instructions to the building Operating Staff.
- .2 The training shall be conducted either in a classroom or at the equipment or system.
- .3 Training will begin when the operating and maintenance manuals have been delivered to The School Board and approved by the consultant.
- .4 Each training session shall be structured to cover:
 - Design intent of each system
 - The use of the operating and maintenance (O&M) manuals
 - Operating procedures
 - System start-up, normal operation, shutdown, seasonal changeover, manual operation and alarms
 - Maintenance procedures
 - Trouble-shooting procedures
 - Spare parts required and parts sources
 - Relevant health and safety issues
- .5 Submit a course outline to the Consultant before training commences. Provide course documentation for up to four people.
- .6 The training sessions shall be scheduled and co-ordinated by the Commissioning Agent. The Commissioning Consultant shall video tape the sessions.

.7 Training shall be provided for the following systems:

<u>System</u>	<u>Minimum Training Times</u>
DX Cooling (if applicable)	1 hour
Boilers	1 hour
Chiller	1 hour
Hydronic Pumps	½ hour
Packaged Air Handling Units	1 hour
Life Safety & Fire Protection Systems	½ hour
Water Treatment Systems	1 hour
The Mechanical System	4 hours

.8 The training requirement for the mechanical system shall include a walk-through of the building by the Contractor. During the walk through the contractor shall:

- Identify equipment
- Identify starters associated with equipment
- Identify valves and balancing dampers
- Identify access doors
- Review general maintenance of equipment
- Review drain points in pipe work systems
- Identify maintenance items

.9 When each training session has been completed The School Board or the Commissioning Consultant shall sign the associated form to verify completion.

3.14 COMMISSIONING CONSULTANT

.1 The School Board shall hire a Commissioning Consultant (CC). The cost of the work by the Commissioning Consultant shall be paid from the Cash Allowance.

.2 The CC responsibilities shall include:

- Preparing the commissioning plan
- Co-ordinating with the contractor to schedule tests
- Preparing a test form manual
- Witnessing selected tests
- Receiving all test forms
- Hiring and guiding the Testing Adjusting and Balancing contractor
- Conducting performance tests
- Conducting deferred seasonal testing
- Co-ordinating the contractors training
- Chair commissioning meetings

.3 Co-operate with the CC.

.4 Provide assistance to the CC and have personnel available during the performance testing procedure. Each mechanical system shall be tested in the operational mode.

.5 Performance testing shall begin when all systems have been completed, tested by the Mechanical Contractor and the Consultant has completed their final review.

3.15 MECHANICAL SYSTEM DEMONSTRATION AND TURNOVER

- .1 Refer to Section 23 00 10.
- .2 The system demonstration and turnover to The School Board shall occur when:
 - The installation is complete
 - The acceptance test conducted by the Consultant has been completed successfully
 - The Commissioning Consultant system performance testing has been completed successfully
 - Training has been completed
 - Operating and Maintenance Manuals have been accepted
 - Shop-drawings have been updated
 - As-built drawings have been completed
 - The commissioning process has been completed successfully and system operation accepted by the Consultant and Commissioning Agent.
- .3 The Mechanical Contractor and manufacturers shall conduct the systems demonstration. The demonstration shall cover a demonstration of equipment installation and operation.

3.16 TESTING FORMS

- .1 The Mechanical Contractor and manufacturers shall fill out the forms listed in this section or provide other forms. The Consultant and The School Board must approve the forms before they are used.

3.17 WARRANTIES

- .1 Equipment and system warranties shall not begin until the system demonstration and turnover has been conducted successfully and accepted by The School Board.
- .2 The Mechanical Contractor shall fill out the warranty form listing the equipment and systems and the start and finishing dates for warranty.
- .3 Conform to Section 23 00 10 for requirements during the warranty period.

3.18 COMMISSIONING PROCESS ALLOCATION

- .1 The commissioning process shall be allocated a value equal to 2% of the contract. The Mechanical Contractor may draw from this allocation as the commissioning process is completed.
- .2 The Mechanical Contractor shall submit all test and verification forms. The Consultant will use these forms to calculate percentage complete.
- .3 The Mechanical Contractor may claim up to 1% of the contract from this allocation leading up to performance testing. The remaining 1% shall not be paid out until performance testing, O & M manuals; as-builts and training have all been completed satisfactorily.

END OF SECTION 23 08 00

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PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

- .1 Refer and conform to the requirements of Section 23 00 10, Division One General Requirements and Peel District Schools Mechanical Design and Co-ordination Manual.
- .2 Refer to Division 26 documents and all Sections of Mechanical Division for related information.
- .3 The work in Division 25 (Controls) shall be part of the base bid under the General Contractor's contract.

