

APPENDIX - E2

TECHNICAL SPECIFICATIONS FOR :

PROJECT: MAYFIELD WEST No. 2 PUBLIC SCHOOL

CLIENT:  peel District
School Board

PROJECT No.: 24112

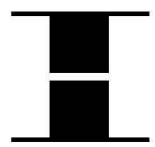
TENDER No.: RFT MA26-5334

DATE: JULY 2026

BINDER: **B** MECHANICAL & ELECTRICAL



ARCHITECT & CONSULTANTS:

 **HOSSACK**
ARCHITECTURE

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Tel (905) 815-8284

 **Salas O'Brien**™

 **rybka**
Ellard Willson

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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

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:

MAYFIELD WEST #2 PUBLIC SCHOOL

29 TWEEDHILL AVE.,

CALEDON, ONTARIO

FOR THE PEEL DISTRICT SCHOOL BOARD

ENGINEER:

**Rybka Ellard Willson Inc.
23 Lesmill Road
Unit 410
Toronto, Ontario
M3B 3P6
(647) 479-3785 - PHONE**

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.

Section of Work

Name

Piping (HVAC)

Sheet Metal

Insulation

Plumbing & Drainage

Others

2. MANUFACTURERS AND SUPPLIERS:

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

ITEM	BASE BID BASIS OF DESIGN	ACCEPTABLE ALTERNATE
Pipe Hangers	Grinnell	Crane, Flamco, Unistrut
Mechanical Grooved Joints	Victaulic	Coupcos, Gruvlok
Unions	Crane	Grinnell, Dart
Expansion Joints	Flexonics	Amtrol, Hydroflex, Tube Turn
Gate, Globe & Ball Valves	Kitz	Jenkins, Toyo/R+W Newman-Hattersley,
Check Valves	Kitz	Jenkins, Toyo/R+W Newman-Hattersley,
Plug Valves	Kitz	Newman-Hattersley, DeZurik
Circuit Balancing Valves	Tour and Andersson	
Butterfly Valves	Kitz	Jenkins, Centerline, Keystone, Newman-Hattersley,
Thermal Insulation	Fiberglas Canada	Manson, Knauf Johns-Manville
Pumps & Circulators (Except as noted)	ITT Fluids	S. A. Armstrong, Taco, Patterson
Extended Shaft Coupling VIL Pumps	ITT Fluids	S.A. Armstrong, Taco
Strainers	Sarco	Crane, McAvity, Morrison Brass, Braukmann
Suction Guides	ITT Fluids	S.A. Armstrong, Victaulic
Plate Heat Exchanger	ITT Fluids	Alfa Laval, S. A. Armstrong, Nixon Vicarb
Automatic Air Vents	Sarco	Amtrol, Braukmann, S. A. Armstrong, Terice

2. **MANUFACTURERS AND SUPPLIERS:** (CONT'D)

ITEM	BASE BID BASIS OF DESIGN	ACCEPTABLE ALTERNATE
Backflow Preventors	Watts	Braukmann, Zurn-Wilkins
Make-Up Assemblies	Watts	S. A. Armstrong, Bell & Gossett, Mueller, Singer
Gauges, Thermometers	Trerice	Ashcroft, Weiss Weksler, Winters, Wika
Finned Tube Radiation and Convectors	Engineered Air	Dunham-Bush, Trane, Sigma, Rosemex, McQuay, Sterling, Rittling, Slant Fin
Hot Water Unit Heaters and Cabinet Heaters	Engineered Air	Dunham-Bush, McQuay, Trane, Sigma, Rosemex, Sterling, Rittling, Slant Fin
Radiant Ceiling Panels	Airtex	Frenger, Sigma, Sunrise Enterprise, Airtite
Hot Water Boilers	Riello Array	Veissmann, Patterson-Kelly Boilers
Prefabricated Chimneys	Van-Packer	Metal-Fab, Selkirk, ICC, Chimenees
Water Treatment	Rochester Midland Canada Corporation	Drew Chemical, Magnus Chemical, Culligan, Finnan
Air Terminal Devices (Diffusers, Registers, Grilles, By-Pass & VAV Boxes)	Nailor	E. H. Price, Kruger, Carnes, Titus, Tuttle & Bailey
Packaged Air Handling Units	Eng.Air	Haakon, Trane, Daikin, Aeon
Air Sanitization Units	Air Sniper	
Heat Pump Air Cooled Condensing Units	Aeon	Daikin
Direct Expansion Cooling Coils	Aeon	Daikin

2. **MANUFACTURERS AND SUPPLIERS:** (CONT'D)

ITEM	BASE BID BASIS OF DESIGN	ACCEPTABLE ALTERNATE
Energy Recovery Ventilators (ERV)	Engineered Air	York, Mafna, Daikin Haakon, PMI, Trane
Heat Recovery Wheels	Engineered Air	Trane, PMI
Packaged Rooftop Units	Aaon	Daikin
Miscellaneous Fans	Cook	Carnes, Greenheck, ACME, Jenn-Air, Twin City
Air Filters	Farr	Cambridge, Airguard, Vibron, A.A.F.
Filter Gauges	Dwyer	Airflow Developments Ltd.
Dampers (except low leakage)	Tamco	Johnson, Powers, Nailor Kerr Hunt, Honeywell, Barber-Coleman, Ruskin,
Low Leakage Dampers	Tamco Series 9000	
Motorized Smoke Dampers	Nailor	Potoroff, Ruskin
Combination Fire/Smoke Dampers	Nailor	Potoroff, Ruskin
Fire Dampers	Nailor	Ruskin, Potoroff, Ventex, Controlled Air
Electrical Starters, Disconnects, MCC's, Alternator Panels	Square 'D'	Allen-Bradley, Moeller Electric
Noise and Vibration Control	Vibro-Acoustics	Korfund-Sampson, Vibron, Coolbreeze, E. H. Price, VAW, J. P. Environmental,
Variable Frequency Drives	Graham Danfoss	ABB
Electric Pipe Tracing	Raychem	Serge-Baril
Trap Primers	PPP	
Plumbing Fixtures	American Standard	Crane, Kohler, Eljer
Floor Drains, Roof Drains, Cleanouts, Drainage Specialties	Zurn	Ancon, J. R. Smith, Mifab

2. **MANUFACTURERS AND SUPPLIERS:** (CONT'D)

ITEM	BASE BID BASIS OF DESIGN	ACCEPTABLE ALTERNATE
Counter Sink Trim	Chicago Faucets	American Standard, Zurn, Delta/CambridgeBrass, Moen
Metered Faucets	Moen	Delta/Cambridge Brass
Toilet Seats	Centoco	Beneke, Moldex, Olsonite
Domestic Water Heaters	Bradford-White	A.O. Smith, John Wood
Fire Extinguishers & Cabinets	National Fire Equipment	Wilson & Cousins,
Electronic Faucets	Sloan	Delta/Cambridge Brass, Zurn, Moen, Symmons
Washfountains	Acorn	Bradley
S.S. Sinks	Franke Commercial	Architectural Metal (Novanni)
Drinking Fountains	Haws	Sunroc, Acorn
Drinking Fountains c/w Bottle Filler	Elkay	Murdock
Emergency Eyewash	Haws	Bradley, Speakman, Acorn
Mixing Valves	Symmons	Powers
Shower Head	Symmons	-

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 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 Tradesmen		\$_____ Per Hour
HVAC Piping Tradesmen		\$_____ Per Hour
Insulation Tradesmen		\$_____ Per Hour
Sheet Metal Tradesmen	Shop	\$_____ Per Hour
	Field	\$_____ Per Hour
(Other) _____		\$_____ Per Hour

SIGNING

This Supplementary Bid Form 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

(Bidder - please print) _____(Seal)

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

ARTICLE NO.

DESCRIPTION

PART 1:

GENERAL

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

PART 2:

PRODUCTS AND MATERIALS

2.1	Valves
2.2	Piping Specialties
2.3	Pipes and Fittings
2.4	Cleanouts
2.5	Floor Drains
2.6	Roof Drains
2.7	Domestic Hot Water Heater
2.8	Plumbing Fixtures
2.9	Fire Protection Systems
2.10	Pumps
2.11	Thermostatic Mixing Valve

PART 3:

EXECUTION

3.1	Piping Systems
3.2	Piping Specialties
3.3	Water Meter
3.4	Service Connections
3.5	Valves
3.6	Tests
3.7	Declaration of Completion
3.8	Drainage Products
3.9	Domestic Water Heaters
3.10	Plumbing Fixtures
3.11	Fire Protection Systems
3.12	Pumps
3.13	Video Inspection (Sanitary and Storm Sewer)

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.

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 and Automatic Flushing Systems.
 - .5 Plumbing Trim.
 - .6 Toilet Seats
 - .7 Valves.
 - .8 Pipe Specialties.

- .9 Domestic Water Heaters.
- .10 Mixing Valve.
- .11 Pumps and Controls.
- .12 Fire Extinguisher Cabinets.
- .13 Fire Extinguishers.
- .14 Sump Basins and Sump Pumps.
- .15 Grease Interceptors.

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 Section 21 00 00, Mechanical Supplementary Bid Form for listings of acceptable 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.
- .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".

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- .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 Valves for fire systems shall be ULC Listed, FM approved, and Authority approved.
- .10 Backflow Preventers: Backflow preventers shall be Watts Series 909-QT-S reduced pressure backflow preventers, complete with quarter-turn ball valve shut-offs and bronze strainer, unless noted otherwise on drawings.
- .11 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 Gate valves larger than 75mm (3") have O.S.&Y., solid wedge disc, bolted bonnet.
- .5 Globe valves 75mm (3") and smaller have union bonnet, replaceable composition disc.
- .6 Globe valves larger than 75mm (3") have O.S.&Y., bolted bonnet, renewable bronze seat ring, composition disc.
- .7 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.
- .8 Check valves larger than 75mm (3") for other than pump discharge of pipes with pulsating flow, are regrindable seat swing check with bolted cap.
- .9 Check valves for pulsating flows such as pump discharge are provided by pump manufacturer, suitable for the service.
- .12 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.
- .13 Balancing Valves: All bronze construction with precision flow balancing, precise flow measurement with metering ports incorporating EPT check valves, on both sides of the valve seat; positive, no-drip shut-off with a soft seat; drain port on each side of the valve seat.
- .1 50mm (2") and smaller:
Tour & Andersson Model STA-D with 360° adjustment turn with a positive memory, allowing valve to be shut off and re-opened to its balancing setpoint.
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- .2 65mm (2.1/2") and larger:
Tour & Andersson Model STA-F with 360° adjustment turn with a positive memory, allowing valve to be shut off and re-opened to its balancing setpoint.

.14 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.

.15 Safety Relief Valves

- .1 Water safety relief valves shall be pressure relief type, with bronze body, bolted cap, non-metallic disc to metal seating, elevated seat design, and complete with test lever. Valves shall be ASME rated.
- .2 Temperature and pressure relief valves shall be similar to the water SRV's specified above, but with an extended copper sheathed thermostat and release mechanism. Thermostat extension shall be selected to suit the installation dimensions. Valves shall be ASME rated and for gas fired appliances, CGA approved.
- .3 Basis of Design: Watts.

.16 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.
- .3 Hose Bibb #2:
For interior mechanical, service and equipment rooms, etc. exposed hose bibbs shall be sediment type faucet with bronze body, wheel handle, composition disc, and hose end outlet complete with attached vacuum breaker.
Basis of Design: Emco No. 10240.

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.

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- .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 |
| W.H.A. - B | 12-32 Fixture Units | - use Model B |
| W.H.A. - C | 33-60 Fixture Units | - use Model C |
| W.H.A. - D | 61-113 Fixture Units | - use Model D |
| W.H.A. - E | 114-154 Fixture Units | - use Model E |
| W.H.A. - F | 155-330 Fixture Units | - use Model F |
- .4 Products as manufactured by the following will be considered as meeting these requirements.
Basis of Design: Precision Plumbing Products.
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.5 Thermometers and Gauges

- .1 Thermometers for installation in piping are light powered digital adjustable angle type with brass stems, chrome plated brass sockets and fittings, brass separable wells, switchable METRIC/IMPERIAL LED temperature display. Stem assemblies are suitable for direct replacement of standard 225mm (9") industrial mercury-in-glass type thermometers.
- .2 Pressure gauges shall have 113mm (4½") dial; cast aluminum case with matte black finish; dual reading range 0 to 1200 kPa (0 to 160 psig) and be complete with union cocks.
Basis of Design: Trerice No. 600.

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 System 15 XFR pipe and fittings.
- Where applicable, water closet bends shall be copper long tangent bends and companion flanges.

.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-SDR28 pipe, hub and spigot push-on type fittings with self-locking gaskets, or DWV PVC solvent weld pipe and fittings.
- Stack and fixture footings shall be cast iron or copper as required.

.5 Storm Water System

.1 Storm Drains (Suspended):

- Class 4000 factory coated cast iron mechanical joint pipe and fittings, or DWV copper tubing with wrought copper solder fittings or Iplex System 15 XFR pipe and fittings.

.2 Storm Drains (Underground, Buried):

- Sizes 50mm (2") and 75mm (3"), Class 4000 factory coated cast iron mechanical joint pipe and fittings, or DWV PVC solvent weld pipe and fittings.
- Sizes 100mm (4") and 150mm (6") shall be Class 4000 factory coated cast iron 'MJ' pipes and fittings; or CSA approved PVC-SDR28 pipe hub and spigot with push-on type fittings with self-locking gaskets.
- Sizes 200mm (8") and over shall be CSA approved PVC SDR-35 municipal type sewer pipe with hub and spigot push-on self-locking fittings, couplings, joints, etc.
- Stack footings shall be cast iron.

.6 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 System 15XFR pipe and fittings.
- Vent terminations through the roof shall be cast iron.
- Note: Flashing for vent terminations through roof shall be by the General Contractor.

.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.

.7 Water Services

.1 Water Piping (Suspended):

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

.2 Water Piping (Underground, Buried):

- Buried piping within the foundation walls of the building shall be Type 'K' soft copper in continuous roll lengths.

.3 Water Piping (Incoming Services, Buried): Note: Confirm with Local Authority on acceptable pipe material prior to installation.

.3.1 Cement Lined Ductile Iron Water Pipe:

Sizes 100mm (4") and larger shall be Class 52 cement lined, (AWWA-C104-74) ductile iron (AWWA-C151-76) pipe for 1724kPa (250 p.s.i.) working pressure with bell and spigot pattern, push-on tyton joints and fittings, and shall be new and clean to ASA Specifications.

100mm (4") Watermain: Class 52 - wall thickness 74mm (0.29").
150mm (6") Watermain: Class 52 - wall thickness 79mm (0.31").
200mm (8") Watermain: Class 52 - wall thickness 84mm (0.33").

Piping shall be complete with static bonding straps, polyethylene encasement outer coating (ANSI ARI-5) and other accessories required by Authority.

.3.2 Copper Water Pipe:

Sizes 75mm (3") and less shall be Type 'K' copper tubing soft temper with compression type corporation fittings. Provide cathodic protection to meet local Authority standards and requirements.

.3.3 Polyvinyl Chloride (PVC) Water Pipe: PVC Class 150, DR18 with cast iron outside diameter conforming to CSA B137.3 and AWWA C900, suitable for listed labelled service by ULC and FM for underground fire lines. Pipe is pressure class 1034 kPa (150 psig) with Standard Dimension Ratio SDR 18 for 100mm (4") to 305mm (12") diameters. Provide pipes with integral wall-thickened bell ends and ring groove. Pipe jointing uses push-on rubber rings conforming to ASTM D3139. Fittings are ductile iron conforming to AWWA C110 with 1723 kPa (250 psi) pressure rating. Jointing conforms to AWWA C111 in either push-on or mechanical joint. Provide cathodic protection as required by the Local Authority and to the Authority Standards. Install tracer wire on all PVC watermains and terminate to Authority Standards.

.3.4 Install risers complete with thrust blocks and tie rods terminated at bolted flange above finished floor. Incoming riser shall be installed to Region standards and requirements. Obtain Standards prior to installation.

.8 Sump Pump Discharge Lines:

.1 Piping shall be type 'L' hard temper copper tubing with wrought copper solder fittings, or Schedule 40 galvanized steel pipe with mechanical grooved end galvanized steel fittings and couplings.

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 ZZN-1612-DC-SP.

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- .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 Carpet: Coated cast iron body with integral anchoring flange, round heavy duty adjustable secured cover with carpet recess with nickel bronze finishing frame, and carpet retainer, complete with all gaskets, seating rings, secondary plugs and accessories. Cleanouts in membrane areas shall have flashing clamp devices.
Zurn ZN-1623-C-DC-SP
- .9 Stacks and Leaders: Cast iron with bolted on secured removable cover plate with gasket and devices.
- .10 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 highly polished nickel bronze 125mm (5") strainer, and baked epoxy body, Zurn ZZN-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 100mm (4") funnel strainer with full opening, and baked epoxy body, Zurn ZN-415-BF-DC.
- .7 Floor Drain FD #3: Mechanical rooms, garbage rooms, maintenance area, 'coated' cast iron with secured cast iron strainer, double drainage flange, weepholes, clamping collar and sediment bucket, and baked epoxy body, Zurn Z-556-Y-DC.
- .8 Floor Drain FD #4: Meter rooms, sprinkler rooms, similar to #3 above, but less sediment bucket, Zurn Z-556-DC.

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- .9 Floor Drain FD #5: Mechanical rooms, boiler rooms, similar to FD #3 above but with coated cast iron combination 9" x 4" elongated funnel and full opening strainer, Zurn Z-556-FO-DC-Y.
- .10 Floor Drain FD #6 (Sheet Metal Plenum Drain at Mechanical Room Floor Level): Plenum drain with lacquered all cast iron body with integral flange and 6" diameter nickel bronze strainer with 1/4" thick grate and 8" diameter flange for attaching to sheet metal work, Zurn ZN-211-O-DC.
- .11 Floor Drain FD #7 (Plenum Drain for Suspended Sheet Metal Plenums): Heavy duty chrome-plated basket strainer with matching basket and 1.1/2 tailpiece installed in ductwork, Zurn Z-8740.
- .12 Floor Drain FD #8: Elevator pit, scupper drain, cast iron body with 45° outlet, aluminum flush type strainer, and complete with backwater valve, Zurn #Z-629.
- .13 Electronic Trap Seal Primers:
- .1 Supply and install a P.P.P. Inc. automatic trap priming system to serve all building floor drains and sprinkler room standpipe. The electronic trap priming system shall be as specified below and as supplied by S.M.S. Ltd., Pickering, Ontario.
- .2 Electronic trap priming manifold to be Precision Plumbing Products Inc. Model PT-4, PT-8, PT-12, PT-16, PT-20 or PT-24. The manifold shall supply a minimum of 10 ounces of water per opening, once in each 24 hour period based on a system pressure of 60 psi.
- .3 The unit shall be factory assembled and prepiped, and shall include a bronze body 3/4" female NPT ball valve, a 3/4" water hammer arrestor, an electronic brass body 3/4" solenoid valve and a Type 1 copper manifold. The manifold shall have 1/2" brass compression fittings with orificed openings for precise water distribution to each trap. Contractor shall cap any openings not required.
- .4 Electrical components shall include single point power connection at 120/1/60, manual override switch, a 5 amp breaker, and a 24 hour geared timer. The timer relay shall have a 5 second dwell function for the PT-4 through PT-12 and a 10 second dwell function for the PT-16 through PT-24.
- .5 All components shall be factory assembled, tested and supplied in a 16 gauge steel enclosure suitable for surface or recess mounting. All plumbing and electrical components required shall be CSA approved, and the unit shall be A.S.S.E. approved as an electronic trap primer.
- .6 This Section shall provide and install a minimum 20mm (3/4") valved cold water supply to the electronic trap priming unit.
- .7 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 ROOF DRAINS

- .1 Roof drains shall be provided for all areas requiring rainwater drainage.
- .2 All roof drains shall be manufactured from C.S.A. approved cast iron body materials, and cast aluminum dome or bronze gratings.

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- .3 Drains shall be installed in all locations as indicated on the drawings.
 - .4 Roof Drains: Shall have coated cast iron bodies, underdeck clamps, combined extension frame, bearing pan, waterproofing flange, extension. Drains shall include membrane clamps and self locking cast aluminum dome strainers. Where required controlled flow drains shall include weirs for flow rates as indicated.
 - .5 Roof Drain RD #1: Lacquered, epoxy coated cast iron roof drain with deep sump and wide serrated flashing flange, flashing clamp device with integral gravel stop, 6.1/2" (165mm) cast dome, sump receiver and deck clamp. Drain to be complete with Control-Flo Weir assembly. Zurn ZACF-121-EBCR-DC.
 - .6 Roof Drain RD #2: Lacquered, epoxy coated cast iron small sump roof drain with wide serrated flashing flange, flashing clamp device with integral gravel stop, 6.1/2" (165mm) cast dome, sump receiver and deck clamp. Zurn ZA-130-AC-EB-R-DC

2.7 DOMESTIC HOT WATER HEATERS

- .1 Provide domestic hot water storage and heating system where shown.
- .2 Efficiency of water heaters shall meet or exceed ASHRAE Standard 90.1b.
- .3 Heater tanks and storage tanks shall be ASME pressure rated for minimum of 860 kPa (125 psig) and CSA approved.
- .4 Gas heaters shall be suitable for use with nominal 1.75 kPa (7" WG) natural gas service, and shall be CGA approved.
- .5 Water heaters shall have glass lined storage tanks with steel jacket, insulated and finished in baked enamel; drain valve; ASME rated temperature and pressure safety relief valve with test lever; operating pressure 860 kPa (125 psig).
- .6 Gas fired water heaters shall be complete with adjustable operating thermostat, high limit cut-out, self contained CSH and CGA approved gas train and draft diverter.
- .7 Water heaters shall be of size, storage and recovery as noted below.
- .8 Water Heater Type "A" (gas-fired), storage capacity of 379 litres (100 U.S.G.P.M) rated at 681 litres (180 U.S. Gals.) per hour recovery 5°C to 60°C (40°F to 140°F) when fed with 150 CFH gas input. Unit shall be complete with approved PVC vent through roof by this Section, installation to manufacturer's Code and Local Authority requirements.
Basis of Design: Bradford White Model EF-100T-150E-3N(A).

2.8 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 handicapped shall be supplied complete with all accessories and features as required by the Standards for the Handicapped.

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- .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'
Bowl: American Standard "Madera Elongated" #3451.001 toilet, vitreous china, floor mounted elongated siphon jet action bowl, 1.28 gal. (4.8L) flush, 1.1/2" (38mm) top spud, floor flange, bolt caps and gasket.
Seat: Centoco #500STSCC white open front seat less cover with stainless steel check hinges.
Flush Valve: Sloan Regal 111-1.28-YO-XL quiet action diaphragm flushometer with vacuum breaker, seat bumper on angle stop, pressure loss check and non-hold open feature.
- .10 Water Closet - Ref. 'A-1' (Barrier-Free)
Bowl: American Standard "Madera Elongated 16.1/2" (419mm) High" #3461.001 toilet, vitreous china, elongated siphon jet action bowl, 1.28 gal. (4.8L) flush, 1.1/2" (38mm) top spud, floor flange, flange bolts, bolt caps and gasket.
Seat: Centoco #820STS white open front seat with cover and stainless steel check hinges.
Flush Valve: Sloan Regal 111-1.28-YG-XL quiet action diaphragm flushometer with vacuum breaker, centre seat bumper on valve, pressure loss check and non-hold open feature.
- .11 Water Closet - Ref. 'A-2' (Kindergarten/Daycare)
Bowl: American Standard 'Cadet Pro' #215DA-104, vitreous china round syphon jet action bowl with lined tank, 1.28 gals. (4.8L), bolted cover, and complete with flange bolts, bolt caps, floor flange and gasket.
Supply: McGuire #H166LKN3 C.P. rigid horizontal with angle supply lockshield stop, escutcheon and flexible riser.
Seat: Centoco #460STS, round heavy duty solid plastic white open front less cover with check hinges and stainless steel posts, washers and nuts.
- .12 Water Closet - Ref. 'A-3' (Daycare)
Bowl: American Standard 'Baby Devoro' #2315.016, vitreous china round syphon jet action bowl with lined tank, and complete with flange bolts, bolt caps, floor flange and gasket.
Supply: McGuire #H166LKN3 C.P. rigid horizontal with angle supply lockshield stop, escutcheon and flexible riser.
Seat: Centoco #2300STCC, round heavy duty solid plastic white open front less cover with check hinges and stainless steel posts, washers and nuts.
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- .13 Urinal - Ref. 'B'
Bowl: American Standard "Washbrook" #6590.001, vitreous china, washdown flushing action, integral flushing rim, open trap, 3/4" (19mm) top spud.
Flushing System: Water Matrix automatic UTCS1.2 Sentinel electronic urinal flushing system complete with programmable control unit, flush mounted motion sensor and slow closing solenoid valve. Note: Water Matrix urinal automatic flushing system shall be supplied and installed by Water Matrix as a sub-contractor to the plumbing contractor. The plumbing contractor shall include all costs associated with the urinal flushing system in the tender price.
Urinal Cleanout: Zurn #Z-1446 with round stainless steel wall access plate.
Carrier: Zurn ZX-1222, with bottom bearing plate and special foot mounted entirely in pipe space.
Mounting: Mounting height shall be confirmed with the Consultant and School Board prior to rough-in.
- .14 Lavatory - Ref. 'C' (Staff)
Basin: American Standard "Lucerne" #0355.012, vitreous china, wall hung with soap depressions, 4" (102mm) centres, front overflow, suitable for concealed arm chair carrier.
Trim: Delta #591T0258TR electronic 'no touch' faucet with Delta ELAVT0008ARI S.S. recessed box, mixing valve and 120/24 transformer.
Waste: McGuire #155A C.P. waste assembly with open grid strainer.
Trap: McGuire #8872C C.P. adjustable type tubular 'P' trap with escutcheon.
Supplies: McGuire #165LKN5 C.P. screwdriver angle supply with flexible risers.
Carrier: Zurn ZX-1231 concealed fixture carrier with arms.
- .15 Lavatory - Ref. 'C-1' (Barrier Free – Staff)
Basin: American Standard #0954.004EC "Murro", 4" (102mm) centres, vitreous china, wall hung lavatory, drilled to accommodate concealed arm supports and #0059.020EC shroud/knee contact guard.
Trim: Delta #591T0258TR electronic 'no touch' faucet with Delta ELAVT0008ARI S.S. recessed box, mixing valve and 120/24 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 Barrier-Free access. Insulate supplies and drain as required by Code.
- .16 Lavatory - Ref. 'C-2' (Barrier Free – Kindergarten/Daycare)
Basin: American Standard #0955.001EC "Murro", single hole, vitreous china, wall hung lavatory, drilled to accommodate concealed arm supports and #0059.020EC shroud/knee contact guard.
Trim: Moen Model #8894 (Chrome) single handle metering faucet.
Drain: McGuire #155WC drain, C.P. offset open grid, C.P. 'P' trap, 17 gauge, 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 must be acceptable to the local Authority and must meet OBC requirements for barrier-free access. Confirm acceptance with the local Authority prior to purchase and rough-in.
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- .17 Lavatory - Ref. 'C-3' (Kindergarten/Daycare)
Basin: American Standard "Lucerne" #0356.421, single hole, vitreous china, wall hung with soap depressions, front overflow, suitable for concealed arm chair carrier.
Trim: Moen Model #8894 (Chrome) single handle metering faucet.
Waste: McGuire #155A C.P. waste assembly with open grid strainer.
Trap: McGuire #8872C C.P. adjustable type tubular 'P' trap with escutcheon.
Supplies: McGuire #165LKN5 C.P. screwdriver angle supply with flexible risers.
Carrier: Zurn ZX-1231 concealed fixture carrier with arms.
- .18 Lavatory - Ref. 'C-4' (Staff)
Basin: American Standard Cadet Universal Access #9494.001, vitreous china, counter top, 4" (102mm) centres, self-rimming, and two rear overflows, front overflow, carrier.
Trim: Delta #591T0258TR electronic 'no touch' faucet with Delta ELAVT0008ARI S.S. recessed box, mixing valve and 120/24 transformer.
Waste: McGuire #155WC drain, C.P. offset open grid, C.P. 'P' trap, 17 gauge (1.5mm), 1.1/4" (32mm) and escutcheon.
Trap: McGuire #8872C C.P. adjustable type tubular 'P' trap with escutcheon.
Supplies: McGuire #H165LKN5 C.P. screwdriver angle supplies with flexible risers.
Note: Installation shall meet the OBC requirements for Barrier Free access. Insulate supplies and drain as required by Code.
- .19 Counter Sink - Ref. 'D' (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: Chicago Faucets #350VPAXKACP (single temp. supply) deck mounted faucet with gooseneck vandalproof aerator and lever handle.
Trap: 1.1/2" cast brass 'P' trap with cleanout and pencil trap as detailed on drawings.
Supplies: Rough brass stop on tempered water supply located below sink in counter.
Note: For Kindergarten sinks confirm elevation with the Consultant and the Board prior to rough-in of services.
- .20 Counter Sink - Ref.'D-1' (Single Bowl, Kitchen)
Sink: Franke Commercial LBS-6808-1C, 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.
Trap: 'P' 1-1/2" (38mm) with cleanout, union and escutcheon.
Trim: Chicago Faucets #1100-L9VPAXKABCP 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.
- .21 Counter Sink - Ref.'D-2' (Double Bowl, Kitchen)
Sink: Aristaline LBD-6408-1C, S.S., 20"x 31" x 8" (508mm x 775mm x 200mm) deep back ledge, stainless steel, double compartment, self-rimming, counter mounted, with crumb cup strainers, sound deadening pads and neoprene rim gasket.
Trap: 'P' 1-1/2" (38mm) with cleanout, union and escutcheon.
Trim: Chicago Faucets #1100-L9-317XKABCP 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 blade handles.
Supplies: Connect with flexible tubes and 1/2" (12.7mm) rough Stops on supply piping.
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- .22 Counter Sink - Ref.'D-3' (Single Bowl, Daycare Laundry)
 Sink: Franke Commercial LBS-6810-1C, S.S., 20"x 20 1/2" x 10" (508mm x 521mm x 250mm) deep back ledge, stainless steel, single compartment, self-rimming, counter mounted, with crumb cup strainer, sound deadening pads and neoprene rim gasket.
 Trap: 'P' 1-1/2" (38mm) with cleanout, union and escutcheon.
 Trim: Chicago Faucets #1100-GN2AE35XKABCP faucet, C.P. 8" (203mm) C.C. deck mounted, with cast brass body, gooseneck 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.
 Installation: Note: Install Symmons #4-10B mechanical mixing valve with in-line check stops on hot and cold supplies to provide tempered water to hot side of faucet. Rough brass stops on hot and cold water supplies and installation to meet Code requirements for barrier-free access.
- .23 Scullery Sink – Ref. 'D-4' (Music Room)
 Sink: Franke Commercial #SL2424-1 Grade 18 – 8 type 302 stainless steel 27" x 27" overall size, galvanized legs with adjustable feet, 9" backsplash. Waste fitting shall be #5, 1 1/2" with standpipe and guard.
 Trim: Chicago Faucets #540-LDLESXKAB with GN2AJKABCP and E3VPJKABCP gooseneck spout with vandal resistant aerator and lever handles.
 Trap: 1 1/2" cast brass 'P' trap with cleanout.
 Installation: Note: Install Symmons #4-10B mechanical mixing valve with in-line check stops on hot and cold supplies to provide tempered water to hot side of faucet. Rough brass stops on hot and cold water supplies.
- .24 Counter Sink - Ref. 'D-5' (Art Room)
 Sink: Franke Commercial #LBS-6810-1C, single hole, single compartment, back ledge, grade 18-8 type 302 heavy gauge stainless steel sink, overall size 20-1/2" x 20" x 10" deep, undercoating, clamps, 3-1/2" crumb cup strainer, 1-1/2" tailpiece.
 Trim: Chicago Faucets #350-VPAABCP (single temp. supply) deck mounted faucet with cast brass body, gooseneck and lever handles.
 Trap: 1-1/2" cast brass 'P' trap with cleanout.
 Supplies: Rough brass stop on water supply located below sink in counter.
 Plaster Trap: Sink shall be complete with SMS #SI-MQ sediment interceptor with removable basket.
- .25 Counter Sink - Ref. 'D-6' (SMT)
 Sink: Franke Commercial #LBS4607/316-P-1 S.S., single compartment, 2-holes drilled 2.3/4" on centres, type 316 stainless steel, sink overall size 470mm x 457mm x 178mm deep (18-1/2" x 18" x 7"), self-rimming counter mounted, undercoating and gasket.
 Trim: Chicago Faucets #50-XKABCP with E7JKCP hot and cold water deck mounted mixing faucet complete with vacuum breaker and hose end nozzle.
 Trap: 1-1/2" cast brass 'P' trap with cleanout.
 Supplies: Rough brass stops on both hot and cold water supplies.
- .26 Counter Sink - Ref. 'D-7' (SMT)
 Sink: Franke Commercial #LBS4607/316-P-1 S.S., single compartment, type 316 stainless steel, sink overall size 470mm x 457mm x 178mm deep (18-1/2"x18"x7"), self-rimming counter mounted, undercoating and gasket.
 Trim: Chicago Faucets #350-ABCP with EJKCP, cold water only deck mounted faucet complete with vacuum breaker and hose end nozzle.
 Trap: 1-1/2" cast brass 'P' trap with cleanout and complete with pencil trap as detailed on the drawings.
 Supplies: Rough brass stop on cold water supply.
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- .27 Counter Sink – Ref. 'D-8' (SMT Students – Barrier Free Sink)
Sink: Franke Commercial ALBS4405P-1 single compartment, single hole, ledge back, 20 gauge, Type 316 stainless steel, overall size 410mm x 478mm x 127mm (16.3/8" x 18.13/14" x 5") deep, undercoating, clamps, 3 1/2 crumb cup strainer and 1 1/2" tailpiece located at back left-hand corner.
Trim: Same as 'D-7' but with blade handle.
Trap: Pencil trap complete with offset drain and cast brass 'P' trap.
Supplies: Rough brass stop on cold water supply located below sink in counter.
Installation: Installation shall meet O.B.C requirements for Barrier Free.
- .28 Scullery Sink - Ref. 'D-9' (Art Room)
Sink: Franke Commercial #SL2424-1 Grade 18-8 type 302 stainless steel 27" x 27" overall size, galvanized legs with adjustable feet, 9" backsplash. Waste fitting shall be #5, 1.1/2" with standpipe and guard.
Trim: Chicago Faucets #540-LDLESXKAB with GN2AJKABCP and E3VPJKABCP gooseneck spout with vandal resistant aerator and lever handles.
Trap: 1.1/2" cast brass 'P' trap with cleanout.
Solids Interceptor: Sink shall be complete with floor mounted SMS #SI-MQ sediment interceptor with removable basket.
Installation: Note: Install Symmons #4-10B mechanical mixing valve with in-line check stops on hot and cold supplies to provide tempered water to hot side of faucet. Rough brass stops on hot and cold water supplies.
- .29 Counter Sink - Ref.'D-10' (Single Bowl, Health)
Sink: Franke Commercial LBS-6808-1/3, 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: Chicago Faucets #431-ABCP, centre deck mount, single lever, cast brass body with chrome plated finish.
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.
- .30 Counter Sink - Ref.'D-11' (Barrier Free - Single Bowl)
Sink: Franke Commercial ALBS4405P-1-1C, S.S., 410mm x 478mm x 127mm (16.1/8" x 18.13/14" x 5") deep, back ledge, stainless steel, single compartment, self-rimming, counter mounted, with crumb cup strainer, sound deadening pads and neoprene rim gasket.
Trap: 'P' 1-1/2" (38mm) with cleanout, union and escutcheon.
Trim: Chicago Faucets #1100-L9-317XKABCP 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 blade handles.
Supplies: Connect with flexible tubes and 1/2" (12.7mm) rough Stops on supply piping.
Installation: Note: Install Symmons #4-10B mechanical mixing valve with in-line check stops on hot and cold supplies to provide tempered water to hot side of faucet. Rough brass stops on hot and cold water supplies.
- .31 Scullery Sink – Ref. 'D-12' (SMT Prep. Room)
Sink: Franke Commercial #SL2424/316-1, 316 stainless steel 27" x 27" overall size, galvanized legs with adjustable feet, 9" backsplash. Waste fitting shall be #5, 1.1/2" with standpipe and guard.
Trim: Chicago Faucets #540-LDLESXKAB with GN2AJKABCP and E3VPJKABCP gooseneck spout with vandal resistant aerator and lever handles.
Trap: 1.1/2" cast brass 'P' trap with cleanout.
Installation: Note: Install Symmons #4-10B mechanical mixing valve with in-line check stops on hot and cold supplies to provide tempered water to hot side of faucet. Rough brass stops on hot and cold water supplies.
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- .32 Counter Sink - Ref. 'D-13' (Daycare)
Sink: Franke Commercial LBS-6807-1/1, 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 178mm (20" x 20.1/2" x 7" deep).
Trim: Chicago Faucets #350-ABCP (single temp. supply) deck mounted faucet with gooseneck vandalproof aerator and lever handle.
Trap: 1.1/2" cast brass 'P' trap with cleanout and pencil trap as detailed on drawings.
Supplies: Rough brass stop on tempered water supply located below sink in counter.
Note: Confirm elevation with the Consultant and the Board prior to rough-in of services.
- .33 Counter Sink - Ref. 'D-14' (Daycare – Change Table)
Sink: Franke Commercial LBS-6807-1/3/8, 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 178mm (20" x 20.1/2" x 7" deep).
Trim: Chicago Faucets #1100-GN2AE3V317AB Faucet, CP 8" (203mm) CC deck mounted, with cast brass body, gooseneck and vandalproof 1.84 gpm (8 lpm) flow aerator and lever handles.
Trap: 1.1/2" cast brass 'P' trap with cleanout.
Supplies: Rough brass stop on hot and cold water supplies located below sink in counter.
- .34 Custodial Sink - Ref. 'E'
Basin: Stern Williams #SB-700, 32" x 32" x 12" precast terrazzo, with reinforced high walls, shoulders, and aluminum bumper guards.
Waste: Cast integral with basin cast brass chrome plated drain with strainer.
Trim: Chicago Faucets #305-VB-R-RCF-XK-hose faucet, C.P. 203mm (8") C.C. wall mounted, cast brass body, with cast metal lever handles, hose and vacuum breaker, integral stops, 787mm (31") vinyl hose and hanger.
Trap: Cast iron 'P' trap.
Eyewash: Locate at each custodial sink a hand held wall mounted eyewash unit, Ref. 'K'. Install separate valved hot and cold water supplies to eyewash.
- .35 Washfountain - Ref. 'F' (Barrier Free) 3 Station 'Tri-Fount Washfountain', infra-red control, 36" x 26" x 34" (900mm x 660mm x 864mm) factory preassembled with individual sectional control. Bowl and sprayhead to be of white aggregate, precast Corterra with heavy steel reinforcing rod construction and finished with a clear epoxy coating. Pedestal to have a front panel of heavy gauge stainless steel access plate, all exposed fasteners to be vandal-resistant. Spray nozzles to be vandal-resistant with 2.3 L (0.5 GPM) flow controls. Fixture with splashback anchored to wall and housing framework anchored to floor. Thermostatic mixing valve with check stops and strainers in 12mm (1/2") hot and cold water supplies and field set water temperature at 105°F. Sensor operated non-hold open individual metering valves, timing cycle shall be field set for approximately 10 seconds and complete with liquid soap dispenser. Supplies and drain from wall. 'P' trap cast brass, 38mm (1.1/2"). Unit shall be electronic 'No-Touch' sensor operated with 110/24 VAC transformer, 12 amp.
Note: Precast Corterra colour to be selected by the Architect.
Acorn Model #3633-OBC-2-SO-PDM-MXT-BF.
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- .36 Washfountain - Ref. 'F-1' (Barrier Free, 4 Station)
4 Station 'Quadra-Fount Washfountain', infra-red control, 46" x 26" x 34" (1168mm x 660mm x 864mm) factory preassembled with individual sectional control. Bowl and sprayhead to be of white aggregate, precast Corterra solid surface with heavy steel reinforcing rod construction and finished with a clear epoxy coating. Pedestal to have a front panel of heavy gauge stainless steel access plate, all exposed fasteners to be vandal-resistant. Spray nozzles to be vandal-resistant with 0.5 GPM (2.3L) flow controls. Fixture with splashback anchored to wall and housing framework anchored to floor. Thermostatic mixing valve. Sensor operated non-hold open individual metering valves, timing cycle shall be field set for approximately 10 seconds and with liquid soap dispenser. Supplies and drain from wall. 'P' trap cast brass, 1.1/2" (38mm). Unit shall be electronic 'No-Touch' sensor operated with 110/24 VAC transformer, 12 amp.
Note: Precast Corterra solid surface colour to be selected by the Architect.
Acorn Model #3644-OBC-2-SO-PDM-MXT-OCC
- .37 Drinking Fountain - Ref. 'G' (Kindergarten)
Cabinet: Unit shall be Haws Model 1105-BP3 wall mounted fountain stainless steel, complete with angle stream bubbler, with regulator, self closing pushbutton valve, etc. All cabinet finishes, etc. shall be stainless steel and unit shall be complete with matching backplate, and Model 6700.4 mounting plate.
Accessories: Complete unit shall be with all accessories including concealed mounting frame, interconnecting piping, etc., concealed trap and service stop package and heavy duty concealed floor mounted fixture carrier, Model #6700.4
Mounting Height: (Confirm with Board).
- .38 Drinking Fountain - Ref. 'G-1' (Hi-Lo Barrier Free)
Cabinet: Unit shall be Haws Model 1119 wall mounted hi-lo fountain stainless steel, complete with angle stream bubblers, with regulator, self closing pushbutton valves, etc. All cabinet finishes, etc. shall be stainless steel and unit shall be complete with backplate.
Accessories: Complete unit shall be with all accessories including concealed mounting frame #6700.4, interconnecting piping, etc., concealed traps and service stop package and heavy duty concealed floor mounted fixture carrier, Model #6700.4
Mounting Height: (Confirm with Board).
- .39 Drinking Fountain c/w Water Bottle Filler – Ref. 'G-2'
Cabinet: Unit shall be Elkay Model #EZSTLDDWSVRSK, bottle filling station, barrier free bi-level unit, vandal resistant stream bubblers, ambient temperature, stainless steel, non-refrigerant filterless unit. Note: Electrical outlet plug required to operate the unit's solenoid valve. Install as per manufacturer's rough-in drawings.
Accessories: Complete unit shall be with all accessories including concealed mounting frame, interconnecting piping, etc., concealed trap and service stop package and heavy duty concealed mounting plate.
Mounting Height: Confirm with Board and Architect. Barrier-free installation shall meet OBC requirements for barrier-free access.
- .40 Drinking Fountain - Ref. 'G-3' (Kindergarten - Barrier Free)
Cabinet: Unit shall be Haws Model 1109-BP3 wall mounted fountain stainless steel, complete with angle stream bubbler, with regulator, self closing pushbutton valve, etc. All cabinet finishes, etc. shall be stainless steel and unit shall be complete with matching backplate, and Model 6700.4 mounting plate.
Accessories: Complete unit shall be with all accessories including concealed mounting frame, interconnecting piping, etc., concealed trap and service stop package and heavy duty concealed floor mounted fixture carrier, Model #6700.4.
Installation: To meet Code requirements for barrier free access.
-