1.2 SCOPE

- .1 Existing building is equipped with a Schneider building automation system (BAS) JBS Services. The BAS for the work under this contract shall be compatible with the existing, and the new system shall be an extension of the existing BAS.
- .2 Provide temperature control systems, equipment and associated operating controls, as detailed on the drawings, or as described in the specifications. All pneumatic systems related to the above work shall be replaced with all electronic system.
- .3 Systems shall be complete in all details not necessarily defined or shown, but as may be reasonably inferred as necessary to complete each system and provide operating service in an acceptable manner. Provide all necessary relays, transformers, etc. to interconnect the equipment where required.
- .4 System installers shall be mechanics and electricians regularly employed by the control equipment manufacturer.
- .5 This Section is responsible for the provision of all control systems including the provision of the Energy Management and Control System (EMCS) and wiring of all related devices installed under all Sections of Mechanical and Electrical Divisions. Provide all engineering and prepare all data files, wiring diagrams and system schematics. Submit for review prior to commencing field work. Provide written operating instructions for the temperature control system and include a description of the sequence of operation, and "As Built" drawings of the system schematics. The graphical appearance, setup and general hardware/software architecture for the EMCS shall be in accordance with the Owner's standards. Provide hard copies of all graphic screens, sequences of operation, function block graphic program, etc. as part of the operating and maintenance manual. Provide a fully functional web-based network for local and off-site communication with the DDC system, including web user license.
- .6 In general, unless otherwise noted, all valve and damper actuation is electric or electronic. Refer to drawings and sequences of operation in this Section for exact requirements.
- .7 Upon completion of the installation, all control equipment supplied under this contract shall be adjusted to place the system in complete operating condition subject to the Consultant's approval. All adjustments shall be made in co-ordination with the field engineer responsible for balancing the air and water systems.

1.3 QUALITY ASSURANCE

- .1 Base bid basis of design products referenced under this Section establish the minimum acceptable standards of product quality, features and performance.
- .2 Work of this Section shall be provided by a recognized contractor regularly employed in the installation and wiring of EMCS and temperature control system and equipment. The following are pre-qualified to bid the work: JBS Services.
- .3 EMCS shall have the capability of dynamic on-line programming, i.e. a real time dynamic point or program editing without the requirement for compiling off-line. This requirement is specific and proof of same shall be demonstrated prior to contract award.
- .4 No field work shall commence prior to the installing contractor having in his possession copies of the approved controls shop drawings.

1.4 EQUIPMENT INSTALLED BY OTHERS

- .1 As required, the following equipment shall be supplied by this Section and installed by Others:
 - Automatic Controls Valves.
 - Temperature Sensing Wells.
 - Pipe System Flow and Pressure Station Fittings.
 - Line Voltage Thermostats.

1.5 GUARANTEE

- .1 Guarantee the installed controls system and all components thereof free from defects in operation sequences, materials and workmanship for a period of three years of normal use and service from the date of certified acceptance by the Owner.

1.6 AIR/WATER BALANCING

- .1 Co-ordinate, co-operate and perform the calibration of all devices (flow measuring, pressure differential, temperature, pressure, etc.) with the Balancing Contractor.
- .2 Accommodate the Balancing Contractor with a loan of a system specific portable device so that the Balancing Contractor may adjust control signals from minimum to maximum for proper balancing and/or calibration. Demonstrate proper use of the portable device. Alternatively, provide a trained technician complete with portable two-way radios to adjust control signals as instructed by the Balancing Contractor. Co-ordinate with the Balancing Contractor. The Balancing Contractor will be responsible for the loss/damage of all loaned devices.

1.7 AS-BUILT DRAWINGS AND OPERATOR MANUALS

- .1 Prepare record drawings on a CAD system utilizing AutoCad Release 2009 or later version software.
- .2 On completion of the contract work, provide a set of CAD produced reproducible contract drawings and associated diskettes of relevant approved, "As-Built" controls documentation. This documentation must identify and show all existing and new controls work for each phase or project.

- .3 As-Built documentation also includes the following as a minimum:
 - .1 Schematic outline of the BAS for quick reference of overall system scope.
 - .2 Adequate record of the work as installed, including exact location of all control panels, TECs, actuators, sensors, transformers, relays, etc.
 - .3 Adequate record of existing controls retained and/or interfaced, including exact location of all control panels, TECs, actuators, sensors, transformers, relays, etc.
 - .4 System hardware specification manual, which provides a functional description of all hardware components.
 - .5 System operator's manual which provides concise instructions for the operation of the system and an explanation and recovery route for all system alarms.
 - .6 System engineering manual which provides all of the information, for system set-up, definition and application.
 - .7 System data manual which provides the applications data programmed into the system.
 - .8 System servicing and maintenance manuals for central unit components including: video monitor; printer; digital control panels (DCP); application specific controllers (ASC); field devices (sensor, switches, etc.).
 - .9 All data specified in the shop drawings section in its final as-built form.
 - .10 System software documentation.
 - .11 List of equipment supplied, including its make, model number, name of local suppliers and quantity.
- .4 All manuals are 3-ring binders with index pages, indexing tabs and cover identification at front and side. Binder size is 215mm x 280mm (8.5" x 11") extension catalogue type bound with heavy weight fabric hot stamped in black lettering front and spine. Each spine is lettered with full identification of the project. The front face of each binder contains the following:
 - .1 Full identification title of the Project and Project No.
 - .2 Full identification title of the Consultant.
 - .3 Full identification title of the Contractor.
- .5 Should there be more than one (1) volume for each type of application, each volume shall be identified as above.
- .6 Submit a detailed description and configuration of the manuals to the Consultant for review.