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- .41 Dishwasher Ref. 'H'
Dishwasher is supplied by School Board. This Section shall rough-in 1/2" (15mm) hot water line and 2" drain line and make final connections as required by Plumbing Code.
Note: Final connection on hot water supply line shall include a shut-off valve and shock absorber down stream of shut-off valve and pressure reducing valve Watts No. U5-GG complete with strainer and pressure gauge.
- .42 Shower Ref. 'J' (Barrier Free and Staff)
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: 4" 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.
- .43 Eyewash - Ref. 'K' (Wall Mounted)
Haws #7360BT stainless steel, wall mounted eye/face wash with two large fine spray outlet heads, 15mm (1/2") IPS unlet and 32mm (1.1/4") outlet with push handle and mounting brackets.
Trap: 32mm (1.1/4") cast brass 'P' trap with cleanout.
Supplies: 15mm (1/2") valved hot and cold water supplies to Lawler Model #911E/F Unit #84908 mixing valve.
- .44 Eyewash - Ref. 'K-1' (Wall Mounted, Hand Held)
Haws #8905-VB hand-held, wall mounted, dual heads, recoil P.V.C. hose and in-line vacuum breaker and wall bracket.
Supplies: 15mm (1/2") valved hot and cold water supplies to Lawler Model #911E/F Unit #84908 mixing valve.
- .45 Eyewash - Ref. 'K-2' (Counter Mounted, Hand Held)
Haws #8904/SP212-VB hand-held counter mounted, twin heads with covers, flow control vacuum breaker, hose guide bracket, C.P. deck flange, 2438mm (96") safety hose.
Supply: 15mm (1/2") valved hot and cold water supplies to Lawler Model 911E/F, Unit 84908 mixing valve.
- .46 Automatic Clothes Washer - Ref. 'L'
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, Symmons "Laundry Mate" Model #LM600 recessed.
Note: "Laundry Mate" shall be located at side of washer for access. Confirm location before rough-in.
- .47 Valve Box – Ref. 'M' (Ice Making Refrigerators)
'PPP' #MM-500MIMB recessed 20 gauge steel box with water hammer arrestor and shut-off valve, installed 900mm ± (36" ±) above floor.
Supply: 1/2" valved cold water supply.
-

2.9 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.
Basis of Design: National Fire Equipment Model CE-950-3 or CE-950-3-FR for fire rated wall installation
 - .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)
- .4 Fire Blanket:
 - .1 Fire blanket shall be National Fire Equipment Model #FB-6078-MC fire blanket cabinet.

2.10 PUMPS

- .1 Provide where shown, pumps and circulators of types, sizes and capacities noted.
- .2 The complete pumping units shall be suitable for the services as noted and shall have:-
 - Non-overloading horsepower characteristics at all points on the curve.
 - Impellers sized at not larger than 85 percent of the maximum for the casing.
 - Mechanical seals unless specified or noted otherwise.
- .3 Where all bronze pumps are specified and noted, provide pumps with bronze casings in place of the cast iron casings specified elsewhere.
- .4 The manufacturer shall conduct running tests to verify the specified head and capacity. Submit certified pump head and power versus flow curves with the Shop Drawings.
- .5 Domestic Hot Water Circulators
 - .1 Domestic water circulator shall be all bronze pump, rated at 10 US gpm against 3.9 meters (13 feet) head, with 1/6 HP 120 VAC motor.
Basis of Design: S.A. Armstrong H-41.

- .2 Each circulator shall be provided with sprinklerproof surface mounted magnetic type starter with H-O-A, running pilot, 24V transformer, auxiliary contacts for interface with Energy Management System.

2.11 THERMOSTATIC MIXING VALVE

- .1 Symmons 'Tempcontrol' thermostatic temperature control valves with thermal motor with turbulator, check stops, stainless steel piston, volume control valve, rough bronze, ball valves, dial thermometer, in a surface mounted steel cabinet, bottom supplies and top outlet, completely factory assembled.
- .2 Unit shall be factory set to provide system outlet temperature of 85°F. Unit setpoint shall be field adjustable from 85° to 120°F.
- .3 Basis of Design: Symmons Temp Control Model #7-900B-M with surface mounted stainless steel cabinet.

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.

.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 (3/4") 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 Hot water piping shall not be buried unless specifically noted on the Drawings.
- .4 All buried water piping shall be type 'K' soft temper copper water piping and shall be installed in continuous lengths with no joints below the slab. Provide isolating shut-off valves above the floor.
- .5 Provide underground buried water piping complete with thrust blocks at each change in direction and take-off fitting; bracing rods at each joint, thrust block, piping and anchor where penetrating the building foundation walls.

- .6 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.
- .7 Provide a balancing valve on each hot water recirculation branch; on the discharge of each piece of equipment requiring flow balancing.
- .8 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 piping 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.

.2 Thermometers and Gauges

- .1 Provide thermometers and pressure gauges where specified and noted.
- .2 Provide each thermometer with a brass separable well.
- .3 Provide each pressure gauge with a pressure tap, snubber and stop valve.

3.3 WATER METERS

- .1 This Section shall be responsible for all applications and payments for providing and installing the project water meter including remote readout devices and associated wiring, in accordance with the standards used by the local Authority. Obtain authority standards prior to submitting tender price.
- .2 This Section shall arrange to accept the meter assembly and deliver it to the site.
- .3 Install meter including valves, unions, flanges, by-pass fittings and slip joints at the meter to facilitate the installation and removal of the meter to locate authority standards. Refer to detail on drawings.
- .4 Provide one pressure gauge on each side of meter.

3.4 SERVICE CONNECTIONS TO (TERMINATIONS OUTSIDE BUILDING)

- .1 This Section shall be responsible for co-ordinating the exact location of the service terminations provided under the Site Services Contract for storm and sanitary sewers, fire service connections and domestic service connections. Verify exact location, size and elevation of service termination prior to commencing work.
- .2 This Section shall make all connections to the service terminations.
- .3 Flush and chlorinate the water service connections and mains as required by local and Provincial Health Departments. Provide all necessary test certificates.
- .4 The fire protection service within the building shall be terminated 300mm (12") above finished floor and 450mm (18") from wall as shown. Exact location of termination shall be co-ordinated with the Sprinkler Section prior to installation of service.

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, rainwater leaders, 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, rain water leaders, 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 Buried incoming fire and water services and all outside buried mains, etc., shall be tested at minimum of 1380 kPa (200 psi) and in accordance with NFPA 24 Standard as referenced in Sub-Section 7.2.11 of the O.B.C.
 - .3 Pressures shall be maintained for minimum 2 hours or as required by the Authority.
 - .4 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 Backflow Devices:
- .1 All backflow devices shall be tested by a certified technician utilizing test procedures outlined in the latest edition of the CAN/CSA-B64.10 Standard, and to local Authority requirements. Submit test certificates to the Consultant and local Authority.
 - .5 Tests shall be repeated until satisfactory to the local Inspector and the Consultant.
 - .6 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.
 - .7 Submit test certificates in NFPA format to the Authority and the Consultant.

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 sewer connections made to service terminations.
 - .2 Drainage and water systems, backflow devices 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 Major equipment identified.
 - .8 Motor list prepared and presented to Architect.
 - .9 Operating and maintenance instruction manuals presented for approval to the Consultant.
 - .10 On site operating instruction given to Owner's representative as follows:-
Name: _____ Date: _____
 - .11 Record "As-Built" Drawings turned over to the Consultant, (see Section 23 00 10).
 - .12 Water systems chlorinated to local authority requirements, flushed out, strainers cleaned and ready for normal service.
 - .13 Water systems checked for expansion and for water hammer.
 - .14 Water heaters connected and tested, recirculation pump installed and tested.
 - .15 Pumps installed and tested.
 - .16 Plumbing fixtures installed, tested and water volume adjusted.
 - .17 Fire protection system including fire extinguisher cabinets, extinguishers, accessories installed, tested and approved.
 - .18 Thermostatic mixing valve installed and tested. Building systems hot water temperature tested and confirmed. Submit written confirmation of temperature readings.
 - .19 Video inspection of underground storm and sanitary drain lines completed and video/report submitted to the Consultant.

3.8 DRAINAGE PRODUCTS

.1 Roof Drains

- .1 Roof drains shall be installed in all locations specified, complete with grates, to manufacturer's requirements.
- .2 The Contractor will flash the drain bodies into the building waterproofing membrane.
- .3 This Section shall secure the membrane clamp; caulk and seal all other joints and openings for a watertight installation.
- .4 In areas where metered drainage is being used, check all drawings to determine required number of weirs for each roof drain.
- .5 In metered flow roof drainage systems, the weir assembly shall not be installed until after the roofing system is completed.

.2 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") and at 30m (100 ft.) for pipes 150mm (6") and larger.
 - Ends of drainage lines.
 - Base of all stacks and leaders.
 - At all urinals to Code requirements.
- .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.

.3 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 All floor drains shall be trapped, vented and primed in accordance with all codes, unless indicated otherwise.

- .3 Unless specifically indicated otherwise, all floor drains must be individually trapped, primed and vented, in accordance with all Codes and Local Authority requirements.
- .4 Unless indicated otherwise all floor drains shall be equipped with primer water supply connected from the nearest approved water supply.
- .5 All primer piping shall be copper tubing as specified, plastic piping or tubing will not be permitted.
- .6 Plumbing fixtures shall NOT be used for floor drain trap priming.

3.9 DOMESTIC WATER HEATERS

- .1 Provide domestic water heaters and set in place where shown.
- .2 Extend pressure relief valve outlet piping at full line size, complete to nearest floor or hub drain.
- .3 Set thermostats in tanks to maintain system supply water at approximately 60C. (140F), (unless noted otherwise).
- .4 Gas-fired water heaters shall have approved venting by this Section and gas piping provided under the Heating Sections.
- .5 All interconnecting piping, valves, etc. shall be complete, as indicated on the drawings.
- .6 All water heaters shall be complete with check valves on the cold water connections.

3.10 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 Provide shims to set floor mounted fixtures level and true. Grout all floor mounted fixtures including floor supported traps, securely in place.
- .4 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; floor mounted water closets shall be complete with companion flanges, gaskets and clamps or bolts, nuts and covers.
- .5 Caulking and sealants shall be approved for the application.
- .6 Colour of grout and sealants shall be as selected by the Architect.
- .7 Adjust flow control features of all flush valves to provide for adequate flushing with minimum water flows.

- .8 Roughing-in shall be securely laid out. No offsets will be accepted. Fixtures shall be installed plumb and perpendicular to Architectural finishes.
- .9 Each fixture shall be fastened securely in place using floor supports, wall hanger, carriers, and deck clamps.
- .10 Fixtures complete with valves, trim, supplies, waste, traps, exposed piping and accessories shall remain rigid during use and shall stay permanently in place.
- .11 All wall hung fixtures shall be installed complete with all pertinent accessories, including anchor screws, etc., in a manner as recommended by the Manufacturer.
- .12 Plumbing fixtures shall NOT be used for floor drain trap priming.

3.11 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.

3.12 PUMPS

.1 Domestic Water Circulators

- .1 Domestic water circulators shall be supported from the building structure and so that no weight is borne by the piping system.
- .2 For each circulator, provide two (2) gate valves and a discharge check valve.
- .3 Pipe and valve sizes shall be full pump size for a distance of at least 3.0m (10 ft.) on each side of the pump.
- .4 Supply starters to Electrical Division 26, and instruct same in required mounting location.
- .5 Division 26 will perform all necessary wiring.

3.13 VIDEO INSPECTION (SANITARY AND STORM SEWER)

- .1 This Section shall perform a video camera inspection of the storm and sanitary sewers, mains runs through the school corridors and to the points of leaving the building up to the first manhole. 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 and repeated prior to finish flooring. Exact time of final video camera inspection shall be co-ordinated with the Consultant. 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.

END OF SECTION 22 00 00

I N D E X

ARTICLE NO. **DESCRIPTION**

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1.3	Discrepancies and Omissions
1.4	Shop Drawings
1.5	Record Drawings
1.6	Additional Work
1.7	Insurance
1.8	Guarantees and Certificates
1.9	Definitions and Interpretations
1.10	Cutting and Patching
1.11	Bonding

PART 2: **PRODUCTS**

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
2.7	Electric Pipe Tracing

I N D E X

PART 3: EXECUTION

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
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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	Electric Pipe Tracing

PART 1 - GENERAL

1.1 GENERAL PROVISIONS AND REQUIREMENTS

- .1 The General Conditions and Supplementary General Conditions in the Division One Specifications apply to this Division 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. Conform to the latest Building Code 2024.
- .3 Conform to all the requirements of the Model National Energy Code of Canada and the ASHRAE 90.1 for buildings.
- .4 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 from the Technical Standards & Safety Association (TSSA) 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 this Division.
- .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 by the consultant and commissioning agent in sufficient quantities to satisfy contractual requirements. Where shop drawings consist of printed catalogue sheets, submit at least ten (10) copies: no sepia will be required. 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. The Contractor must subsequently print and submit full sized, red line copies of such reviewed documents to each reviewer. Each submission 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 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.
- .3 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 **RECORD DRAWINGS**

- .1 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 drawings available for inspection at the site at all times.
- .2 Upon completion of the project and before final payment is made, request one set of CADD disks for Tender Drawings and to pay REW an administrative fee of \$150.00 per drawing or \$750.00 (whichever is greater) per issuance (plus HST) for the provision of the electronic files, and transfer all the recorded information, and changes issued during construction, from the white prints to the disks. As-Built disk files shall be prepared using AutoCAD Release 2018 or later version.

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 this Division's own forces, a markup of 15% for additions unless otherwise stipulated in the General Conditions.
- .4 For work performed by a Sub-Contractor of this Division, a markup of 5% for additions unless otherwise stipulated in the General Conditions.

1.7 INSURANCE

- .1 In addition to the insurance specified in the General Conditions 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 boilers (minimum 5 years).
- .3 All repairs to systems required during the guarantee period shall be performed by this 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 have 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 23.
- .12 The term "concealed" means, not exposed.

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 for holes up to 200mm (8") diameter. All work shall be performed by qualified tradesmen.
- .2 Openings larger than 200mm (8") as required to complete the work will be provided by the Contractor. 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.

1.11 BONDING

- .1 No Bid Bond is required. An agreement to furnish 50% Performance and 50% Labour and Materials Bonds from a surety firm who is licensed to do business in the Province of Ontario is required. These bonds shall be issued in favour of "The Successful General Contractor" and the Peel District School Board jointly. The period of acceptance for these consents shall be 90 days from the closing date of the General Contract tenders. Copies of these consents must be submitted with the Supplementary Bid Form.

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 Bid Form 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 Bid 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 this Division.
- .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 Division 26 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 Refer to schedules and starter legend for type required. Combination magnetic starters are complete with 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. Magnetic starters for motors 10 HP and larger are "soft start" type. Soft-starts are manufactured by Benshaw and no alternates will be accepted. Provide commissioning for the soft start type starters.
- .6 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.
- .7 All electrical equipment (except motors) installed in sprinklered rooms are of sprinkler proof construction as defined by Code.
- .8 Listed armoured 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.
- .9 All magnetic motor starters are complete with disconnect switch. Fuses protecting other motor circuits are Form I Class 'J' time delay. Other fuses up to 600A are Form I Class 'J'.

- .10 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.

- .11 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.
- .12 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 this Division 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 (¼ inch) steel plate with total 13mm (½ 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 this Division conforms to, or exceeds, the efficiency levels noted hereunder. Efficiency testing standards comply with ASHRAE 90.1-2013 and/or CSA Standard C390-M1985 or US Standard IEEE-112B.
- .2 Minimum high efficiency levels are as follows:

Motor Size (HP)	Efficiency @ 3600 RPM (%)	Efficiency @ 1800 RPM (%)	Efficiency @ 1200 RPM (%)	Efficiency @ 900 RPM (%)
1.0	75.5	82.5	80.0	74.0
1.5	82.5	84.0	85.5	77.0
2.0	84.0	84.0	86.5	82.5
3.0	85.5	87.5	87.5	84.0
5.0	87.5	87.5	87.5	85.5
7.5	88.5	89.5	89.5	85.5
10.0	89.5	89.5	89.5	88.5
15.0	90.2	91.0	90.2	88.5
20.0	90.2	91.0	90.2	89.5
25.0	90.5	91.7	91.3	89.6
30.0	90.8	91.9	91.4	90.7
40.0	91.4	92.5	92.3	90.6
50.0	91.9	92.7	92.3	91.3
60.0	92.4	93.2	92.9	91.6
75.0	92.5	93.5	93.1	92.8
100.0	93.0	93.7	93.5	92.7
125.0	93.6	93.9	93.6	93.4
150.0	93.8	94.3	94.2	93.4
200.0	94.3	94.5	94.6	93.9
500.0	95.0	95.0	95.0	95.0

- .3 All motors not complying with the above will be replaced by this Division at no cost to the Owner or his Agents.

2.7 ELECTRIC PIPE TRACING

- .1 Tracing cables are Raychem's Chemelex Auto-Trace self regulating heat tracing system, cut to length for use on 120 volt single phase circuits.
- .2 The self-regulating heater shall consist of two 16 AWG tinned-copper bus wires embedded in parallel in a self-regulating polymer core that varies its power output to respond to temperature all along its length, allowing the heater to be crossed over itself without overheating. The heater shall be covered by a radiation cross-linked modified polyolefin dielectric jacket.
- .3 Provide all end seal, splicing and tee kit components as required to suit installation.
- .4 Banding and heat transfer tape is Raychem AT180 aluminum banding and heat transfer tape.
- .5 Each tracing circuit is controlled by a bulb-sensing thermostat set at 4.5°C. (40°F.) through an appropriate contactor.
- .6 The electric pipe tracing shall be supplied and installed by the mechanical contractor, and powered and wired by the Division 26. Co-ordinate with Section 25 00 00 and Division 26 with respect to enabling/disabling each heating circuit from the Building Automation System.