PART 2 - PRODUCTS

2.1 AUTOMATIC CONTROL DAMPERS

- .1 Refer to the "Dampers" article in Section 23 00 40 of this Division.

- .2 All control dampers are low leakage type Tamco Series 9000. Dampers for modulating service are opposed blade type while dampers for two position service are parallel blade type. All dampers are flanged to ductwork.

2.2 DAMPER OPERATORS

- .1 Provide dampers with electric or electronic actuators (as specified in sequences of operation). All actuators are complete with spring return to fail safe position. Size actuators to provide sufficient force to maintain damper rated leakage characteristics.
- .2 Provide dedicated damper actuators on all dampers used for minimum fresh air application.
- .3 Mount all damper actuators rigidly and supply with heavy duty linkage consisting of a crankarm, pushrod and swivel balljoint to connect to the damper shaft. Secure linkages in such a manner as to prevent slipping under normal operating torque. Actuators shall not be installed in freezing air streams.
- .4 Acceptable manufacturers: Johnson, Honeywell, Siemens, Belimo.

2.3 ELECTRICAL LINE VOLTAGE THERMOSTATS

- .1 Provide heavy duty type. All thermostats are complete with blank metal cover (without setpoint scale and without thermometer on cover). Include backplate and bracket for mounting on standard size outlet box where required.
- .2 Provide heating/cooling type thermostat with deadband where sequencing of heating and cooling/ventilation is required.

2.4 ELECTRICAL LOW VOLTAGE THERMOSTATS

- .1 Provide complete with heat anticipator, and backplate and bracket for mounting on standard size outlet box where required. Include sub-base with fan On-Off-Auto switch with each thermostat where summer ventilation is required. Include modulating heating or cooling stage where used in conjunction with control valves; step controllers; SCR's; or similar equipment requiring modulation, and mercury switches where On-Off control is required.

2.5 CONTROL VALVES

- .1 Provide valves for the operating pressure and temperature conditions of the system. Ensure that valves will close against system operating differential pressures.
- .2 Provide globe body control valves with characteristics to suit the application. Straight through (two-port) water valves shall be single seated with equal percentage flow characteristics. Three-port valves shall be linear for each port to give constant total flow.
- .3 Valves shall have stainless steel stems and packing to suit the application.
- .4 Valves 50mm (2") and smaller shall have screwed 1035 kPa (150 lb.) bronze bodies. Valves 65mm (2½") and larger shall have flanged 860 kPa (125 lb.) cast iron bodies.

- .5 Use positive positioning relays on valves that are sequenced with other actuators or where necessary for high shut-off rating.
- .6 Unless specifically mentioned otherwise, the design flow pressure drop shall be as follows:-
- | | |
|--|----------------|
| - Hot water valves | 20 kPa (3 psi) |
| - Glycol valves | 20 kPa (3 psi) |
| - Valves for terminal unit application
(radiation and reheat coils) | 7 kPa (1 psi) |
- .7 Acceptable manufacturers: Johnson, Honeywell, Siemens.

2.6 VALVE ACTUATORS

- .1 Control valves shall be provided with electric or electronic actuators (as specified in sequences of operation). Select actuators to allow the control valve to shut off against normal inlet operating pressures.
- .2 Electric valve actuators are of the enclosed reversible gear drive type with spring return to fail safe position.
- .3 Electric valve actuators accept modulating control signals as required. Actuators have no balance relays or mechanical travel limiting switches. Provide actuators with potentiometer adjustment of zero signal position and angular rotation. Conceal all adjustments with access by means of removable cover plate.
- .4 Acceptable manufacturers: Johnson, Honeywell, Siemens, Belimo.

2.7 POSITIVE POSITIONING RELAYS

- .1 Whenever a controller has to proportion more than one motor on a single damper, a positive positioning relay must be used. Whenever a controller has to sequence two or more devices, such as valves or dampers, and for all damper operators on modulating dampers, positive positioning relays must be used. Sequencing by spring ranges alone will not be acceptable. Positive positioning relays have positive mechanical feedback of the controlled device, ratio relays are not acceptable.

2.8 HIGH TEMPERATURE LIMIT THERMOSTATS (FIRESTATS)

- .1 Provide DPDT high limit thermostats to shut down respective fan system(s) as follows:-
- .1 For ducts where the longest dimension is not over 760 millimetres (30") provide a bi-metal type manual reset limit thermostat set at 57.2° celsius. (135°F.)
 - .2 For ducts of greater dimension, provide multiple limit thermostats or, when compressed air is available, multiple temperature sensitive heads connected to a normally open pressure electric switch. Provide one limit thermostat or sensing heat per 1.1 meter (4 ft.) square of duct cross sectional area. Install in a staggered arrangement to give complete coverage of the duct.

2.9 LOW TEMPERATURE LIMIT THERMOSTATS (FREEZESTATS)

- .1 Provide DPDT manual reset low temperature limit thermostats complete with sensing capillary. Length of sensing capillary shall be such that every 0.1 sq.m. (1 sq.ft.) of coil is covered by element. Provide one limit thermostat for approximately every 6 square meters (60 sq. ft.) of duct area.
- .2 Each freezestat is complete with two contacts. One contact is hardwired to fan starter, and the second for BAS interface.

2.10 SWITCHES

- .1 Pressure electric switches have diaphragm operated D.P.D.T. snap acting contacts with electrical rating suitable for applications as specified. Pressure electric switches withstand up to 25 psig. and are provided with adjustable cut-in and cut-out settings between 3 and 20 psig.
- .2 Water flow switches are general purpose with a paddle actuated snap acting D.P.D.T. switch rated at 16 amp 120/1/60 A.C. full load.
- .3 Air proving (differential pressure) switches utilize a differential pressure activated, diaphragm actuated, snap acting D.P.D.T. switch rated at 9.8 amp 120/1/60 A.C. full load. Select differential pressure range to suit the application and setpoint is adjustable. Mount switches with diaphragm in a vertical plane. Switches are CSA approved.
- .4 Install minimum positioning switches inside local cabinets and lock switches after system balancing.
- .5 Damper end switches are DPDT, lever operated, activated by damper blade movement and mounted securely on damper frame. Switches have contact ratings of 5A at 120 VAC and are CSA approved.

2.11 ELECTRONIC TEMPERATURE SENSORS

- .1 All mixed air sensors are 1000 ohm nickel, resistance temperature detector (RTD) type with a twenty-five foot averaging element. Accuracy of the RTD sensor shall be +/- 0.6°C over a range of -7°C to 49°C (19°F to 120°F).
- .2 All supply and return air sensors are thermister or 1000 ohm nickel RTD type temperature detectors. The sensor probe has a minimum length of 450mm (18"). The accuracy of the sensor is +/- 0.6°C over a range of 4°C to 66°C (39°F to 151°F).
- .3 All space sensors are thermister or 1000 ohm nickel RTD type temperature detectors. All space sensors are provided with vented protective covers, plug-in port for portable operator's terminal, and system time schedule override. The accuracy of the sensor is +/- 0.6°C over a range of 4°C to 49°C (39°F to 120°F).
- .4 All liquid immersed sensors are thermister or 1000 ohm nickel RTD type temperature detectors. Each sensor is provided with a stainless steel well, suitable for the working temperature and pressure of the fluid. The accuracy of the sensor is +/- 0.6°C over a range of -7°C to 49°C (19°F to 120°F).
- .5 Outdoor air sensor is the thermister or 1000 ohm nickel RTD type temperature detector. The RTD sensor is mounted in a weatherproof enclosure. The accuracy of the sensor is +/- 0.6°C over a range of -34°C to 40°C (-29°F to 120°F).

.6 All sensor elements other than those for space sensors shall be housed in a factory made stainless steel sheath.

.7 All sensors shall be calibrated and linearized.

2.12 ELECTRONIC HUMIDITY SENSORS

.1 The humidity sensors incorporate solid state all polymer capacitance type sensing element and have a range of 0-100% RH with a temperature operating range of 0°C to 60°C (32°F to 140°F).

.2 The sensing element has an accuracy of +/- 3% RH over the humidity range.

.3 Duct mounted sensors are mounted halfway across the duct. Room mounted sensors are provided with vented covers.

2.13 DIFFERENTIAL PRESSURE SENSORS

.1 Provide differential pressure sensors for water velocity pressure and static pressure applications. The differential pressure range is selected to match the applications. Select materials suitable for the measured variable, i.e. water and air, and to withstand a minimum of twice the normal working pressure.

.2 Each sensor is provided with an industry standard 4-20 mA transmitter, mounted at the sensor not the SCU or panel unless in a finished area. The transmitter and sensor have a combined accuracy of 0.5% of the differential pressure range.

.3 Static pressure pickups within finished areas are in blank thermostat cases. Outside static pressure reference heads are complete with a wind baffle cap to eliminate wind pressure effects. The static pressure controller is of the slack diaphragm type with a minimum setpoint range of .01 inches to 6.0 inches W.G.

2.14 NAMEPLATES

.1 Provide lamoid nameplates 25mm x 63mm (1" x 2½") minimum size at all control system devices to clearly indicate the service of a particular device. All manual switches, unless they come with standard nameplates, are labelled. All thermostats, thermometers and switches installed on all local panels are similarly labelled. Permanent painted stencil labels may be used on the controllers and relays mounted inside local panels, if so desired. Tape labels are not acceptable.

.2 All controllers (except application specific controllers) shall have a laminated points list left inside the controller enclosure, or wall mounted adjacent to the controller. All controllers shall have power source location identification. All application specific controllers shall be labelled with their system name and their system address number for future replacement and reload.

.3 All end devices (sensors, relays, switches, transducers, etc.) installed in service rooms shall be labelled with the name, point descriptor and point address on a plastic tag mechanically fastened (or tie-wrapped) to the device. All end devices installed in ceiling spaces outside of service rooms shall be labelled with name, point descriptor, location of ASC to which the end device is connected and location of power supply serving the end device on a yellow sticker tag installed on the T-bar ceiling grid.

- .4 All conductors are numbered with Brady or Z-type numbers at both the control panel and device ends. Labels are visible without removing through covers.