PART 3 - EXECUTION

3.1 EXISTING CONDITIONS AND OTHER TRADES

- .1 Visit the site to determine existing conditions affecting the work of this Division and include for the complications resulting from these conditions.
- .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 this Division. 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. For openings larger than 200mm (8") the Contractor will cut or leave openings in walls, floors, ceilings and roof as required by this Division for ducts, drains, pipes, recessed fixtures, etc. Provide the Contractor with the 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. Supply the Contractor with 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 this Division, 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 gas piping provided by this Division in accordance with the requirements of the Gas Code including painting. Gas piping on the roof to be painted yellow and gas vertical piping on the exterior wall to be painted same colour as wall and banded yellow. Identify all other piping installed by this Division 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.

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- Copy of all guarantees and warranties issued on the installation, showing all dates of expiration.
 - Copy of all approved "Shop Drawings", also including Commissioner reviews.
- .4 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.
- .5 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.
- .6 Prepare a list of all motors, equipment etc., as follows:
- Location.
 - Unit name.
 - Motor manufacturer and serial number.
 - Rated power output, voltage, frequency, amps and RPM.
 - Starter manufacturer, type, size, and overload heater ratings.
 - Fan manufacturer, serial number, R.P.M., airflow and static pressure.
 - Oil or grease lubrication type.
- .7 Compile a list on letter size sheets. Include copies of the lists in the data books and submit three additional copies of the list on completion of the project. Number all starters to correspond with the motors.
- .8 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 this Division. 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 This Division is 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 this Division 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

- 2 meters (6.1/2 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 this Division 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 levelling 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 CAN4-5115 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 Provide remote disconnect switches where required by Code if not already provided by the Electrical Division. Fuses for fusible disconnects and starters for mechanical equipment are supplied by this Division as specified regardless of who supplied the disconnect or starter. Coordinate the fuses with the starter or disconnect fuse clips to ensure compatibility.
- .4 Unless specified otherwise in other Sections of this Division, 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 Division 26.

- All control wiring including wiring between thermistors and relays and interlocking wiring shall be provided by this Division. No wiring shall be exposed. Make all Division 23 power wiring conform with the requirements of Division 26 Specifications.
- Install all wiring by this Division except as defined below in EMT conduit. Where acceptable to Authorities, listed armoured control cable may be used in lieu of EMT and wiring. Armoured control cable must be attached to the structure with suitable clips at a maximum of 1M (3.28 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.
- .4 Refrigerant piping is UL approved, tubular foamed plastic of closed cell structure, having a thermal conductivity of 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.
- .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.
- .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.

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- .8 Heating tanks, equipment and breeching insulation is UL approved 38mm (1.1/2") thick, glass fibre rigid type have a thermal conductivity of 36W-mm/hr. m2 deg. C. (0.25 Btu-in/hr. sq.ft. deg. F.) at 37.8 deg. C. (100 deg. F.) and 112 kg/m3 (7 lb/ft. 3) density.
- .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 41W-mm/hr. m2-deg. C. (0.286 Btu-in/hr. sq. ft. deg. F.) at 32.2 deg. C. (90 deg. 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 and OA plenums from the fresh air fan to the terminal outlet.
 - All supply air ducts (including silencers), as follows:
 - * Constant volume systems: From air handler up to flexible branch ducts serving individual diffusers, except circular exposed ductwork external to mechanical/service rooms.
 - * Variable air volume systems: From air handler or rooftop unit up to VAV by-pass boxes, except circular exposed ductwork external to mechanical/service rooms.
 - 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.
 - All heat recovery coil plenum and ductwork from downstream of plenum.
- .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 metal rainwater leaders above grade including rainwater hoppers, upturn and downturn fittings, couplings, etc..
 - Heating and water valves, flanges and strainers.
 - All glycol heating piping and fittings throughout.
 - Circuit balancing valves with case insulation.

- .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.
 - 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 Bakelite 100-44 fibrated insulation coating reinforced with Bakelite 990-06 yellow jacket open weave synthetic fabric membrane applied in a 3.2 to 6.4mm (1/8" to 1/4") film thickness. After the fibrated coating has dried, apply a coating of Bakelite 120-03 decoralt white colour acrylic resin emulsion finish coat. 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.
- .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 use metal 90 degrees angle frames extending a minimum of 50.8mm (2") along the leading edge of duct liners at each cleated joint in both directions to eliminate any possibility of uplift. Provide 12.7mm x 12.7mm (1/2" x 1/2") galvanized expanded metal mesh on the first 3.048m (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 ($T \geq 4.5^{\circ}\text{C}$)	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 ($T < 4.5^{\circ}\text{C}$)	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"-1.1/4") 38mm (1.1/2") and larger	38mm (1.1/2") 50mm (2")
Domestic cold water	All sizes	25mm (1")
Domestic hot and recirc. water	Up to 50mm (2") 65mm (2.1/2") and larger	25mm (1") 38mm (1.1/2")
Condensate drains	All sizes	12mm (1/2")
Horizontal storm and sanitary	All sizes	12mm (1/2")
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 50mm (2") 65mm - 150mm (2.1/2"-6") 200mm (8") and greater	38mm (1.1/2") 50mm (2") 90mm (3.1/2")

<u>Application</u>	<u>Pipe Size</u>	<u>Insulation</u>
Steam (T > 121°C) and condensate	Up to 25mm (1") 32mm - 100mm (1.1/4"-4") 125mm (5") and greater	50mm (2") 65mm (2.1/2") 90mm (3.1/2")
Heat Recovery Supply and Return	All Sizes	25mm (1")

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 this Division, 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.
- .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 section of the Specification.
- .2 Provide all cast-in-place concrete, including concrete bases for equipment, 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 this Division shall be responsible for the systems installed and are completely familiar with the project. 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 General Contractor.

3.22 SCHEDULE FOR COMPLETION

- .1 All work must be substantially performed by the date as indicated in Division One, Paragraph 1.1.5.

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 ELECTRIC PIPE TRACING

- .1 Field Measurement:
 - .1 Establish the quantities of cable required by field measurement. Do not use drawing estimates for ordering materials.
- .2 Manufacturer's Instructions:
 - .1 Adhere to the manufacturer's requirements and recommendations in the installation of the system.
 - .2 For steel and copper piping, secure cables with fiberglass tape applied circumferentially. For all other piping materials, secure cables with aluminum tape applied longitudinally continuously over the cable.

.3 Application & Test Procedures:

- .1 Install cables with temporary banding until the installation is complete and megger checked.
- .2 Replace with permanent circumferential banding and place heat transfer tape over and parallel to the cable.
- .3 Test each cable with 500 volt "Biddle" insulation tester prior to initial installation, after initial installation, prior to insulating and after insulation installed. An acceptable reading shall not be less than 10 megohms.
- .4 Submit six (6) copies of the test results for review.

.4 Tagging:

- .1 Provide a permanent non-corroding type metal tag, securely fastened to each cable identifying the cable number, total watts, watts per foot, cable length, amperage and voltage.

END OF SECTION 23 00 10

I N D E X

ARTICLE NO. **DESCRIPTION**

PART 1: **GENERAL**

1.1	Requirement
1.2	Conformance to Architectural & Structural Layouts

PART 2: **PRODUCTS**

2.1	Piping Systems
2.2	Piping Specialties
2.3	Valves
2.4	Pumps
2.5	Expansion Tanks
2.6	Natural Gas Distribution System
2.7	Prefabricated Chimneys
2.8	Water Treatment Systems
2.9	Heating Coils
2.10	Packaged Air Handling Units
2.11	Packaged Heat Pump Rooftop A/C Units
2.12	Hot Water Unit Heaters and Cabinet Heaters
2.13	Convectors and Finned Tube Elements
2.14	Heating Boilers
2.15	Heat Pump Air Cooled Condensing Units
2.16	Heat Recovery Wheels
2.17	Heat Exchangers
2.18	Magnetic Flow Meter
2.19	Radiant Ceiling Panels
2.20	Variable Frequency Drives
2.21	Energy Recovery Ventilators (ERV)
2.22	Antimicrobial Ultraviolet (UV) Lamp Systems (Air Sanitization Units)

PART 3: **EXECUTION**

3.1	Piping Installation
3.2	Hydronic Systems' Testing
3.3	Hydronic Systems' Balancing

PART 1 - GENERAL

1.1 REQUIREMENT

- .1 Section 23 00 10 forms part of Section 23 00 20. 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 include 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 may be used in lieu of flanged or threaded piping and fittings for water services only. Piping preparation conforms to CSA-B242-M1980. Gaskets conform to ASTM D-2000 for Grade "E" EPDM compound suitable for operating temperatures between minus 34.4 degrees C. (-30 degrees F.) and plus 93.3 degrees C. (200 degrees F.). All piping and operating pressures conforms to that specified above for water services.

2.2 PIPING SPECIALTIES

- .1 Manual air vents are nickel-plated screwdriver operated vent cock type with 6mm ($\frac{1}{4}$ ") 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 ($\frac{1}{16}$ ") 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 ($\frac{3}{4}$ ") 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 ($\frac{3}{4}$ ") 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 ($4\frac{1}{2}$ ") 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. 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 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 (Crane #428, Jenkins #810J, Newman-Hattersley #607, Toyo/R+W #293). Gate valves larger than 50mm (2") have O.S.&Y., solid wedge disc, bolted bonnet (Crane #465-1/2, Jenkins #454J, Newman-Hattersley #504, Toyo/R+W #421A).
- .4 Globe valves 50mm (2") and smaller, except for steam service, have replaceable composition disc, union bonnet (Crane #7, Jenkins #106BJ, Newman-Hattersley #13, Toyo/R+W #221). Globe valves 50mm (2") and smaller for steam service have stainless steel disc and seat ring, union bonnet (Crane #14-1/2P, Jenkins #2032J, Newman-Hattersley #14, Toyo/R+W #214). Globe valves larger than 50mm (2") have O.S.&Y., bronze disc, renewable bronze seat ring, bolted bonnet (Crane #351, Jenkins #2342J, Newman-Hattersley #731, Toyo/R+W #400A).
- .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 (Crane #37, Jenkins #4092J, Newman-Hattersley #47, Toyo/R+W #236). Check valves larger than 50mm (2"), except for pump discharge or pipes with pulsating flow, are swing type with regrindable seat and bolted cap (Crane #373, Jenkins #587J, Newman-Hattersley #651, Toyo/R+W #435A). 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. Acceptable products: Keystone #F1020-CLJ2, Crane #44BXZ-L/G, Jenkins #2232E-L/G, Newman-Hattersley #45-313321-1/2, Centerline #200LE-L/G. 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.

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- .7 Circuit balancing valves are globe style, 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 (Crane #9302, Jenkins #901J, Newman-Hattersley #1969, Toyo/R+W #5044A). 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.
DeZurik Series 400, Newman-Hattersley.
 - .10 Drain valves are ball type complete with anti-condensing cap and chain.

2.4 PUMPS

- .1 Provide pumps and circulators of types, sizes and capacities noted. Each pumping unit is suitable for the services noted; has non-overloading horsepower characteristics at all points on the curve; has impellers sized at no larger than 85 percent of the maximum for the casing. Conduct running tests to verify the specified head and capacity. Submit certified pump head and power versus flow curves with the shop drawings.
- .2 Pump motors are squirrel cage induction type with open drip-proof enclosure, solid shaft, suitable for either vertical or horizontal mounting as noted.
- .3 Provide all pumps and circulators with mechanical seals unless specifically noted otherwise on the drawings.
- .4 Provide in-line type pumps with extended shaft and couplings to allow easy removal and replacement of the mechanical seals without disrupting the pump, motor or piping. Where the extended coupling feature is designated the requirement is specific and substitute equipment without this option is not acceptable.
- .5 Vertical in-line type centrifugal pumps are single stage, radially split casing type, with cast iron casing, bronze impeller dynamically balanced, stainless steel shaft; have a minimum casing working pressure of 1200 kPa (175 psig) and a minimum hydrostatic test pressure of 1½ times the working pressure, have a seal flushing connection. Extended shaft type pumps, in addition, are complete with a micron type filter and petcocks; three (3) spare micron filters per pump; sight flow indicators; mechanical seal durametallic type RA outside balanced with carbon on durachrome faces.

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- .6 Circulators are single stage centrifugal type pumps with cast iron casings, bronze impellers, resilient-mount sleeve bearing motor, integral thrust collar; mounted on two oil lubricated bronze sleeve bearings; have removable metal mesh guards at pump couplings where moving parts are exposed; have a minimum working pressure of 860 kPa (125 psig).
 - .7 For each circulator, provide a strainer and a check valve. For each in-line type pump, provide a suction guide and a silent check valve and circuit balancing valve (refer to detail on drawings). Suction guides have full pipeline size inlets and outlets. Provide reducers on each side of pump to adapt pump flanges to line size.
 - .8 For in-line pumps supported from the floor, provide adjustable saddle supports complete with base plate and vibration isolation. Place the supports under the piping on either side of the pump. For each in-line pump provide a structural support (lifting lugs or steel beam) over top to facilitate motor and pump removal. For in-line circulators provide wall brackets or suspension rods and base plate to support the motor.

2.5 EXPANSION TANKS

- .1 Provide Extrol diaphragm type expansion tanks of capacity noted for each separate closed water system, designed for a minimum 690 kPa (100 psig) working pressure, and constructed in accordance with the ASME Code.
- .2 Provide with each tank an air charging valve, air shut-off valve, air eliminator fitting and a pressure gauge.
- .3 Where space permits, standard cushion tanks designed and constructed as specified above may be used in lieu of the diaphragm type tanks. When this option is selected submit shop drawings of the proposed tanks and capacity calculations. Standard tanks include: two coats of prime paint; gauge glasses with insulating valves; code rated adjustable relief valve of minimum 20mm (3/4") size; drain fitting; tank support saddles; relief valve piped to nearest drain; and drain fitting piped to nearest hub drain.

2.6 NATURAL GAS DISTRIBUTION SYSTEM

- .1 The Gas Company will supply and install the incoming gas mains, including the gas service to the emergency generator. Gas shut-off valve to the emergency generator shall have supervisory switch, pressure regulators and gas meter and payment for this work, if any, will be made by the Contractor from the gas service cash allowance. Gas meter is complete with pulse initiator with isolation module for remote reading of consumption via the BAS - co-ordinate exact requirements with Section 25 00 00. Contact the Gas Company and become familiar with their exact requirements regarding installation and testing procedures for work of this Division. All x-rays and tests of welds required by the Gas Company for work of this Division shall be included in the tender sum. Co-ordinate all Gas Company work to service equipment provided under this contract, with the work of the other trades. Refer also to Article 3.23 in Section 23 00 10.
- .2 Piping shall be black wrought steel to ASTM A-53 minimum Schedule 40 standard. Piping 50mm (2") and smaller may have screwed ends. Fittings for screwed end piping 50mm (2") and smaller shall be minimum 150 pound malleable iron; fittings for welded piping shall be standard black steel butt welding type.
- .3 Piping larger than 50mm (2") and all piping installed in supply air and return air plenums shall be all welded construction, with work performed by a welder holding a Gas Company Licence.
- .4 Provide an approved gas cock at every outlet on the gas piping system and place it in a readily accessible location as close as practicable to the equipment served. Where required by Code, provide an emergency gas shut-off valve at the exit from service rooms. Use lubricated cocks for all outdoor applications; where gas pressure exceeds 3.5 kPa (0.5 psig); and where required by Authorities. All gas cocks must be approved for the application.
- .5 Where the distribution system provides higher pressures than required by the connected appliances, provide an approved pressure regulator at each appliance or group of appliances.
- .6 Paint, or arrange and pay for the painting of all gas piping in the colour required by the Gas Company and/or as shown on the drawings.

2.7 PREFABRICATED CHIMNEYS

- .1 Provide a complete venting system for products of combustion from all fuel fired heating and ventilating equipment and for other equipment where specified or noted on the drawings. Vents are as required by Code comprising prefabricated chimney, locking bands, fittings, supports, base tee, cleanouts, firestop spacer, roof flashing, counter-flashing, guy wires and rain cap as necessary for complete, APPROVED installation. Venting system supplier must provide engineered shop drawings indicating the routing, height, length, termination, sizes and detailed calculations, based on the boiler manufacturer's requirements, all in accordance with CAN/CSA-B149.1-10 and local Codes. Boiler vent sizes are for reference only.

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- .2 Vents are Category I for atmospheric draft appliances and Category II, III or IV for non-atmospheric draft appliances, conforming to the following:
- .1 Category I: Type 'B' vent for maximum flue temperature up to 243°C (470°F) and Type 'A' positive pressure vent for maximum flue temperature up to 538°C (1000°F).
 - .2 Category II: Type 'BH' double wall vent for maximum flue temperature up to 288°C (550°F).
 - .3 Category III: Type 'BH' double wall vent for maximum flue temperature up to 288°C (550°F) and Type 'A' positive pressure vent for maximum flue temperature up to 540°C (1000°F).
 - .4 Category IV: Type 'BH' double wall vent for maximum flue temperature up to 288°C (550°F).

2.8 WATER TREATMENT SYSTEMS

- .1 Provide complete water treatment systems for the following piping systems:
 - Hot Water Heating System.
 - Glycol Heating System.
- .2 Provide pre-cleaning of all piping systems. Do not operate the systems without the direct supervision of a Company representative or until a Company report is received stating the water treatment work is complete. Submit a copy of the report for record purposes.
- .3 The water treatment work shall be administered by the Chemical Supply Company who shall provide:-
 - Installation drawings;
 - On-site supervision;
 - Typewritten operating instruction;
 - On-site operating instructions to the Owner's operating personnel;
 - Monthly service calls for the first year's operation;
 - Monthly testing and test equipment, apparatus and reagents;
 - All chemicals for pre-operational cleaning of the piping systems;
 - All chemicals for boil-out of boilers.
 - All chemicals for the first year's operation (based on 2400 full load operating hours annually) as recommended by the Company from their review of the test results and from good engineering practice.
- .4 Submit typewritten reports each month with records of test procedures, test results, control charts, treatment dosages, etc.
- .5 Chemical treatment shall control scale, corrosion, algae and suspended matter. Chemicals shall be approved by Authorities. Biocides shall be registered under the applicable regulations of the Authorities.
- .6 Chemical treatment company shall be responsible for all test kits during the maintenance program.

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- .7 Chemicals for each water system shall be as specified below:-
- .1 Hot Water Heating System:
Pre-operational cleaner – CSW600
Organic based corrosion inhibitor – Assetguard 3245T
 - .2 Heat Recovery Glycol System:
Pre-operational cleaner – CSW600
- .8 Provide 18.9 litre (5 U.S. gal.) $\frac{3}{4}$ " bypass pot feeders complete with three shut-off valves, $\frac{3}{4}$ " flow indicator to introduce chemicals to the following:
- Hot Water Heating System.
 - Glycol System.
- .9 Provide for the services of a qualified specialist from the Company to supervise the cleaning and certify the systems are acceptable. Submit a copy of the written certification, signed by the Company specialist.
- .10 Prior to cleaning, inspect the systems and remove debris, excessive oil and dirt. Provide temporary strainers at each pump suction; temporary bypass around the boilers. Check pump rotations. Flush the systems to remove loose dirt. Hydrostatically test the systems to detect excessive leaks; repair all leaks before proceeding. Introduce cleaner using 35 kg per 4000 litres (75 lbs/1000 U.S. gals.) of system capacity and circulate. Drain off 25 percent of system water every two (2) hours and recharge with water and cleaner. Circulate for at least six (6) hours and until all contaminants are removed. After cleaning, drain and flush all systems. Following flushing, drain the systems again, replace the start-up strainers with the specified strainers, refill with fresh water and corrosion inhibitor chemicals.
- .11 Boil-out boilers with all main valves closed. Run boilers to half capacity with chemical being added at a controlled rate. Drain water until clear. Flush boilers when cool to prevent thermal shock. All traces of the chemicals must be flushed from the boilers to prevent any odour carry-over.
- .12 Provide a 4-port corrosion coupon rack, carbon steel with $\frac{3}{4}$ " regulator and sampling valves for the following water systems as applicable, and pipe as recommended by the Company:-
- Hot Water Heating System.
 - Glycol System.
- .13 Provide micron filter units for systems as shown on drawings. Units are complete with 1 micron cartridges only. Filter housing shall be GF020-3/4.
- .14 Provide complete charges of glycol/water solution for the entire glycol heat recovery system, including holding tank volume. Solution is 45% propylene glycol providing freeze protection to -27.5°C (-17.5°F). Propylene glycol shall contain specially formulated packages of industrial anti-corrosion inhibitors and shall be equal to Mid Cool IP glycol virgin grade (propylene glycol, inhibited). Follow manufacturer's recommendations for mixing and filling.