2.15 WIRING

- .1 Electrical wiring incidental to the control system conforms to Electrical Division specifications except that control wiring from 50 to 120 volts may be minimum of #14 gauge wire and all wiring less than 50 volts may be a minimum of #18 gauge wire. Two-wire systems have black and white conductors; three-wire systems have black, white and red conductors.
- .2 Plenum cable may be used for 24V and less in concealed, fully accessible non-corridor areas only, provided that said cable meets Code requirements for flame-spread rating and smoke developed classification. Use conduits in equipment rooms, exposed areas, corridor ceiling spaces and non-accessible areas. In accessible corridor ceiling spaces, control wiring in cable tray is acceptable. Cable outer jacket is yellow, no other colour is acceptable.
- .3 Sensor wire for each analog input is colour coded #18 AWG twisted-shielded cable.

2.16 PANELS

- .1 Control panels are fully enclosed cabinets with all steel construction. Cabinets have hinged door with locking latch or bolt on cover plate. All cabinet locks are common keyed finished with two coats of paint.
- .2 Panels are wall mounted or free standing located as per the Mechanical Drawings.
- .3 All controllers, relays, transducers, etc. are located within the control panels.
- .4 Each control enclosure has a standard duplex AC power receptacle located within the enclosure to provide power for test equipment, operation communication devices and cassette tape storage devices. Receptacles are labelled with circuit number of breaker supplying power to panel.

2.17 CONTROL RELAYS

- .1 Control relays are DPDT for control of electrical starters and equipment where shown on the Point Schedule.
- .2 Coil voltage matches the Unit Controller. Contacts are rated at 5A at 120 VAC. Relays are Allen-Bradley #700HF32A24-1-4 or equal.

2.18 POWER CONDITIONERS

- .1 All electronic equipment shall be complete with all necessary devices to safeguard against voltage spikes, fluctuations or any other power line anomalies which might damage the equipment.

2.19 FACILITY MANAGEMENT SYSTEM - GENERAL

- .1 The Facility Management System (FMS) shall be capable of integrating multiple building functions, including equipment supervision and control, alarm management, energy management, and trend

data collection including the integration of the variable refrigerant flow air conditioning system. The FMS shall be the top of the line system available from the installation contractor that has been previously reviewed and accepted by the Owner.

- .2 The FMS shall consist of the following:
 - .1 Network Control Units.
 - .2 Standalone Application Specific Controllers (ASCs)
 - .3 Sensing devices, relays, switches, indicating devices, transducers, etc. required to perform functions listed.
 - .4 Monitoring and control wiring and air tubing, as applicable.
 - .5 Set-up of Owner's central office terminals, including graphics, for receipt, logging, reporting, trending, etc. of data received via the Owner's web-based network.
- .3 The system shall be modular in nature, and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, ASCs, and operator devices. The failure of any single component or network connection shall not interrupt the execution of control strategies at other operational devices.
- .4 The design of the FMS shall be networked. Inherent in the system's design shall be the ability to expand or modify the network via a local network.
- .5 FMS is complete with suitable communication protocol for connection to Owner's local area network. Provide a functional Ethernet communication interface at the site, including the provision of a web user licence. DDC system communications is based on local and remote Ethernet communications. Provide all necessary DDC panel hardware/software and remote computer software to provide full DDC communications for Ethernet communications. Provide an Ethernet communications port directly at the DDC panel. Network the DDC system with the school LAN network Hub. School LAN interface drop at the Ethernet module will be by others, termination at the Ethernet module is by this Section.
- .6 Each ASC is complete with a communication outlet for a portable operator terminal connection. Provide a notebook cable to allow connection to the ASC.

2.20 AIR QUALITY (CO2) DETECTORS

- .1 Provide carbon dioxide (CO2) sensors with suitable duct mounting kits as required where shown, or specified in the Sequences of Operation. Sensors are photo-acoustic, requiring 24 VAC power supply, transmitting a 0-10 VDC output signal with a range of 0-2000 PPM. Sensors are equal to Siemens Model QPA63.1.

PART 3 - EXECUTION

3.1 GENERAL

- .1 The building operator communicates with the modular controller network through the terminal located in the Custodial Office and the VRF system in Adult Education electrical room.
- .2 Provide all installation work required for a complete operational system, under this Section. The system includes all control and remote hardware, software, all interconnecting wire and conduit as required for a fully operational system as specified, and be in accordance with local and national codes and Electrical Division.
- .3 Provide all engineering, data file preparation and entry, system check out and calibration labour for a complete and fully operational system.
- .4 Electrical material and installation is in accordance with the appropriate requirements of the Electrical Division of these Specifications, and in accordance with applicable sections of the current edition of the applicable local codes for signaling systems. Wiring is in conduit or approved totally enclosed raceways. No cable raceway, troughs or open wiring (except plenum cable) of any kind is permitted.
- .5 Assume full responsibility for locating all sensing devices so as to provide an accurate and representative measure of the parameter being measured. Any sensing devices which do not meet this requirement shall be relocated by this Section at its expense.

3.2 SYSTEM COMMISSIONING

- .1 Refer to "System Commissioning" Article in Section 23 00 10.
- .2 Prior to the commissioning process:
 - Adjust, calibrate, set and test the controls systems by a qualified manufacturer's representative.
 - Provide a report for each system and controller and include all pertinent data relating to the BAS.
 - Each point clarification to be signed by technician employed by manufacturer.
- .3 Upon completion of the above this Section shall request, in writing, to the Owner that the commissioning procedure can commence. The procedure is conducted with two (2) representatives of the Controls Contractor and the Owner present and consists of:-
 - A point log of all points connected to the system, detailed in the input/output summary.
 - Each commandable point, i.e. analog output and digital outputs is commanded.
 - Each program sub-routine is demonstrated as functioning.
 - Each DDC loop is demonstrated as functioning and stable.
 - All other functions and reports detailed in Section 17100 are demonstrated as functioning.
- .4 Should this procedure prove satisfactory then the system will perform, without any downtime, for a period of 30 days before the system is accepted by the Owner.
- .5 Submit three (3) copies of commissioning report.

3.3 THERMOSTATS (ROOM TEMPERATURE SENSORS)

- .1 Mounting Heights (roughed-in by Electrical Division in new masonry walls):
- | | |
|----------------------------|------------|
| - Office Areas | 1.5 meters |
| - Service Areas | 1.5 meters |
| - Classrooms and Corridors | 1.5 meters |
- .2 Provide all sensors in public and service areas (Corridors, Gymnasiums, Changerooms, Cafeterias, and other high traffic areas as noted) and all thermostats with metal vandal-proof guards. Plastic guards are not acceptable. Where classroom sensors are installed in control panels provided by others, co-ordinate mounting heights with panel supplier. Calibrate all sensors to compensate for inaccuracy of type of installation. Calibrate all thermostats.

3.4 SENSORS

- .1 Where sensors are specified to be in the outside air they shall be installed so as not to be affected by exhaust air, reverse warm airflow through air supply units, or the direct ray of the sun.
- .2 Where sensors are installed in pipe walls apply temperature sensitive grease for increased response. Ensure sensor elements are immersed in heat transfer compound and firmly seated against tip of well. Elements to extend at least two-thirds of pipe diameter into the pipe. Use thermowells with extensions where required to accommodate pipe insulation.
- .3 Use averaging element sensors in mixing plenums.
- .4 Provide pressure sensor transmitters with valved pressure connections.
- .5 Mount sensors and combination sensor-controllers in accessible locations.
- .6 Where sensors and controllers are to be mounted on or within air handling units, co-ordinate with the air handling unit assembler before mounting control devices.
- .7 All sensors are calibrated to such a level as to permit on the job installation that will require minimum field adjustment or calibration. All sensors are mounted to provide ready access for calibration, servicing and removal.

3.5 WIRING

- .1 Extend wiring and provide all ancillaries from 15 amp/120 volt separately fused circuits provided by Electrical Division. Where none are provided this Section shall arrange (and pay) for Electrical Division to extend a suitable service.
- .2 Label each wire with its point descriptor at the point where it attaches to the panel. All wiring between panels and end devices shall be provided continuous; splicing/terminations/joints are not acceptable.

3.6 FREEZESTATS AND LOW LIMIT CONTROLLERS

- .1 Freezestats are directly interlocked with fan starter control circuits and the interlock signal does not pass through any device which requires calibration nor any device which interrupts the signal.
- .2 Demonstrate the calibration and proper functioning of freezestats at +2°C (35°F) and low limit controllers at the specified temperatures.

3.7 FIRE ALARM AND SMOKE DETECTORS

- .1 As applicable and required by local Codes, Electrical Division will wire the smoke detectors into the fire alarm system.
- .2 Mechanical Divisions shall arrange the motor starter control circuits wiring to allow the fire alarm system to shut down the fans and air handling systems.
- .3 Electrical Division will provide suitable switches and/or 120 VAC auxiliary relays at the fire alarm panel, and wire from the relay contacts to alarm terminals in fan starters.

3.8 FIRESTATS

- .1 Firestats are directly interlocked with supply and/or exhaust fan starter control circuits and the interlock signal does not pass through any device which interrupts the signal.
- .2 Interconnect shutdown with combination smoke and fire dampers as required.

3.9 CONTROLLER PANELS

- .1 Wherever possible, locate panels on wall surfaces which are not occupied by other equipment at a centreline height of approximately 5'-0". Locate in an area which satisfies the environmental requirements of the panels. Panels may not be located in hallways, offices, classrooms or any other areas normally accessible to the public.
- .2 Where existing equipment must be moved to accommodate panels ensure that all relocated existing equipment is properly reconnected and mounted in a neat and workmanlike manner.
- .3 Ensure that all panels are mounted so as to provide ready access for servicing purposes.
- .4 Provide wiring diagrams for each panel and install plastic laminated copy inside each panel, on wall adjacent to panel or provide folder inside cabinet door with wiring diagrams.

3.10 GRAPHICS

- .1 Provide colour graphic schematic representations for all systems controlled. Graphics are based on the system schematics included as part of the Shop Drawing submission.
- .2 Graphic displays of building systems shall include the system name. Identify all major system components, including fans and sensors, using English descriptors. Adjacent to each sensor, display the current sensed value with the setpoint (where applicable) displayed in brackets directly beneath. Display actual equipment status. All status displays shall indicate "true status" achieved

by wiring through current sensing/metering devices at equipment starters. A point in alarm shall be highlighted with a flashing display or a coloured background which is different to that used when point is in normal condition.