2.9 HEATING COILS

- .1 Provide coils as shown on the drawings and/or noted in the Schedules. Make coil sections installed in banks of equal size and capacity, unless noted otherwise.

- .2 Provide duct mounted heat recovery and pre-heat coils as noted on the drawings and in the schedules. Pre-heat coil shall be complete with a filter section. Filters shall be washable type and the section shall be equipped with side access. The coil assembly dimension shall be limited to coil width plus 150mm (6") coil height plus 150mm (6"), and 650mm (26") in depth. Design the complete coil assembly in collaboration with Section 23 00 40 to suit ductwork as indicated on plans.
- .2 Construct coils from copper tubing with mechanically bonded aluminum fins, unless noted otherwise, with fin spacing not exceeding 2.3mm (0.1") on centres. Construct coil casings, drain pans and supports from non-corroding materials such as aluminum or stainless steel. Hot-dipped galvanized steel coil casings or phosphatized carbon steel which has been chemically cleaned, and finish with primer and baked enamel paint. Treat all welds and unprotected surfaces with zinc rich paint. Unless noted otherwise, coil connections are at the same end. Provide gasketed plates around each pipe connection and seal air tight to the coil casing. Contain coil headers and U-bends within the air handling unit casing or alternatively cover with internally insulated sheet metal enclosures with construction and finish as specified herein for coil casings.
- .3 Make water coils drainable of the return bend type and arrange for counterflow of water and air, with water inlet at the bottom. Coils are self-venting except for coils with headers. Provide each coil header with a hose-end valve with cap and chain, for draining and/or venting. Capped pipes are not acceptable for this purpose. Test coils with 1725 kPa (250 psig) air under water at 93°C. (200°F.) and suitable for 1375 kPa (200 psig) working pressure.
- .4 Provide duct mounted heating coils of the multi-pass serpentine, or continuous tube type construction, suitable for use with steam or hot water as noted on the drawings and/or in the schedules.
- .5 Individually support coils and make removable without interference with other coil sections. Design supports for side withdrawal so that coil sections slip into place without bolting into position. Where shown on the drawings, make coils removable into adjacent access plenums. Provide adequately sized and suitably positioned access panels for coil removal. Panels shall be double wall insulated construction with 25mm (1") thick rigid fibreglass insulation sandwiched between two minimum 18 gauge galvanized steel sheets. Provide a heavy gauge galvanized steel angle frame and rivet or bolt the frame to the casing. Provide a continuous neoprene gasket to seal the bearing surfaces between the panel and the frame. Panels may be attached with compression type catches in lieu of hinged panels.

2.10 PACKAGED AIR HANDLING UNITS

- .1 Provide air handling units of type, size and capacity scheduled on the drawings. Rate units as completely stacked assembled packages and not as individual components alone. Refer to related specification articles for requirements of individual components. Include fan curves and both transmitted and radiated sound power levels for each air handling unit as part of the shop drawing submittal. A five percent (5%) deviation of RPM and fan power will be accepted for proposed alternative and substitute products.
- 2 Provide units complete with: supply and return fan sections; future cooling coil section (where scheduled); access section between coils; heating coil section; access section between heating coils and filters; filter section; mixing box complete with dampers and adjustable anti-stratification baffle; exhaust/return plenum complete with damper; belt guard; drive package and motor; drain pans and other accessories as noted. Match filter sections to the dimensions and appearance of the fan/coil sections. Construct unit casings of heavy gauge sheet metal braced to prevent drumming, sagging, vibrating. Casings are double wall construction comprising factory painted minimum 16 gauge

galvanized steel outer wall, minimum 2" (50mm) thick 4.5lb/cu.ft. (72kg/mg³) density neoprene coated flexible duct liner fully secured to casing with fire retardant approved adhesive and mechanical fasteners, minimum 22 gauge solid galvanized steel inner liner and 16 gauge floor. Fans and motors are installed on an all welded steel base on free standing vibration isolation springs with sound deadening pads, levelling bolts and 25mm (1") static deflection. Provide flexible connection between fan and casing. Provide structural steel supports suitable for mounting all components as an integral unit on the concrete housekeeping pad provided. Provide full size piano hinged access doors with "Ventlock" latches (operable from either side of door) and full perimeter gaskets in fan, coil access and mixing sections for access to all internal parts. Provide removable panels at coil and filter sections for their removal. Provide a vapourproof, weathertight incandescent marine light with die-cast aluminum guard inside the units at each section provided with an access door. Provide a single SPDT switch for all marine lights in a weathertight enclosure factory wired to the light fixtures through sealed metal conduits. Mount switch on unit exterior adjacent to supply fan access doors on latch side. Provide 250 x 250 minimum double "plexiglass" viewing windows in all access doors.

- .3 Provide fans statically and dynamically balanced in the factory after installation in the unit complete with full size drain pans. Provide coils as specified in the "Heating and Cooling Coils" article, factory installed in the units complete with full size drain pans. Provide eliminators as required to prevent carry-over of condensate at design face velocities. Mixing sections are complete with low leakage dampers arranged for proper mixing of the air streams during all control sequences. Exhaust/return plenums are complete with low leakage dampers. Low leakage dampers are opposed blade Tamco Series 9000 installed by unit manufacturer prior to unit shipment to site. Damper shafts extend through unit casing on unit access side. Provide baffling plates within the mixing section adjustable as necessary to deflect outside air into the return air stream and to prevent stratification. Provide filters and metal filter frames as specified in the "Air Filters, Frames and Gauges" article of this Specification complete with access doors and digihelic gauges suitable for 24 VAC power. Provide one set of spare filters for each unit. Provide 25mm Ø (1" Ø) instrument test ports equal to Duro Dyne IP-2 at each pressure drop section of the units.
- .4 Drain pan bases are welded, sloped galvanized steel with insulation and drain connection. Water shall not remain in base. Provide a minimum 20mm (3/4 inch) condensate drain line complete with deep seal trap and extend to the nearest hub drain. The trap seal depth exceeds the fan static pressure by 25mm (1 inch) W.G.
- .5 Unless noted otherwise fans are belt driven. Provide variable pitch sheaves on fans with motors up to and including 7.1/2 HP, 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.
- .6 Air handling units are complete with heat reclaim wheel with bypass dampers where indicated on drawings. Provide heat reclaim wheels as specified in the "Heat Recovery Wheels" article, factory installed in the units.

2.11 PACKAGED HEAT PUMP ROOFTOP A/C UNITS

- .1 Supply and install roof-top heating/cooling heat pump air conditioning units of size, capacity, etc. as shown on the drawings complete with minor details not specifically mentioned or shown, but as may be reasonably inferred and necessary to complete the system and place same in satisfactory operating condition.

- .2 The complete unit shall be cETLus listed. The unit shall be ASHRAE 90.1-2019 compliant and labeled. Each unit shall be specifically designed for outdoor rooftop application and include a weatherproof cabinet. Each unit shall be completely factory assembled and shipped in one piece. Packaged units shall be shipped fully charged with R-32/ R454 Refrigerant and oil. The unit shall undergo a complete factory run test prior to shipment.

The factory test shall include a refrigeration circuit run test, a unit control system operations checkout, a unit refrigerant leak test and a final unit inspection. All units shall have decals and tags to indicate caution areas and aid unit service. Unit nameplates shall be fixed to the main control panel door. Electrical wiring diagrams shall be attached to the control panels. Installation, operating and maintenance bulletins and start-up forms shall be supplied with each unit. Performance: All scheduled EER, IEER, capacities and face areas are minimum accepted values. All scheduled amps, kW, and HP are maximum accepted values that allow scheduled capacity to be met.

- .3 The units carry a standard one year warranty on parts and labour plus additional four (4) years warranty on compressors, materials only. The warranty period shall commence at start-up or six months after shipment, whichever occurs first.
- .4 Start-up must be done by trained personnel experienced with rooftop equipment. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters and remote controls are in place, bearings lubricated and manufacturers' installation instructions have been followed.
- .5 Delivery, Storage and Handling: Deliver, store, protect and handle products to site. Accept products on site and inspect for damage. Store in a clean, dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures and finish.
- .6 Construction:
- .1 All cabinet walls, access doors, and roof shall be fabricated of double wall, impact resistant, rigid polyurethane foam panels.
- .2 Unit insulation shall have a minimum thermal resistance R-value of 13. Foam insulation shall have a minimum density of 2 pounds/cubic foot and shall be tested in accordance with ASTM D1929-11 for a minimum flash ignition temperature of 610°F.
- .3 Unit construction shall be double wall with G90 galvanized steel on both sides and a thermal break. Double wall construction with a thermal break prevents moisture accumulation on the insulation, provides a cleanable interior, reduces heat transfer through the panel, and prevents exterior condensation on the panel.
- .4 Unit shall be designed to reduce air leakage and infiltration through the cabinet. Cabinet leakage shall not exceed 1% of total airflow when tested at 3 times the minimum external static pressure provided in AHRI Standard 340/360. Panel deflection shall not exceed L/240 ratio at 125% of design static pressure, at a maximum 8 inches of positive or negative static pressure, to reduce air leakage. Deflection shall be measured at the midpoint of the panel height and width. Continuous sealing shall be included between panels and between access doors and openings to reduce air leakage. Piping and electrical conduit through cabinet panels shall include sealing to reduce air leakage.
- .5 Roof of the air tunnel shall be sloped to provide complete drainage. Cabinet shall have rain break overhangs above access doors.

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- .6 Access to filters, dampers, cooling coils, heaters, energy recovery wheels, and electrical and controls components shall be through hinged access doors with quarter turn, zinc cast, lockable handles. Full length stainless steel piano hinges shall be included on the doors.
 - .7 Exterior paint finish shall be capable of withstanding at least 2,500 hours, with no visible corrosive effects, when tested in a salt spray and fog atmosphere in accordance with ASTM B 117-95 test procedure.
 - .8 Units with cooling coils shall include double sloped 304 stainless steel drain pans.
 - .9 Unit shall be provided with base discharge and return air openings. All openings through the base pan of the unit shall have upturned flanges of at least 1/2 inch in height around the opening.
 - .10 Unit shall include lifting lugs on the top of the unit.
 - .11 Unit shall include factory installed, painted galvanized steel condenser coil guards on the face of the condenser coil.
- .7 Outdoor/Return Air Section:
- .1 Unit shall be provided with an outdoor air economizer section. The economizer section shall include outdoor, return, and exhaust air dampers. The economizer operation shall be fully integral to the mechanical cooling and allow up to 100% of mechanical cooling if needed to maintain the cooling discharge air temperature. The outdoor air hood shall be factory installed and constructed from galvanized steel finished with the same durable paint finish as the main unit. The hood shall include moisture eliminator filters to drain water away from the entering air stream. The outside and return air dampers shall be sized to handle 100% of the supply air volume. The dampers shall be parallel blade design. Damper blades shall be gasketed with side seals to provide an air leakage rate of 1.5 cfm / square foot of damper area at 1" differential pressure in according with testing defined in AMCA 500. A barometric exhaust damper shall be provided to exhaust air out of the back of the unit. A bird screen shall be provided to prevent infiltration of rain and foreign materials. Exhaust damper blades shall be lined with vinyl gasketing on contact edges. Control of the dampers shall be by a factory installed direct coupled actuator. Damper actuator shall be of the modulating, spring return type. A comparative enthalpy control shall be provided to sense and compare enthalpy in both the outdoor and return air streams to determine if outdoor air is suitable for "free" cooling. If outdoor air is suitable for "free" cooling, the outdoor air dampers shall modulate in response to the unit's temperature control system.
 - .2 UltraSeal low leak dampers shall be provided. Damper blades shall be fully gasketed and side sealed and arranged vertically in the hood. Damper leakage shall be less than 1.5 CFM/Sq. Ft. of damper area at 1.0 inch static pressure differential. Leakage rate to be tested in accordance with AMCA Standard 500. Damper blades shall be operated from multiple sets of linkages mounted on the leaving face of the dampers. Control of the dampers shall be from a factory installed actuator.
 - .3 Control of the outdoor dampers shall be by a factory installed actuator. Damper actuator shall be of the modulating type. Damper to open when supply fan starts, and close when supply fan stops.
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- .8 Energy Recovery (As noted in the Schedule):
- .1 The rooftop unit shall be designed with a track so the entire energy recovery wheel cassette can slide out from the rooftop unit to facilitate cleaning.
 - .2 The unit shall have 2" Merv 13 filters for the outdoor air before the wheel to help keep the wheel clean and reduce maintenance. Filter access shall be by a hinged access door with ¼ turn latches.
 - .3 The matrix design shall have channels to reduce cross contamination between the outdoor air and the exhaust air. The layers shall be effectively captured in aluminum and stainless-steel segment frames that provide a rigid and self-supporting matrix. All diameter and perimeter seals shall be provided as part of the cassette assembly and shall be factory set. Drive belt(s) of stretch urethane shall be provided for wheel rim drive without the need for external tensioners or adjustment.
 - .4 The total energy recovery wheel shall be coated with silica gel desiccant permanently bonded without the use of binders or adhesives, which may degrade desiccant performance. The substrate shall be lightweight polymer and shall not degrade nor require additional coatings for application in marine or coastal environments. Coated segments shall be washable with detergent or alkaline coil cleaner and water. Desiccant shall not dissolve nor deliquesce in the presence of water or high humidity.
 - .5 Wheels shall be provided with removable energy transfer matrix. Wheel frame construction shall be a welded hub, spoke and rim assembly of stainless, plated and/or coated steel and shall be self-supporting without matrix segments in place. Segments shall be removable without the use of tools to facilitate maintenance and cleaning.
 - .6 Wheel bearings shall be selected to provide an L-10 life in excess of 400,000 hours. Rim shall be continuous rolled stainless steel. Wheels shall be connected to the shaft by means of taper lock hubs.
 - .7 The exhaust air fan shall be a direct drive SWSI plenum fan. The exhaust fan shall be sized for the airflow requirements per the construction schedule. The unit controller shall control the exhaust fan to maintain building pressure. A VFD shall be provided for the exhaust fan motor, or the exhaust fan motor shall be an ECM motor. The rooftop unit shall have single point electrical power connection and shall be ETL listed
 - .8 The control of the energy recovery wheel shall be an integral part of the rooftop unit's DDC controller. The DDC controller shall have visibility of the outdoor air temperature, leaving wheel temperature, return air temperature, and exhaust air temperature. These temperatures shall be displayed at the rooftop units DDC controller LCD display. All of these temperatures shall be made available through the BACnet interface.
 - .9 The rooftop unit with the energy recovery wheel shall incorporate the economizer operation. The energy recovery wheel shall have a bypass damper. When the unit is in the economizer mode of operation the energy recovery wheel shall stop and the bypass dampers shall be opened. The outdoor air shall be drawn through the bypass dampers to reduce the pressure drop of the outdoor airstream.
 - .10 The rooftop unit (DDC controller shall provide frost control for the energy recovery wheel. When a frost condition is encountered the unit controller shall stop the wheel. When in the

frost control mode the wheel shall be jogged periodically and not be allowed to stay in the stationary position.

.9 Exhaust Fan:

- .1 Exhaust fan shall be a single width, single inlet (SWSI) airfoil centrifugal fan. The fan wheel shall be Class II construction with aluminum fan blades that are continuously welded to the hub plate and end rim. The exhaust fan shall be a direct drive fan mounted to the motor shaft. Belts and sheaves are not acceptable due to the additional maintenance.
- .2 The fan motor shall be a totally enclosed EC motor that is speed controlled by the rooftop unit controller. The motor shall include thermal overload protection and protect the motor in the case of excessive motor temperatures. The motor shall have phase failure protection and prevent the motor from operation in the event of a loss of phase. Motors shall be premium efficiency.
- .3 The unit DDC controller shall provide building static pressure control. The unit controller shall provide proportional control of the exhaust fans from 25% to 100% of the supply air fan designed airflow to maintain the adjustable building pressure setpoint. The field shall mount the required sensing tubing from the building to the factory mounted building static pressure sensor.

.10 Filters: Unit shall be provided with a draw-through filter section. The filter rack shall be designed to accept a 2" prefilter and a 4" final filter. The unit design shall have a hinged access door for the filter section. The manufacturer shall ship the rooftop unit with 2" MERV 13 construction filters. The contractor shall furnish and install, at building occupancy, the final set of filters per the contract documents.

.11 Cooling Coil:

- .1 The indoor coil section shall be installed in a draw through configuration, upstream of the supply air fan. The coil section shall be complete with a factory piped cooling coil and an ASHRAE 62.1 compliant double sloped drain pan.
- .2 The direct expansion (DX) cooling coils shall be fabricated of seamless high efficiency copper tubing that is mechanically expanded into high efficiency aluminum plate fins. Coils shall be a multi-row, staggered tube design with a minimum of 3 rows. All cooling coils shall have an interlaced coil circuiting that keeps the full coil face active at all load conditions. All coils shall be factory leak tested with high pressure air under water.
- .3 The cooling coil shall have an electronic controlled expansion valve. The unit controller shall control the expansion valve to maintain liquid subcooling and the superheat of the refrigerant system.
- .4 The refrigerant suction lines shall be fully insulated from the expansion valve to the compressors.
- .5 The drain pan shall be stainless steel and positively sloped. The slope of the drain pan shall be in two directions and comply with ASHRAE Standard 62.1. The drain pan shall have a minimum slope of 1/8" per foot to provide positive draining. The drain pan shall extend beyond the leaving side of the coil. The drain pan shall have a threaded drain connection extending through the unit base.

.12 Supply Fan: (Fan option dependent on unit size)

- .1 Supply fan shall be a single width, single inlet (SWSI) airfoil centrifugal fan. The fan wheel shall be Class II construction with fan blades that are continuously welded to the hub plate and end rim. The supply fan shall be a direct drive fan mounted to the motor shaft. Belts and sheaves are not acceptable due to the additional maintenance.
- .2 All fan assemblies shall employ solid steel fan shafts. Heavy-duty pillow block type, self-aligning, grease lubricated ball bearings shall be used. Bearings shall be sized to provide a L-50 life at 250,000 hours. The entire fan assembly shall be isolated from the fan bulkhead with a flexible collar and mounted on 1" spring isolators.
- .3 All fan assemblies shall be statically and dynamically balanced at the factory, including a final trim balance, prior to shipment.
- .4 Supply fan and motor assembly combinations larger than 8 hp or 22" diameter shall be internally isolated on 1" deflection, spring isolators and include removable shipping tie downs.
- .5 The fan motor shall be a totally enclosed EC motor that is speed controlled by the rooftop unit controller. The motor shall include thermal overload protection and protect the motor in the case of excessive motor temperatures. The motor shall have phase failure protection and prevent the motor from operation in the event of a loss of phase. Motors shall be premium efficiency.
- .6 The motor shall be T Frame and open drip proof. Overload protection and speed control is provided by the factory installed VFD and rooftop unit controller. The motor shall have phase failure protection and prevent the motor from operation in the event of a loss of phase. Motors shall be premium efficiency.
- .7 The supply fan shall be capable of airflow modulation from 30% to 100% of the scheduled designed airflow. The fan shall not operate in a state of surge at any point within the modulation range.

.13 Variable Air Volume Control:

- .1 The unit controller shall proportionally control the Electronically Commutated Motors (ECM) on the supply and exhaust fans. The supply fan shall be controlled to maintain an adjustable duct pressure setpoint. A duct static pressure sensor shall be factory mounted in the control panel. The field shall furnish and install the pneumatic tubing for the duct static pressure sensor and the building pressure sensor. The field shall furnish and install the outdoor air pressure sensor.
- .2 The unit controller shall proportional control the ECM motors on the supply fan based on space temperature. The unit controller shall increase/decrease the speed of the supply fan in order to maintain the space temperature within its setpoint and dead band. The unit controller shall provide discharge air temperature control with the compressor modulation.
- .3 An electronic variable frequency drive shall be provided for the supply air fan. Each drive shall be factory installed out of the air stream in a conditioned cabinet. Drives shall meet UL Standard 95-5V. The completed unit assembly shall be listed by a recognized safety

agency, such as ETL. Drives are to be accessible through a hinged door assembly. Mounting arrangements that expose drives to high temperature unfiltered ambient air are not acceptable.