- .3 Display outside air (or fresh air) temperature on all system graphics.

3.11 CONTROL STRATEGIES

- .1 The intended operation of major systems are described in the Sequences of Operation and I/O Summary included hereinafter. Provide, install, pipe and wire such components as are required to achieve the end result as described.
- .2 Unless otherwise specified, all information and schedules required to initialize and implement control programs is to be based on information provided by the Owner. This Section shall list all requirements for information and submit to Consultant.
- .3 Where a system does not fit into any of the categories defined for control purposes, notify Consultant before proceeding.
- .4 Be responsible for maintaining the correct sequence of operation for controlled devices in the event that there is a change or reduction in the number of existing control loops.
- .5 The local operator shall be able to change and/or define all setpoints and schedules outlined in this Section, unless otherwise specified.

3.12 SEQUENCES OF OPERATION

1. GENERAL

- .1 All control is electronic or electric as noted. Line voltage control, including mounting and wiring of thermostats, will be by Electrical Division.
- .2 Abbreviations used in describing the sequences of operation hereinafter:

EA	-	Exhaust Air
OA	-	Outside Air
MA	-	Mixed Air
RA	-	Return Air
SA	-	Supply Air
EAT	-	Exhaust Air Temperature
OAT	-	Outside Air Temperature (see 1.3 below)
FAT	-	Fresh Air Temperature (see 1.3 below)
MAT	-	Mixed Air Temperature
RAT	-	Return Air Temperature
SAT	-	Supply Air Temperature
HWS	-	Heating Water Supply
HWR	-	Heating Water Return
<	-	Less Than
>	-	Greater Than
=	-	Equal to
</=	-	Less Than or Equal To
>/=	-	Greater Than or Equal To
RH	-	Relative Humidity
GLS	-	Glycol Supply
GLR	-	Glycol Return
VFD	-	Variable Frequency Drive

- .3 OAT is meant to be the actual ambient temperature. FAT, used in systems with heat recovery, is meant to be the temperature downstream of the heat recovery device on the incoming air side.

2. PERIMETER/CONVECTOR RADIATION (DDC)

- .1 Space temperature sensor modulates heating control valve on a call for heat to maintain an operator defined setpoint.

3. UNIT HEATERS (DDC)

- .1 For hot water heating units, space temperature sensor energizes unit fan on a call for heat to maintain setpoint, unless indicated otherwise.

4. MISCELLANEOUS HEATING AND VENTILATION (DDC)

- .1 Applicable for areas ventilated with building air: On a temperature rise above cooling setpoint, space temperature sensor energizes exhaust fan to maintain an operator adjustable cooling setpoint. On a temperature drop below heating setpoint, space temperature sensor energizes unit heater fan (and heater coil in case of electric heat) or modulates perimeter heater control valve to maintain an operator adjustable heating setpoint.

- .2 Applicable for areas ventilated with outside air (low air capacity): On a temperature rise above setpoint, space temperature sensor energizes exhaust fan and NC low leakage electric motorized damper (120 VAC) at air intake duct to maintain an operator adjustable setpoint. Wiring of fan and damper motors will be by Division 26 through fan motor starters. On a temperature drop below heating setpoint, space temperature sensor energizes unit heater fan (and heater coil in case of electric heat) or modulates perimeter heater control valve to maintain an operator adjustable heating setpoint.
- .3 Applicable for areas ventilated with outside air (high air capacity): On a temperature rise above setpoint, space temperature sensor opens low leakage NC motorized dampers (120 VAC) at air intake and exhaust ducts. An end switch on exhaust damper “makes” on damper full-open position which starts respective exhaust fan to maintain an operator adjustable setpoint. Section 25 00 00 to supply/install damper end switches. Wiring of fan and damper motors and end switches will be by Division 26 through fan motor starters. On a temperature drop below heating setpoint, space temperature sensor energizes unit heater fan (and heater coil in case of electric heat) or modulates perimeter heater control valve to maintain an operator adjustable heating setpoint.
- .4 Provide a deadband between heating and cooling space temperature setpoints. Between the setpoints, space temperature floats.

5. EXHAUST FANS

- .1 Applicable equipment: F-3, F-3N.
- .2 BMS controls all fans from operator adjustable individual time schedules.

6. MODULAR AIR-COOLED VARIABLE REFRIGERATION FLOW SYSTEM (DDC)

- .1 Applicable equipment: Fan coil units, condensing units.
- .2 Unoccupied Mode: Fan coil unit fan Off, condensing units Off.
- .3 Occupied Mode: Time Schedule. On a call for cooling, BAS shall enable VRF controller, space temperature sensor maintains operator defined setpoint by modulating VRF system to maintain space temperature.
- .4 Co-ordinate with the VRF systems installation.
- .5 BAS Contractor shall integrate with the VRF system controller. BAS system shall provide Start/Stop and all temperature adjustments.

7. ERV-1 SYSTEM (CV-DDC)

- .1 Applicable equipment: ERV-1, SA and EA fans, electric duct heaters EH-1 and EH-3.
- .2 On System Start in Occupied Mode:
 - .1 OA and EA dampers open. Supply fan ERV to start on time of day schedule and then exhaust fan to start and operate after 15 minutes delay. Heating to be provided by enabling electric heater EH-1. The electric heater EH-3 will be enabled to maintain the ERV entering air temperature at -17.8°C (0°F) or as suggested by the ERV manufacturer.