- .4 The unit manufacturer shall install all power and control wiring.
 - .5 The supply air fan drive output shall be controlled by the factory installed main unit control system and drive status and operating speed shall be monitored and displayed at the main unit control panel.
- .14 Gas Heating:
- .1 Stainless steel heat exchanger furnace shall carry a 25 year non-prorated warranty, from the date of original equipment shipment from the factory.
 - .2 Gas furnace shall consist of stainless steel heat exchangers with multiple concavities, an induced draft blower and an electronic pressure switch to lockout the gas valve until the combustion chamber is purged and combustion airflow is established.
 - .3 Furnace shall include a gas ignition system consisting of an electronic igniter to a pilot system, which will be continuous when the heater is operating, but will shut off the pilot when heating is not required.
 - .4 Unit shall include a single gas connection and have gas supply piping entrances in the unit base for through-the-curb gas piping and in the outside cabinet wall for across the roof gas piping.
 - .5 High Turndown Modulating Natural Gas Furnace shall be equipped with modulating gas valves, adjustable speed combustion blowers, stainless steel tubular heat exchangers, and electronic controller. Combustion blowers and gas valves shall be capable of modulation. Electronic controller includes a factory wired, field installed supply air temperature sensor. Sensor shall be field installed in the supply air ductwork. Supply air temperature setpoint shall be adjustable on the electronic controller within the controls compartment. Gas heater shall be capable of capacity turndown ratio as shown on the unit rating sheet. Heat trace shall be include on the condensate drain.
 - .6 Auxiliary gas heating capacity shall be sized to meet heating leaving air temperature setpoint when heat pump heating is in operation. Auxiliary heating capacity shall be available for operation when heat pump heating is in operation.
- .15 Heat Pump Heating:
- .1 The evaporator coil, condenser coil, compressors and refrigerant circuit shall be designed for heat pump operation. The refrigerant circuit shall contain a 4-way reversing valve for the heat pump operation. The outdoor coil shall have an electronic expansion valve to control the refrigerant flow. The unit controller shall modulate the expansion valve to maintain compressor operation within the compressor operational envelope.
 - .2 The refrigerant system shall have a pump-down cycle.

- .3 The unit shall have a hot water coil for hybrid heating. When the heat pump operation cannot maintain the discharge air temperature setpoint the hot water coil shall temper the airstream to the discharge air temperature setpoint.
- .16 Condensing Section:
 - .1 Outdoor coils shall have seamless copper tubes, mechanically bonded into aluminum plate-type fins. The fins shall have full drawn collars to completely cover the tubes. A sub-cooling coil shall be an integral part of the main outdoor air coil. Each outdoor air coil shall be factory leak tested with high-pressure air under water.
 - .2 Fan motors shall be an ECM type motor for proportional control. The unit controller shall proportionally control the speed of the condenser fan motors to maintain the head pressure of the refrigerant circuit in ambient conditions up to 125°F. Mechanical cooling shall be provided to 0°F. Heat Pump Heating shall be provided to -10°F. The motor shall include thermal overload protection and protect the motor in the case of excessive motor temperatures. The motor shall have phase failure protection and prevent the motor from operation in the event of a loss of phase.
 - .3 The condenser fan shall be low noise blade design. Fan blade design shall be a dynamic profile for low tip speed. Fan blade shall be of a composite material.
 - .4 The unit shall have scroll compressors. One of the compressors shall be an inverter compressor providing proportional control. The unit controller shall control the speed of the compressor to maintain the discharge air temperature. The inverter compressor shall have a separate oil pump and an oil separator for each compressor that routes oil back to the compressor instead of through the discharge line.
 - .5 Pressure transducers shall be provided for the suction pressure and head pressure. Temperature sensor shall be provided for the suction temperature and the refrigerant discharge temperature of the compressors. All of the above devices shall be an input to the unit controller and the values be displayed at the unit controller.
 - .6 Refrigerant circuit shall have a bypass valve between the suction and discharge refrigerant lines for low head pressure compressor starting and increased compressor reliability. When there is a call for mechanical cooling the bypass valve shall open to equalizing the suction and discharge pressures. When pressures are equalized the bypass valve shall close and the compressor shall be allowed to start.
 - .7 Each circuit shall be dehydrated and factory charged with R32 Refrigerant and oil.
- .17 Electrical:
 - .1 Unit wiring shall comply with NEC requirements and with all applicable UL standards. All electrical components shall be UL recognized where applicable. All wiring and electrical components provided with the unit shall be number and color-coded and labeled according to the electrical diagram provided for easy identification. The unit shall be provided with a factory wired weatherproof control panel. Unit shall have a single point power terminal block for main power connection. A terminal board shall be provided for low voltage control wiring. Branch short circuit protection, 115-volt control circuit transformer and fuse, system switches, and a high temperature sensor shall also be provided with the unit.

Each compressor and condenser fan motor shall be furnished with contactors and inherent thermal overload protection. Supply fan motors shall have contactors and external overload protection. Knockouts shall be provided in the bottom of the main control panels for field wiring entrance.

- .2 A single non-fused disconnect switch shall be provided for disconnecting electrical power at the unit. Disconnect switches shall be mounted internally to the control panel and operated by an externally mounted handle.
- .3 An optional fused disconnect and 22,000 amp SCCR capability shall be provided.
- .18 Units are suitable for control from a remote building automation system. Co-ordinate with Section 25 00 00. A terminal strip in unit control panel facilitates the remote control/monitoring and includes terminals for:
 - heat pump mode (DO)
 - lead compressor cooling enable (DO)
 - lead compressor cooling control (AO)
 - lag compressor cooling enable (DO, each compressor)
 - damper control (AO)
 - heating enable (DO)
 - heating control (AO)
 - heating blower fan status (DI)
- .19 Roof Curb: A prefabricated heavy gauge galvanized steel, mounting curb shall be provided for field assembly on the roof decking prior to unit shipment. The roof curb shall be a full perimeter type with complete perimeter support of the air handling section and condensing section. The curb shall be a minimum of 24" high and include a nominal 2" x 4" wood nailing strip. Gasket shall be provided for field mounting between the unit base and roof curb.
- .20 Power wiring to unit unfused disconnect is by Division 26. BAS control wiring is by Section 25 00 00.

2.12 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 62.78°C/46.11°C. (145°F/115°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.

2.13 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 62.78°C/46.11°C. (145°F/115°F.) entering/leaving 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 butt joined 300mm (12") inside panel with profile identical to enclosure complete with flat hinged door (150 x 225 H) with screw driver operated lock 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.

2.14 HEATING BOILERS

- .1 Provide and install two hydronic heating stainless steel condensing boilers as manufactured by Riello Array Series in accordance with all applicable codes and authorities having local, state and federal jurisdiction. Each boiler shall be CSA (US and Canada) listed to ANSI Z2113, UL795 Standards, CSD-1 approved, ASME coded and stamped. The burner/boiler control shall incorporate the functions of temperature control, combustion safeguard control, message annunciation, and fault diagnostic display. Boiler shall be approved to be directly vented for outside air.
- .2 Design: The boiler shall be gas floor standing condensing boiler with multiple stainless steel heat exchangers for redundancy. Each 500 MBH cassette is fully independent and "stand alone" thus allowing boiler operation even if an adjacent cassette is turned off. The boiler shall be ETL certified as a condensing boiler. The boiler shall operate with natural gas or propane and have an ETL certified input rating as noted on the drawings, and shall be listed with AHRI and shall have a minimum thermal efficiency rating of 96.1% at rated input. The boiler shall be designed for a minimum of 20:1 turn down on AR2000 with constant CO₂ over the turn down range. The boiler will use a direct ignition system. The design shall provide quiet burner ignition and operation. The burner shall be pre-mix radial type and fire in 360 degrees vertical pattern.
- .3 Boilers shall have inherent N+1 design allowing for plant sizing to match building heat loss exactly. Boiler pumps shall provide variable flow matching boiler output, constant flow boiler pumps are not acceptable. Boilers shall incorporate a Zero Down Time design ensuring heat is supplied to building even when a module is being serviced. Boilers that do not meet this requirement must provide minimum plant redundancy of 65% which may require additional capacity and or number of boilers.
- .4 Boilers listed as Equal must meet or exceed the requirements of this specification in relation to Efficiency, Modulation, Controls and Redundancy. The contractor will take full responsibility when submitting an Equal boiler which is heavier, larger or requires piping modifications. The Contractor must submit with shop drawings certified Structural review for heavier equipment, piping and venting conflict resolution drawings as well as certified electrical modification drawings required. Equal boilers shall be CB Clear Fire and Viessman.
- .5 Components:
 - .1 Casing: The frame shall be made of extruded aluminum alloy (EN AW-6060) and finished with a baked enamel powder coat (RAL7016). The panels shall be made of 18 and 22 gauge carbon steel and finished with a baked enamel powder coat (RAL9006).
 - .2 Heat Exchanger:
 - 1. The water tube (AISI 316L) stainless steel heat exchangers shall be inspected and tested to ASME Section IV requirements and shall bear the ASME section IV seal of approval.

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2. The heat exchangers shall have welded construction (no gaskets) consisting of two pipes working in parallel. Each pipe shall have three welded joints. The heat exchanger shall be a fully condensing cylindrical counter-flow water tube design with AISI stainless steel tubes and headers.
 3. Each 500 MBH cassette shall be fully independent and "stand alone" with maximum working pressure of 80 psig (550 kPa).
 4. The individual cassette shall be removable from the boiler while the remainder of the cassettes, on other rows, within the boiler remain operational. The removal and replacement of such heat exchanger shall not require welding or hoisting equipment.
 5. The boiler shall be capable of operating with a minimum outlet water temperature of 68 °F.
 6. Each heat exchanger shall be accessible for visual inspection and cleaning of all internal fire side surfaces.
 7. The boiler shall be equipped with an ASME certified pressure relief valve on module.
 8. Each heat exchanger shall be equipped with a dedicated water pump, flow meter, condensate trap and drain valve.
 9. The heating surface of each cassette shall be 43 SQ.FT/ 500,000BTU
- .3 Combustion Chamber:
1. The boiler shall have sealed combustion capability with an engineered gas/air chamber that ensures proper mixing for stable combustion at all firing rates.
 2. The combustion chamber shall be a stainless steel construction and an integral part of the heat exchanger which shall be a cylindrical stainless steel counter-flow design.
 3. A window view port shall be provided for visual inspection of the boiler combustion during firing.
- .4 Gas Train:
1. Each boiler shall be provided with a factory assembled, piped and wired main gas train.
 2. The main gas train shall consist a low gas pressure switch (manual reset) and a high gas pressure switch (manual reset) as required by code.
 3. Each heat exchanger shall have its own zero governing gas valve to include dual safety shut off. Each heat exchanger shall also have its own manual gas shutoff valves; one upstream of the zero governing gas valve and one between the zero governing gas valve and the blower.
 4. The boiler shall be LPG convertible.
 5. The boiler shall operate on 3.5"-14" W.C. gas pressure when operating with natural gas and 8"-13" W.C. gas pressure when operating with propane gas.
 6. The boiler shall need no component changes to operate at high altitude.
 7. Each heat exchanger shall have an air/gas ratio control gas valve. The air/gas ratio gas valve shall sense the pressure across the venturi and supply gas to premix with air. This operation shall provide seamless modulation through the entire range of firing rate.
- .5 Burner:
1. The burner shall be a premix burner with a stainless steel knitted metal fiber construction.
 2. The burner shall operate with a 5:1 turn down on each cassette; AR2000 shall operate with a minimum 20:1 turndown ratio.
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3. The burner shall not produce more than 0.04% of Carbon monoxide (CO) at all firing rates.
 4. The burner shall be certified for Oxides of Nitrogen (NOx) of 9 ppm corrected to 3% oxygen.
 5. Air/Gas ratio control gas valve shall operate on the principle of negative pressure and modulate to maintain combustion characteristics across the full operating range, which shall provide safe operation even in the case of blocked air intake.
- .6 Controls:
1. The boiler shall have a touchscreen display located outside the front panel and a service screen located inside the front panel.
 2. The outer display shall have a 7" color touchscreen and shall provide full diagnostics including real time data logging.
 3. Control shall duty cycle all components to ensure equal run time and reduce cycling extending the service life of the equipment.
 4. The control shall control the boiler pumps flow varying flow based on building demand and boiler output.
 5. The control shall be capable of lead/lag sequencing up to eight 8 boilers in "Cascade".
 6. The control shall display any error codes whether automatically reset or manually reset.
 7. The boiler shall be provided as a standard with ModBus RS485 communication capabilities with an optional protocol converter for ModBus Lonworks, N2, BacNet MS/TP or BacNet IP.
 8. The boiler control system shall be capable of accepting 0-10VDC remote external analog signal to control the temperature set point.
 9. The control system shall be capable of resetting the set point based on outdoor air temperature with the optional outside air temperature sensor (field installed).
 10. The control shall monitor flue gas temperature and stop the boiler if the temperature is excessive.
 11. The boiler safety control shall be furnished with controls for low gas pressure and high gas pressure, water pressure and low water cut off. Each cassette within the boiler shall be furnished with the following safety control devices which if in alarm shall not affect the normal operation of other cassettes within the boiler, blocked flue, blocked condensate, water temperature high limit, stack limit, water flow meter and temperature rise limiter.
 12. The control shall graphically show the firing rate of each module in the boiler and each boiler in the cascade.
 13. The boiler touchscreen shall have the capability to be upgraded via USB stick.
 14. The control shall be capable of switching its mode to operate from an internal setpoint if its external control signal is lost.
 15. The boiler shall display service reminder notifications.
 16. A Riello supplied BacNet Gateway will be supplied and shipped loose for integration to BAS. Only 1 Gateway is required for multiple boiler installation.
 17. Main Power Wiring to be 208/1/60 rated for 15.5 FLA.
 18. Manufacturer will provide local/remote switch and dry contact to indicate switch in local position. Monitor dry contact and provide indication and alarm for boiler running on local controls.

.7 Venting:

1. The boiler shall be designed for vertical or horizontal category IV venting, up to 100 equivalent feet of combined air intake and exhaust length with 8" diameter vent.
2. Air may be taken from the room or ducted directly to the boiler using up to up to 100 equivalent feet of combined air intake and exhaust length.
3. The following category IV vent materials shall be utilized: AL29-4C Stainless for all system applications

The following guideline shall be used to determine the suitability of vent material:

Vent Material	Maximum Flue Temperature (°F)
AL29-4C	300+, limited only by rating of seals
316L Stainless Steel	300+, limited only by rating of seals

4. The boiler shall be equipped with factory installed flue exhaust damper on each module, which allows common venting of Array boilers in cascade.

.8 Installations:

1. Installation shall be performed by the contractor in accordance with the requirements of the applicable codes and manufacturer's instructions. Contractor shall review the boiler and installation for compliance with requirements and/or issues that may affect boiler performance. Installation should not proceed until unsatisfactory conditions have been corrected.
2. Equipment Mounting: Install boilers level on concrete base. Concrete base is specified in Division 23 Section "Common Work Results for HVAC", and concrete materials and installation requirements are specified in Division 03.
3. The boiler must be installed on a level housekeeping pad at least 3" above the floor for proper condensate drainage and boiler operation.
4. Comply with requirements of vibration isolation devices. Vibration isolation devices and installation requirements are specified in Division 23 Section "Vibration and Seismic Control for HVAC Piping and Equipment".
5. Install gas-fired boilers according to NFPA 54 and ANSI Z223.1
6. Assemble and install boiler trim.
7. Install electrical devices furnished with boiler but not specified to be factory mounted.
8. Install control wiring to field-mounted electrical devices.

.9 Connections:

A. Piping

1. Riello ARRAY AR2000 supplied with 4" flanged inlet and outlet connections on top of the boiler. 1 1/2" Gas connection also located on top of the boiler Refer to specific Boiler's specification sheet for connection sizes. Piping installation requirements are specified in other Division 23 Sections such as Section 23 20 00 "HVAC Piping and Pumps". Drawings indicate general arrangement of piping, fittings, and specialties.
2. Check manufacturer's installation manual for clearance dimensions and install piping adjacent to boiler to allow service and maintenance.

3. Install piping from equipment drain connection to nearest floor drain. Piping shall be at least full size of connection and adhere to proper codes for neutralization. Provide an isolation valve if required.
 4. Connect piping to boilers, except safety relief valve connections, with flexible connectors of material suitable for service. Flexible connectors and their installation are specified in Division 23 Section "Common Work results for HVAC".
- B. Venting
1. Install air intake and exhaust venting system per manufacturer's recommendations and state/provincial codes.
 2. Components shall comply with requirements in Section 23 51 00 "Breechings, Chimneys and Stacks".
- C. Electrical Requirements
1. Voltage shall be 208/1/60 for Array 2000.
 2. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems".
 3. Connect wiring according to Division 26 Section "Low Voltage Electrical Power Conductors and Cables".
- .10 Demonstration: Engage a factory authorized service representative to train Owner's maintenance personnel as specified below:
1. Operate boiler, including accessories and controls, to demonstrate compliance with requirements.
 2. Train Owner's maintenance personnel on procedures and schedules related to startup and shutdown, troubleshooting, servicing, and preventive maintenance.
 3. Review data in the maintenance manuals. Refer to Division 1 Section "Contract Closeout" AND "Operation and Maintenance Data".
 4. Schedule training with Owner with at least 7 days advance notice.

2.15 HEAT PUMP AIR COOLED CONDENSING UNITS

- .1 Provide split system condensing units, configuration and capacity noted, suitable for a single point power connection.
- .2 Unit shall be certified in accordance with UL Standard 1995/CSA C22.2 No. 236, Safety Standard for Heating and Cooling Equipment. Unit and refrigeration system shall comply with ASHRAE 15, Safety Standard for Mechanical Refrigeration. Energy Efficiency Ratio (EER) shall be equal to or greater than prescribed by ASHRAE 90.1, Energy Efficient Design of New Buildings except Low-Rise Residential Buildings. Unit shall be safety certified by ETL and be ETL US and ETL Canada listed. Unit nameplate shall include the ETL label. The nameplate, safety labels, and warnings shall be in English and French.
- .3 Delivery, Storage, and Handling: Unit shall be shipped with doors bolted shut to prevent damage during transport and thereafter while in storage awaiting installation. Follow Installation, Operation and Maintenance manual instructions for rigging, moving, and unloading the unit at its final location. Unit shall be stored in a clean, dry place protected from construction traffic in accordance with the Installation, Operation and Maintenance manual.
- .4 Warranty: Manufacturer shall provide a limited "parts only" warranty for a period of 12 months from the date of equipment startup or 18 months from the date of original equipment shipment from the

factory, whichever is less. Warranty shall cover material and workmanship that prove defective, within the specified warranty period, provided manufacturer's written instructions for installation, operation and maintenance have been followed. Warranty excludes parts associated with routine maintenance and refrigerant. Compressors shall carry a 5-year warranty from date of original equipment shipment from the factory.

- .5 Air-Source heat pump condensing unit shall include compressors, air-cooled condenser coils, condenser fans, suction and liquid connection valves, accumulator, receiver, reversing valve, filter driers with check valves, and thermal expansion valves. Unit shall be factory assembled and tested including leak testing of the coil and run testing of the completed unit. Run test report shall be supplied with the unit in the control compartment. Unit shall have decals and tags to indicate lifting and rigging, service areas and caution areas for safety and to assist service personnel. Unit components shall be labeled, including pipe stub outs, refrigeration system components and electrical and controls components. Installation, Operation and Maintenance manual shall be supplied within the unit. Laminated color-coded wiring diagram shall match factory installed wiring and shall be affixed to the interior of the control compartment's access door. Unit nameplate shall be provided in two locations on the unit, affixed to the exterior of the unit and affixed to the interior of the control compartment's access door.
- .6 Construction: Unit shall be completely factory assembled, piped, and wired and shipped in one section. All cabinet walls, access doors, and roof shall be fabricated of G90 galvanized steel panels. Unit shall be specifically designed for outdoor application. Access to compressors and control components shall be through hinged access doors with quarter turn, lockable handles. Access to condenser coils and fans is through removable access panels. Exterior paint finish shall be capable of withstanding at least 2,500 hours, with no visible corrosive effects, when tested in a salt spray and fog atmosphere in accordance with ASTM B 117-95 test procedure. Unit shall include lifting lugs. Unit shall include factory installed, painted galvanized steel condenser coil guards on the face of the condenser coil.
- .7 Electrical: Provide with standard power block for connecting power to the unit. Control circuit transformer and wiring shall provide 24 VAC control voltage from the line voltage provided to the unit. Unit shall have a 5kAIC SCCR. Provide with factory installed and factory wired, non-fused disconnect switch. Provide with a factory installed and field wired 115V, 20-amp GFI outlet in the unit control panel. Provide with phase and brown out protection which shuts down all motors in the unit if the electrical phases are more than 10% out of balance on voltage, the voltage is more than 10% under design voltage, or on phase reversal. Provide with remote stop/start terminals which require contact closure for unit operation. When these contacts are open the low voltage circuit is broken and the unit will not operate.
- .8 Refrigeration System:
 - .1 Unit shall be provided with two tandem circuited R-454B scroll compressors with thermal overload protection. The lead tandem set shall include a variable capacity scroll compressor on the first compressor of the set which shall be capable of modulation from 10-100% of its capacity.
 - .2 Each compressor shall be furnished with a crankcase heater.
 - .3 Compressors shall be mounted in an isolated service compartment which can be accessed without affecting unit operation. Lockable hinged access doors shall provide access to the compressors.

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- .4 Compressors shall be isolated from the base pan with the compressor manufacturer's recommended rubber vibration isolators and mounted on an elevated compressor deck, to reduce any transmission of noise from the compressors into the building area.
 - .5 Each refrigeration circuit shall be equipped with automatic reset low pressure and manual reset high pressure refrigerant safety controls, Schrader type service fittings on both the high pressure and low-pressure sides, and service valves for liquid and suction connections. Liquid line filter driers shall be factory provided and installed. Field installed refrigerant circuits shall include the low side cooling components, refrigerant, thermal expansion valve, liquid line, insulated hot gas bypass line and insulated suction line.
 - .6 Unit shall include a factory holding charge of R-454B refrigerant and oil. Adjusting the charge of the system will be required during installation.
 - .7 Unit shall be configured as an air-source heat pump. Each refrigeration circuit shall be equipped with a bypass loop including two liquid line filter driers with two check valves, reversing valve, suction line accumulator, liquid line receiver, and a bypass loop with check valve around a thermal expansion valve. Reversing valve shall de-energize during the heat pump heating mode of operation. The matching indoor air handler must include a bypass loop with check valve around the thermal expansion valve.
 - .8 Each refrigeration circuit shall be equipped with a liquid line sight glass.
 - .9 Units shall be provided with a suction pressure transducer on each refrigeration circuit.
 - .9 Fans: Variable frequency drive controlled variable speed condenser fans shall be provided for head pressure control and allow operation down to 35°F. Fan motor shall be weather protected, single phase, direct drive, and open, air over (OPAO) with thermal overload protection.
 - .10 Coils: Coils shall be designed for use with R-454B refrigerant and constructed of copper tubes with aluminum fins mechanically bonded to the tubes and aluminum end casings. Fin design shall be sine wave rippled. Coils shall be designed for a minimum of 10°F of refrigerant sub-cooling. Coils shall be hydrogen leak tested.
 - .11 Controls: Unit shall be provided with supervisory controls. A remote forced cooling/heating signal and 0-10V SA reset signal is required from BAS. Unit control panels are equipped with terminal strips for BAS wiring interfaces.
 - .12 Disconnect switches are non-fused, externally mounted, weatherproof configuration, permanently labelled, heavy duty complete with front operating handle, quick-make/quick-break mechanism, cover/handle/switching mechanism interlock, factory load-side wiring.
 - .13 Size units to match evaporator coil requirements scheduled at a 35°C (95°F) condensing temperature.
 - .14 Install units on roof supports provided by the Contractor with neoprene pads (NSN) bolted on the sleepers. Power wiring to unit non-fused disconnect switch is by the Electrical Division. DDC control wiring is by Section 25 00 00. All other control wiring, including all solenoid valves and supply air fan interlock (hardwire), is by this Section.
 - .15 All equipment, including internal components, shall be 575V/3/60. Control voltage may be 24V.

2.16 HEAT RECOVERY WHEELS

- .1 Provide heat recovery wheels of sizes and capacities noted, factory installed in the air handling units. Supply and return air tunnels are side-by-side or stacked, 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 a 575V, 3-phase 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, achieved via variable frequency drive (VFD). VFD shall be same manufacturer as all other VFDs provided on this project.
- .8 Power wiring to unit non-fused disconnect switch is by Division 26. BAS control wiring, including AHU interlock, is by Section 25 00 00.

2.17 HEAT EXCHANGERS

- .1 Provide heat exchangers in accordance with the plans, schedules and manufacturer's recommendations. Design, construction, inspection and testing shall comply with the applicable Provincial Pressure Vessel Regulations. During manufacturing, the manufacturer shall perform all tests and inspections required by applicable regulations and codes to assure that material, workmanship, finish, dimensions and markings are in accordance with the specifications. Testing shall include hydrostatic testing.

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- .2 Heat exchanger manufacturer shall provide insulation package for around the unit.
 - .3 Provide drain valves for draining the units.
 - .4 Install and pipe strictly in accordance with manufacturer's instructions. Pipe size reductions to suit unit connections shall be made at unit nozzles.
 - .5 Plate Heat Exchangers:
 - .1 Construction shall consist of a carbon steel frame with one stationary cover and one movable cover. The heat transfer plates and the moveable cover shall be suspended from an upper carrying bar and guided by a lower guiding bar, which shall be attached to the stationary frame plate and the support column. Make the moveable cover and the heat transfer plates easy to move after disconnection of the tightening bolts. The design shall permit ready access to the plate pack for inspection and cleaning and shall permit removal of individual plates. Minimum thickness of plate shall be 0.5mm.
 - .2 The materials for the heat transfer plates shall be stainless steel and the gaskets shall be suitable for the given fluids and the given conditions.
 - .3 The frame parts shall be sandblasted and painted with a primer and a finishing paint.
 - .6 Shell-and-Tube Heat Exchangers:
 - .1 Except as otherwise noted or specified, shells and headers shall be cast iron or steel; tubes shall be seamless copper mechanically expanded into 304 stainless steel tube sheets with steel intermediate supports and baffles. Select units for a maximum velocity of 1.8 m/s (6 ft/s) and a 0.0005 fouling factor. Finish heat exchangers externally with one good coat of red oxide zinc chromate primer.
 - .2 Units shall have threaded connections for pipe sizes up to 50mm (2") and flanged connections for 65mm (2½") and larger sizes. In addition to flow connections, each unit shall have drain and vent/vacuum breaker connections and saddles.
 - .3 Glycol/water heat exchangers utilize glycol/water in the tubes and heating water in the shell.
 - .4 Provide a welded steel angle frame, cross-braced, for floor mounted units.

2.18 MAGNETIC FLOW METER

- .1 Provide on the heating water return main in the boiler room a magnetic flow meter station comprising a pipe mounted flowtube and a remote wall mounted transmitter. Operating temperature will be 4.5°C to 95°C (40°F to 203°F) and flow range will be 0 to 1,900 L/min (0 to 500 USgpm). Flow meter is equal to Rosemount Series 8700, distributed by Lakeside Process Controls, Mississauga, Ontario.
- .2 Flowtube is Rosemount #8705, flanged (ANSI Class150) to suit adjacent piping, constructed of non-magnetic stainless steel with a Teflon (PTFE) liner suitable for working temperatures of -29°C to 177°C (-20°F to 350°F). Sensor electrodes are 316 stainless steel equipped with an attached junction box that is NEMA 4 protected.

- .3 Transmitter is Rosemount #8732E, suitable for 120V power supply and is wall mounted in the boiler room. Transmitter is complete with local operator interface (keypad and digital display of flow), diagnostic functions including calibration verification, NEMA 4X and IP65 enclosure, 4 to 20 mA output.
- .4 Flow sensor and transmitter accuracy is $\pm 0.25\%$ of flow rate ± 1.5 mm/s for velocities up to 12 m/s (40 ft/s).
- .5 Transmitter power wiring is by Division 26. EMCS interface wiring at the transmitter is by Section 25 00 00. All other wiring is the responsibility of this Section. Obtain the services of a manufacturer's representative to test (verify) electronically that the meter is in calibration and in proper operating condition and submit a report stating same. Verification is done after completion of installation and before placement into service.

2.19 RADIANT CEILING PANELS

- .1 Provide heating water radiant panels of the type, configuration and capacity noted. Unless noted otherwise, capacities shall be based on 62.78°C/46.11°C. (145°F/115°F.) entering/leaving water temperature and 21°C (70°F) air temperature with natural convection.
- .2 Submit complete scale shop drawing layouts and complete details of all areas where radiant panels are indicated. Co-ordinate and clear all interference with other trades. Shop drawings shall indicate location of supply and return hook-ups in addition to interconnection details for each zone.
- .3 Modular Type Panels:
 - .1 Modular type panels comprise 1mm (0.04") aluminum face plate and 16mm (5/8") copper six pass serpentine coil metallurgically bonded to face plate. Panel operating weight does not exceed 7.5kg/sq.m. (1.5 lbs/sq.ft.).
 - .2 Where panels are to be installed in a suspended T-bar ceiling grid, co-ordinate metric or imperial sizing, standard or fineline grid flanges. Panels in t-bar ceilings are silkscreen finished to match adjacent acoustic tile. Panels in drywall ceilings are complete with one-piece extruded aluminum frame for recessed or surface mounting as detailed.
 - .3 Provide all interconnection of panels with 16mm (5/8") soft copper tubing.
- .4 Linear Type Panels:
 - .1 Linear type panels are extruded aluminum with 16mm (5/8") copper tubing mechanically bonded to an aluminum face plate. The copper tube is held in place by aluminum saddles which extend more than half-way around tube diameter. A non-hardening heat conductive paste is placed between copper tubing and aluminum face plate. Use of adhesives and/or clips to attach the tubing to the extrusion is not acceptable.
 - .2 Panels are complete with factory supplied 360° inter-connecting loops and 180° return U-bends. Supply water first to panel tubing pass closest to perimeter wall. Circuit multiple panels to ensure serpentine flow over complete length of zone. Individual serpentine panel coils connected in series is unacceptable for multiple panel zones.

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- .3 Panel operating weight does not exceed 10.5 kg/sq.m. (2.15 lbs/sq.ft.). Provide hanger supports at 1200mm (4 ft.) on centre or as recommended by manufacturer, whichever is less.
 - .4 All panels run continuous from wall to wall. Field trim to length ensuring adequate expansion allowance while maintaining panel end coverage by architectural mouldings. Provide filler panels where necessary.
 - .5 Panels are finished to suit manufacturer's standard powder coat - Off White. Ceiling support mouldings are provided by the Contractor. Division 23 shall co-ordinate with the Contractor to ensure that ceiling openings and wall mouldings are installed as per radiant panel shop drawings.
 - .5 Co-operate with other trades working on ceilings to achieve a neat, well co-ordinated overall installation. Follow manufacturer's installation instructions. Terminate run-out piping as detailed on drawings at panel supply/return points or within 300mm (12") of panel tube connections.
 - .6 Panel installation shall not commence until all glazing has been completed and all exterior openings closed-in. Panel installation shall be performed by personnel wearing clean white gloves to avoid soiling the panel face. On final completion clean panel faces to manufacturer's recommendations.
 - .7 Heating system piping shall be thoroughly cleaned, flushed, drained and refilled before panels are connected to the system. Pressure test each zone of interconnected panels in accordance with that specified for the heating system piping.
 - .8 Cover all active panels with minimum 50mm (2") thick foil-backed fibreglass batt insulation. Apply insulation after pressure testing. Thoroughly clean panel upper face prior to application of insulation. Insulation shall cover entire panel, no part of panel shall be exposed.

2.20 VARIABLE FREQUENCY DRIVES

- .1 Supply variable frequency drive (VFD) units to Division 26 for installation and wiring. All VFD's shall be of one manufacturer.
- .2 VFD's are CSA approved, pulse width modulated (PMW) AC design for speed control of EEMAC design high efficiency squirrel cage induction motors. The inverter section is complete with necessary devices to reduce motor noise.
- .3 Unit enclosure is heavy all steel construction.
- .4 Units are rated for the specified 3 phase, 60 Hz voltage supply and have the following features:
 - Total harmonic distortion 5%.
 - Input and output line reactors.
 - Radio frequency interference and electro-mechanical interference filters on PWM drives.
 - Under and over voltage protection, phase loss protection, and phase unbalance protection.
 - Ground fault protection.
 - Inherent short circuit protection for line to line and line to ground faults providing safe shutdown without damage to power circuit devices.
 - Instantaneous electronic over-current protection.
 - Current limit adjustable from 0-115%.
 - Min/Max speed independently adjustable (10-100%).
 - Acceleration/deceleration time independently adjustable (2-300 sec).
 - Internal over-temperature protection.

- Motor stall protection.
 - Rotating motor restart, match voltage and frequency to actual speed before accelerating to control speed signal.
 - Key pad and display for set-up, adjustment and diagnostics.
 - Door mounted H.O.A. to provide local or remote control, output contacts for remote status indication.
 - Local/remote selector for source speed reference (local control to be digital not potentiometer).
 - Door mounted status indicators: power on, drive ready, run, H.O.A., local/remote, keypad lockout on, reverse.
 - Fault indicators: under voltage, high line voltage, phase loss, bus overvoltage, overcurrent, output open, external fault, overload, ground fault, overtemperature. Fault codes are not acceptable.
 - Digital meter with selector switch to indicate: percent load and speed, output frequency, input KW, output voltage and current.
 - Output signals to Building Management System: run and fault (dry contacts), speed and load (4-20mA).
 - Input signals: stop/start, safety shutdown(freeze, smoke, etc.), speed control signal (4-20mA, 0-5 VDC, 0-10 VDC).
 - Two resonant frequency lockouts (adjustable bond width).
- .5 VFD's are complete with minimum 36 month onsite warranty which includes parts, labour, travel and living, and a 36 month warranty on the motors connected to the VFD's against insulation damage from VFD operation.
- .6 Provide complete start-up and commissioning by factory trained technicians who shall also provide training to the Owner.

2.21 ENERGY RECOVERY VENTILATORS (ERV)

- .1 Provide units of type, size and capacity scheduled on the drawings, complete with minor details not specifically mentioned or shown, but as may be reasonably inferred and necessary to complete the system and place same in satisfactory operating condition. Refer to related specification articles for requirements of individual components. Provide units complete with heat recovery heat exchangers consisting of multiple rows of finned aluminum heat pipe; supply and exhaust sections complete with dampers and exhaust fan; supply air filter section complete with access doors and other accessories as noted. Construct unit casings of heavy gauge sheet metal braced to prevent drumming, sagging, vibrating. Casings are double wall construction comprising factory painted minimum 18 gauge galvanized steel outer wall, minimum 2" (50mm) thick 4.5 lb/cu.ft. (72kg/mg³) density neoprene coated flexible duct liner fully secured to casing with fire retardant approved adhesive and mechanical fasteners, minimum 22 gauge solid galvanized steel inner liner. Provide full size piano hinged access doors with "Ventlock" latches and full perimeter gaskets in coil access for access for internal parts.
- .2 Provide heat recovery heat exchangers consisting of multiple rows of finned aluminum heat pipe, R410A or other environmentally friendly refrigerant filled for instant heat transfer. Working fluid is selected on the basis of the heat pipe operating temperature and is compatible with tube and wick materials. Cross-contamination between air streams is 0%. Air-to-air heat exchangers will not be accepted. Provisions for frost protection, supply temperature regulation and seasonal summer/winter changeover is accomplished by a factory assembled tilt package. Face-and-bypass damper control will not be accepted. Tilt package is complete with standard sub-base to distribute the unit weight

uniformly, suitable tilt control actuator, flexible connectors and pivot mechanism complete with accessible pillow block type sealed bearings and pivot shaft. Tilt actuator control is by Section 25 00 00. Co-ordinate actuator requirements with Section 25 00 00. Provide floor drains for all condensate removal. Water shall not remain in base.

- .3 Supply and install for each unit, a steel roof mounting frame mating to the bottom perimeter of the equipment. When flashed into the roof it makes a unit mounting curb and provides weatherproof duct connection and entry into the conditioned area. Equipment is capable of bottom handling of conditioned air, where shown. Side discharge units are complete with insulated weatherproof downturn sections.

2.22 ANTIMICROBIAL ULTRAVIOLET (UV) LAMP SYSTEMS (AIR SANITIZATION UNITS)

- .1 Provide units of type, size and capacity scheduled on the drawings, complete with minor details not specifically mentioned or shown, but as may be reasonably inferred and necessary to complete the system and place same in satisfactory operating condition. Refer to related specification articles for requirements of individual components.
- .2 Definitions:
- UV-C: Ultraviolet-C short-wave spectrum. UV bulbs should be pure quartz for maximum transmission of wavelength. Wave spectrum should be between 250 - 260 nm wavelength
 - UV-C Lamp System: Unit including ultraviolet lamp, power supply, housing, sensors, controller and supports.
 - UVGI: Ultraviolet germicidal irradiation.
- .3 Products: UV-C lamp systems for inline duct and AHU installation, subject to compliance with requirements, provide UV Resources Air Sniper comparable products. 99.9% effectiveness against airborne viruses, bacteria, and molds. Produces 0% ozone. Up to 5 years (43,800 hours) bulb life. Airflow sense activation. Induction lamp to be water resistant. Operating Temperature: From -13°F (-23°C) to 140°F (60°C). UV-C lamp system consisting of power supply, power supply housing, wiring, ultraviolet lamp(s), lamp plug, lamp plug protector, encapsulated lamp, lamp holder and controls. Power Factor: High power factor, Class P, Sound Rated A, Type 1 Outdoor and with inherent thermal protection and without polychlorinated biphenyl. Wiring Harness: Plug-and-play. Electrical Connection: Single electrical connection with service disconnects. Power Supply Housing: aluminum, powder coated finish, for installation inside ducts or plenums. Wiring Loom: UV-C resistant jacket materials with an internal Teflon coated protection.
- .4 Controls: Interface with DDC system for HVAC, factory-installed hardware and software (where applicable) to enable the DDC system for HVAC to monitor, control, and display status and alarms. WiFi / Ethernet connection available. UV light status indicator on front panel. Airflow sensor for lamp activation. Lamp and power supply monitoring: Factory-assembled and tested, consisting of a housing, PC board, and wire block. Construction is designed to withstand installation inside air-handling unit airstream. Operating Control: Monitor lamp and power supply combination and provide a single on/off signal to the facility DDC system. UV-C lamp system operates continuously. Interlock UV-C lamp system operation with air-handling unit and component access doors.
- .5 Installation: Install UV-C lamp systems in accordance with manufacturer's installation manual and drawings, unless otherwise indicated.

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 Support grooved piping on both sides of all couplings and both sides of elbows at directional changes. Support pipes otherwise as previously specified for threaded and flanged piping. Anchor vertical grooved piping at its base with a minimum of one intermediate clamp for every other length of pipe except on hot water risers where tee fittings are used in which case every length of pipe shall be clamped. Such clamps shall prevent the angular movement of the pipe. Provide and install sufficient clamps, anchors and guides to prevent the grooved pipe from buckling. All personnel involved in the installation of the alternate mechanically grooved piping system shall be fully conversant with the methods of pipe preparation; coupling selection; proper assembly to allow for expansion, contraction

and flexibility; the method of support, anchoring, and guiding of the grooved piping systems. The grooved piping system is specifically approved for its coupling concept. All other requirements apply to the grooved system as they do for the welded and screwed system.

- .9 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.
- .10 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.
- .11 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. The Balancing Company will be selected by the Owner.

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 will be provided by an independent Balancing Company. The cost of Work of this Section will be paid from the Cash Allowance.
- .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 Testing and balancing company shall be competent, experienced and specifically trained in the balancing of air and hydronic systems.
- .5 The testing and balancing shall be performed by any one of the following:
 - Designtest & Balance Co. Ltd. (Tel. (905) 886-6513).
 - Clark Balancing Ltd. (Tel. (905) 873-0373).
 - National Air Balance (Tel. (905) 690-9559).
- .6 Section 23 00 10 forms part of Section 23 00 30. Related work is specified in Sections 23 00 20, 23 00 40 and 25 00 00. Refer to same.
- .7 The General Contractor shall call the tender for the Testing and Balancing contractor.
- .8 The Testing and Balancing contractor shall comply with commissioning agents requirements.