- .2 To initiate ERV and electric duct heaters in sequence, in order to maintain supply air temperature (13°C-22°C operator adjustable).
- .3 On System Stop to Unoccupied Mode:
 - .1 OA and EA dampers to close.
 - .2 Electric heaters to be disabled, supply fan ERV to stop and then exhaust fan RF to stop.
- .4 Safeties: System to be de-energized if smoke detector (Division 26) senses products of combustion.
- .5 Low SAT protection is also alarmed on EMCS.

8. ERV-2 SYSTEM (CV-DDC)

- .1 Applicable equipment: ERV-2, SA and EA fans, electric duct heaters EH-2 and EH-4.
- .2 On System Start in Occupied Mode:
 - .1 OA and EA dampers open. Supply fan ERV to start on time of day schedule and then exhaust fan to start and operate after 15 minutes delay. Heating to be provided by enabling electric heater EH-2. The electric heater EH-4 will be enabled to maintain the ERV entering air temperature at -17.8°C (0°F) or as suggested by the ERV manufacturer.
 - .2 To initiate ERV and electric duct heaters in sequence, in order to maintain supply air temperature (13°C-22°C operator adjustable).
- .3 On System Stop to Unoccupied Mode:
 - .1 OA and EA dampers to close.
 - .2 Electric heaters to be disabled, supply fan ERV to stop and then exhaust fan RF to stop.
- .4 Safeties: System to be de-energized if smoke detector (Division 26) senses products of combustion.
- .5 Low SAT protection is also alarmed on EMCS.

9. INPUT/OUTPUT SUMMARY

- .1 I/O summary is appended hereto.

END OF SECTION 25 00 00

**BURNHAMTHORPE PUBLIC SCHOOL ELEVATOR & ACCESSIBLE WASHROOM RENOVATION
INPUT/OUTPUT SUMMARY**

POINT DESCRIPTION	GEN	PROGRAMS										DO			DI			AO			AI															
		Graphic (Colour)	Intercom	Totalize (Run Time)	Analog Limit (Lo)	Analog Limit (Hi)	Maintenance	Event Program	Reset	Demand Limits	Duty Cycle	Opt. Enthalpy	Opt. Start/Stop	Time Schedule	P-I-D	Norm/Assembly	Occ./Unocc.	Open/Close	Start/Stop	Alarm (Low)	Alarm (High)	Status	3-13 PSIG	0-10 Volts	4-20 mA	Concentration (PPM)	AMPS (Status)	Temperature	Pressure	Rel. Humidity	Flow (CFM)	Velocity	KW			
SYSTEM DESCRIPTION																																				
<u>ENERGY RECOVERY VENTILATOR ERV-1 & ELECTRIC DUCT HEATERS EH-1, EH-3</u>																																				
System	X																																			
EA Fan			X									X						X									X									
SA Fan			X									X						X									X									
SA & EA Temp of ERV-1. (each)																												X								
OA & EA Damp. (each)																									X	X										
Disch. Air Temp. Reset												X													X	X										
Temp. Between EH-3 and ERV-1																											X									
Temp. at Downstream of EH-1																											X									
Electric Duct Heater EH-1												X						X																		
Electric Duct Heater EH-3												X						X																		
ERV Control																		X								X	X									
Freestat																																				
Dirty Filter																																				
Unit Trouble/Failure																																				

**BURNHAMTHORPE PUBLIC SCHOOL ELEVATOR & ACCESSIBLE WASHROOM RENOVATION
INPUT/OUTPUT SUMMARY**

POINT DESCRIPTION	GEN	PROGRAMS										DO			DI			AO			AI															
		Graphic (Colour)	Intercom	Totalize (Run Time)	Analog Limit (Lo)	Analog Limit (Hi)	Maintenance	Event Program	Reset	Demand Limits	Duty Cycle	Opt. Enthalpy	Opt. Start/Stop	Time Schedule	P-I-D	Norm/Assembly	Occ./Unocc.	Open/Close	Start/Stop	Status	Alarm (High)	Alarm (Low)	3-13 PSIG	0-10 Volts	4-20 mA	Concentration (PPM)	AMPS (Status)	Temperature	Pressure	Rel. Humidity	Flow (CFM)	Velocity	KW			
SYSTEM DESCRIPTION																																				
<u>ENERGY RECOVERY VENTILATOR ERV-2 & ELECTRIC DUCT HEATERS EH-2, EH-4</u>																																				
System	X																																			
EA Fan			X									X						X									X									
SA Fan			X									X						X									X									
SA & EA Temp of ERV-2. (each)																											X									
OA & EA Damp. (each)																									X	X										
Disch. Air Temp. Reset												X													X	X										
OA Temp.																											X									
Temp. Between EH-4 and ERV-2																											X									
Disch. Air Temp. at Downstream of EH-2																											X									
Electric Duct Heater EH-2												X						X																		
Electric Duct Heater EH-4												X						X																		
ERV Control																		X							X	X										
Freeestat																																				
Dirty Filter																																				
Unit Trouble/Failure																																				