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 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 For all VAV boxes and by-pass boxes record air quantity readings, as indicated above, for maximum and minimum primary air.
- .10 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

ARTICLE

DESCRIPTION

PART 1: GENERAL

1.1	Requirements
1.2	Conformance to Architectural and Structural Layouts
1.3	Ductwork

PART 2: PRODUCTS

2.1	Ductwork
2.2	Ductwork Access Panels
2.3	Dampers
2.4	Diffusers, Registers & Grilles
2.5	Fans
2.6	Air Filters, Frames and Gauges
2.7	Variable Air Volume Valves
2.8	Noise Control Devices
2.9	Dust Collector
2.10	Louvre Blank-Off Panels

PART 3: EXECUTION

3.1	Ductwork Fabrication Methods
3.2	Plenums and Casings
3.3	Anti-Stratification Devices
3.4	Air System Testing and Running-In
3.5	Air System Testing and Balancing
3.6	Fire Protection and Smoke Control

PART 1 - GENERAL

1.1 REQUIREMENT

- .1 Section 23 00 10 forms part of Section 23 00 40. 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 VAV component or first reheat coil shall be constructed to SMACNA 750 Pa (3" wg) duct construction class. All other supply air ductwork upstream of VAV components or 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 VAV components or 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. Tie rods may be used only where specified 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.
- .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 high velocity ductwork, as applicable.
- .7 All fume exhaust ductwork to the fume exhaust fans shall be stainless steel spiral duct or rectangular duct. All fittings shall be fabricated from prime quality stainless steel. All fume exhaust ducts must be sealed airtight with approved sealant for fume exhaust.
- .8 Dust collector exhaust air ductwork shall be spiral and to suit pressure rating, and as required in Section 23 00 40.2.10.

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 motor.
- .2 Access panels are maximum size possible in ducts up to and including 305mm (12 inches) in width or height. 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 in thermally insulated ducts of double panel construction with insulation as specified for adjacent ducts sandwiched between panels.

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.

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- .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 axes 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 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. Linear diffusers in countertops and cabinetry shall be supplied and installed by Division 06 (Architectural).
- .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.
- .5 Where floor grilles are used, frames and bars are heavy duty type to prevent deflection when walked upon.

2.5 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. Division 26 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.

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- 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 are belt driven. Provide variable pitch sheaves on fans with motors up to and including 7.1/2 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.
- .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 Provide disconnect switches for all fans which are out of the line of sight of their starters.
 - .6 Duct blowers mounted in ceiling spaces include internal acoustic lining and filter section where air is being recirculated to the occupied space.
 - .7 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.
 - .8 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.
 - .9 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.
 - .10 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.
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- .11 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.
 - .12 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 300mm (12 inches) high, complete with nailing strip, cant and flashing pan.
 - .13 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.
 - .14 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.
 - .15 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.
 - .16 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. Where roof mounted fans are specified with backdraft dampers, these dampers shall be low leakage heavy duty dampers. Submit shop drawings for review.

2.6 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).

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- .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%. Metal 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 magnehelic type with scale reading of zero to 125% of manufacturer's published dirty filter pressure drop.
 - .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.
 - .7 The filter list must be prepared and made available to the School Custodian.

2.7 VARIABLE AIR VOLUME VALVES

- .1 Provide, where detailed and scheduled on the drawings, single duct variable air volume control assemblies of the throttling type and by-pass type, and single duct fan-powered variable air volume control assemblies of the series or parallel flow throttling type.
- .2 Accessories such as heating coils, multi-outlet adaptors, actuators, or sound attenuators shall be as scheduled or detailed on the drawings.
- .3 All units shall be internally lined with sound insulation. Fan-powered units are also complete with internal sound baffles to minimize noise transmission out of the induced air inlet.
- .4 Single duct units with heating coil have a low leakage, internally lined, gasketted access door on the underside of unit immediately upstream of coil. Access doors have dimensions of:
 - Minimum 203mm (8") in the direction parallel to airflow.
 - Unit width less 51mm (2") in the direction perpendicular to airflow, to a maximum dimension of 457mm (18").
- .5 Primary air damper leakage shall not exceed two (2%) percent rated in accordance with Air Diffusion Council Standards.

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- .6 All primary air assemblies shall be complete with air flow sensor, pressure taps and airflow calibration chart, shall be of pressure independent type and shall be able to be reset to any air flow between zero and the maximum catalogued air quantity. Factory set each unit to quantities shown on the drawings.
 - .7 Sound data shall be included for all valve sizes as a part of shop drawing submittal. Sound data includes manufacturer's certified sound power ratings with an octave band analysis when tested in accordance with ASHRAE Standard 36B-63. With silencers or acoustically lined ductwork as shown, and a room attenuation of 8dB, the sound power level (ref: 10 to the -12 power watts) shall be such that the sound pressure in the room receiving air, and in room in which the box is located, does not exceed NC32 at an inlet static pressure of 375 Pa (1.5" WG) with noise generated by diffuser excluded. Box radiated noise level shall also meet NC32 criteria. Boxes which do not meet the required sound ratings shall be field enclosed with one pound lead sheathing over a 25mm glass fibre insulation at no additional cost to the Owner.
 - .8 Fan blower shall be steel, forward curved, completely balanced and direct driven. Motors shall be permanent split capacitor type with permanently lubricated bearings and thermal overload protection. Fan and motor assembly shall be internally isolated from unit casing. Fan air supply shall be adjustable via unit mounted solid state speed controller.
 - .9 Secure terminals to the structure using threaded rods and inserts as per the manufacturer's recommendations.
 - .10 Provide flexible connections for all fan powered terminals and ensure that there is no part of the unit that can reverberate on the structure or otherwise generate undue noise. Each unit is complete with nominal 25mm (1") thick fibreglass throw-away filter. Permanent filter rack duct collar on induced air inlet houses the filter. Filter access is through a side access door/panel. Access doors/panels are complete with seals.
 - .11 Actuators are supplied by Section 25 00 00 and installed by the box supplier (shipping at the cost of Section 25 00 00, installation at the box supplier's cost) as an integral part of the box prior to shipping to the site, including wiring of fan motors.
 - .12 Each fan-powered unit is suitable for single point power connection and is complete with a power disconnect.
 - .13 Power wiring for fan-powered units is by Division 26. All control wiring for all units is by Section 25 00 00. Co-ordinate all requirements with Section 25 00 00.

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:-

Music Rooms	25
Stage	30
Office & Classroom Areas	35
Library Area, AV Rooms, Gymnasium	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:-
- An analysis of all areas not meeting the specified performance, complete with corrective proposals.
 - 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.
 - 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 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 DUST COLLECTOR

- .1 Provide a packaged dust collector as shown. Unit is factory fabricated, assembled and tested prior to shipment. Unit includes all components for proper operation.
- .2 Provide a N.R. Murphy MRX-7A portable blow through design indoor rated dust collector, exhaust fan rated at 950 CFM at 10" S.P., 208V/3/60 voltage complete with: mild steel construction; size 7, type MR light duty material handling industrial exhauster, arrangement 4 straight radial wheel with backplate c/w 3 HP TEFC P.EFF motor, type "C" spark resistant construction; 7" dia. Inlet, & 6" dia. Outlet; solid long radius outlet elbow connecting fan outlet to filter section; 4 – 16oz polyester felt filter bag design for better filtration; dolly c/w castors for mobility; factory pre-fit and broken down for shipping (on-site assembly by the mechanical contractor).

- .3 Provide a prewired EEMAC-12 & CSA approved 208V/3/60 control panel complete with: 3 HP std exhauster starter; 120V control transformer; manual start/stop push buttons; 2 X pilot lights (system energized & fan running); 1 set of NO/NC auxiliary contacts (for machine power interlock as required by the OFC); fused door disconnect.
- .4 Division 26 will provide power wiring to exhaust fan motor. All other wiring, including interlock of equipment, is by this Section.
- .5 Provide all spiral ductwork to suit pressure rating and accessories including final connection to shop equipment. Ductwork is rigid up to individual pieces of equipment, all joint connections shall be Vanstone flanges terminating with a blast gate at 1200mm (48") above finished floor set at 25% max. closed position. All blast gates shall be full collar cast aluminum type. Provide final connections to equipment from this point using approved neoprene dust clear flexible hose.
- .6 All equipment shall be provided and installed and wired in strict accordance with manufacturer's recommendations. Provide the services of a factory trained technician to carry out a thorough check of system installation and its operation. Ensure that a representative of the installing contractor is present at this time to correct any deficiencies. Submit a complete test report to Consultant and include a copy in the Data Books.

2.10 LOUVRE BLANK-OFF PANELS

- .1 Large louvers and associated birdscreens in the Mechanical Room 247 and rooftop screening shall be provided by general trades. All other louvers by this Division. Colour of louvers provided by this Division shall have custom colour for each louver location as selected by the Architect similar to the wall finish. 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 louver. Blank-off panels shall be painted black on the outside (louver 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 to 30 degrees and on the leaving side of equipment 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 as specified in Section 23 00 10.
- .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 Design elbows and bends for rectangular ducts for easy airflow with a centre radius of not less than 1½ times the width of the duct. Where space requirements do not permit the use of specified elbows and wherever shown on the drawings use turning vanes or turning radii.
- .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. 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.
- .17 PVS fume exhaust ductwork shall have all joints sealed with #8 PVS duct sealer and taped with PVS tape or Peerless hardcast tape in accordance with the manufacturer's written installation instructions.
- .18 During the installation of PVS fume exhaust ductwork and prior to sealing joints and/or concealing, inspect for scratches of exposed edges. Paint all scratches and exposed edges, etc. with two coats of PVS touch-up paint.
- .19 Hangers for fume exhaust ductwork shall be as specified for sheet metal ductwork.
- .20 Arrange and perform testing of the fume exhaust ductwork as required by the Building Department. These tests shall include, but not be limited to, smoke tests to ensure integrity of fire rated enclosure surrounding the ductwork.

3.2 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.

3.3 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.

3.4 AIR SYSTEM TESTING AND RUNNING-IN

- .1 Start-up and run-in and test the complete heating, ventilating and air conditioning system.
- .2 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.
- .3 Provide all equipment necessary to perform the required tests. Test all air systems for leakage in accordance with SMACNA standards. All ductwork shall be pressure tested at minimum 500 Pa (2" WG). For CV systems, test all supply air ductwork from air handler to outlet ducts serving individual air terminals, including associated fire dampers and reheat coils, excluding spin-in fittings and outlet ducts serving air terminals. 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.
- .4 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.
- .5 Any components of the systems which might be damaged during tests shall be removed before the tests and reinstalled after the tests.

3.5 AIR SYSTEM TESTING AND BALANCING

- .1 This work will be provided by an independent balancing company selected by the Owner. Refer to Section 23 00 30.

3.6 FIRE PROTECTION AND SMOKE CONTROL

- .1 Provide for fire protection and smoke control as noted hereafter.

- .2 Division 26 provides smoke detectors in air handlers in accordance with NFPA 90A and wires same including the relays. This Division provides the relays for shut-down of the air handler on actuation of the corresponding smoke detector. Co-ordinate with Division 26 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 Division 26.
- .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.

END OF SECTION 23 00 40

I N D E X

ARTICLE NO. **DESCRIPTION**

PART 1: **GENERAL**

1.1 General Requirements

PART 2: **PRODUCTS**

2.1 Materials

PART 3: **EXECUTION**

3.1 The Commissioning Process
3.2 Shop Drawings and Record Drawings
3.3 Installation Inspection and Equipment Verification
3.4 Plumbing and Drainage System Testing
3.5 Testing of Piping Systems
3.6 Flushing and Cleaning of Piping Systems
3.7 Independent Contractors Testing and Balancing of Water System
3.8 Testing of Air Systems
3.9 Independent Contractors Testing and Balancing of Air Systems
3.10 Testing of Equipment and Systems
3.11 Commissioning Meetings and Reporting
3.12 Operating and Maintenance Manual
3.13 Operator Training
3.14 Commissioning Consultant
3.15 Mechanical System Demonstration and Turnover
3.16 Testing Forms
3.17 Warranties
3.18 Commissioning Process Allocation

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

I N D E X

ARTICLE NO. **DESCRIPTION**

PART 1: **GENERAL**

1.1	General Requirements
1.2	Scope
1.3	Quality Assurance
1.4	Equipment Installed by Others
1.5	Guarantee
1.6	Submittals
1.7	Maintenance
1.8	Instruction Adjustment and "As-Built" Drawings
1.9	Acceptance Procedures
1.10	EMCS Operation Summary

PART 2: **PRODUCTS**

2.1	Automatic Control Dampers
2.2	Damper Operators
2.3	Electrical Line Voltage Thermostats
2.4	Electronic Room Temperature Controllers
2.5	Control Valves
2.6	Valve Actuators
2.7	Positive Positioning Relays
2.8	High Temperature Limit Thermostats (Firestats)
2.9	Low Temperature Limit Thermostats (Freezestats)
2.10	Switches
2.11	Electronic Temperature Sensors
2.12	Electronic Humidity Sensors
2.13	Differential Pressure Sensors
2.14	Nameplates
2.15	Wiring
2.16	Panels
2.17	Control Relays
2.18	Power Conditioners
2.19	Temperature Indication
2.20	Local Override
2.21	Energy Management Control System
2.22	Direct Digital Control Processor Software
2.23	Digital Inputs
2.24	Digital Outputs
2.25	Analog Inputs
2.26	Carbon Dioxide Sensor

<u>ARTICLE NO.</u>	<u>DESCRIPTION</u>

<u>PART 3:</u>	<u>EXECUTION</u>

3.1	General
3.2	System Commissioning
3.3	Instruction Adjustment and "As-Built" Drawings
3.4	Thermostats (Room Temperature Sensors)
3.5	Sensors
3.6	Wiring
3.7	Freezestats and Low Limit Controllers
3.8	Fire Alarm and Smoke Detectors
3.9	Firestats
3.10	Manufactured Equipment
3.11	Remote Support (Software)
3.12	Heating Boilers Low Water Temperature Alarm
3.13	Controller Panels
3.14	Graphics
3.15	Control Strategies
3.16	SEQUENCES OF OPERATION I/O SUMMARY

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 Provide temperature control systems, equipment and associated operating controls, as detailed on the drawings, or as described in the specifications.
- .2 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.
- .3 System installers shall be mechanics and electricians regularly employed by the control equipment manufacturer.
- .4 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 other Sections of Mechanical Division and Division 26. 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. When referencing room numbers in the control system, DO NOT USE ROOM NUMBERS FROM DESIGN DRAWINGS. Room number designation will be issued by the Owner. Provide digital copies of all graphic screens, sequences of operation, function block graphic program, etc. as part of the operating and maintenance manual. With reference to Architectural, Mechanical and Electrical Drawings, submit a layout of the Building Operator's room showing the most practical arrangement of the EMCS front-end equipment. Show all dimensions and power requirements. Co-ordinate installation with other equipment, i.e. fire alarm and security monitoring. **All submission of documents must be in Digital Form.**
- .5 In general, unless otherwise noted, all valve and damper actuation is electronic or electric. Refer to drawings and sequences of operation in this Section for exact requirements.
- .6 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 complete. Energy Management Control System shall be supplied and installed by Schneider Electric (J.B.S. Services Inc., 905-453-8297). Alternate supplier is Johnson Controls Ltd. (Branch Office only, 3070 Mainway Road, 1-800-263-6226) with NAE or later version. No other suppliers are acceptable. General Contractors shall name the Control supplier at the time of tender. Work of this Section shall be under the contract of the General Contractor and not the Mechanical Contractor.
- .3 If an alternate system is selected, all thermostats, sensors, actuators, valves, Direct Digital Controls, etc. shall be manufactured by one company. Hybrid systems using components manufactured by different companies are not acceptable.
- .4 The system for the new school shall be connected via the Board's wide area network to existing central DDC system and monitored by the existing main system. All system functions including displays, programs and graphics shall be accessible from any personal computer on the Board's network with web browser software. The control contractor shall demonstrate to the consultant the ability to access programming and graphics remotely from a location as chosen by the Consultant.
- .5 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.
- .6 The Network Cabling Installer shall bring network connection(s) to the Energy Management Control System's supervisory panel and Operators Terminal.

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.
 - Automatic Control Dampers (except OA, EA and RA dampers on air handling units).
 - Temperature Sensing Wells.
 - Pipe System Flow and Pressure Station Fittings.
 - Power wiring for all electric motors and starters will be Division 26.
 - Electromagnetic starters with the required number of ancillary contactors supplied and installed by applicable Division 26.
 - Installation of control dampers shall be by the Sheet Metal sub-contractor.
 - Bidders to note that some air handling equipment may have factory-supplied motor-operated dampers. Refer to Section 23 00 20 and Mechanical Equipment Schedules. Coordinate with Equipment Suppliers to Section 23 00 20.

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 one year of normal use and service from the date of certified acceptance by the Owner.
- .2 Emergency repair service on a twenty-four (24) hour basis during warranty period.

- .3 Replacing defective parts and components as required.
- .4 Provide emergency maintenance and service, responding within four (4) hours notice given by the Board to attend to malfunctions relating to the controller and all field equipment such as valves, wiring, etc.

1.6 SUBMITTALS

- .1 Submit ten (10) copies of control working drawings and wiring diagrams with written sequences of operation and components description.
- .2 Submit catalogue cuts and specifications on all EMCS equipment, i.e. Network Controller, Local Control Module, PC etc.
- .3 Submit DDC data by systems, i.e. S1 air handling unit, whereby schematics, panel terminal wiring, sequences of operation, hardware and component lists are grouped together without requiring cross reference to other areas of the submittal.
- .4 With reference to Architectural, Mechanical and Electrical Drawings submit a layout of the Building Operator's room showing the most practical arrangement of the EMCS front-end equipment. Show all dimensions and power requirements. Coordinate installation with other equipment, i.e. fire alarm and security monitoring.

1.7 MAINTENANCE

- .1 Service technicians particularly trained to work on the systems installed shall handle system servicing and maintenance.
- .2 Provide emergency maintenance and service, responding within four hours notice given by the Board to attend to malfunctions relating to the controller and all field equipment such as valves, wiring, etc.

1.8 INSTRUCTION ADJUSTMENT AND "AS-BUILT" DRAWINGS

- .1 On completion of the Work, calibrate and adjust all components to operate as required. Provide three complete instruction manuals with "as construction" control drawings and instruct the Board's operating personnel in the operation and function of the system.
- .2 All as-built submittal information to be submitted in acceptable electronic format.
- .3 Maintenance manuals describing maintenance on all system components including inspection, preventative maintenance, fault detection, and repair or replacement procedures.
- .4 All data specified in the "Submittals" section of this specification in its final as-built approval form.
- .5 As-built interconnection wiring diagrams or wire list, of the complete field-installed system with proper identification and ordering number of each system component and device.
- .6 As-built single line diagrams for each floor level showing building outline, corridors, approximate

room layout, etc. with location of central processor and remote controllers.

- .7 Provide point to point commissioning sheets including the date commissioned and initials of technician performing the work.
- .8 Provide a minimum of eight (8) hours (2-4 hour days) instruction on EMCS operation to Board's staff and 2 call-back sessions of 2 hours each during the first year of operation if required. This training to apply to schools with DDC components only.

1.9 ACCEPTANCE PROCEDURE

- .1 Acceptance by the Consultant will be granted when all components are installed, operating and calibrated.
- .2 Prior to on-line operation, a complete demonstration and readout of computer real time responsibilities of surveillance and command shall be performed in the presence of the Board's authorized maintenance representative and the Board's representative.
- .3 Upon successful completion of on-line operation, Board's authorized representative shall be requested in writing to inspect and approve satisfactory operation of building automation system.
- .4 Complete all outstanding deficiencies as determined by the Board's representative in his inspection report after which a resubmission of formal acceptance shall be made. This procedure shall be repeated if necessary until acceptable performance has been established.

1.10 EMCS OPERATION SUMMARY (POINT LIST)

- .1 The EMCS Operation Summary is a supplement to the drawings and the written sequences of operation. It is intended as a guide and clarification of requirements.
- .2 It is not a complete I/O summary since it only describes requirements for each type of system and unit component. The quantities of systems and components will be shown on the drawings.
- .3 It is the responsibility of this Contractor to determine quantities of input/output points, sensors, devices, wiring, etc.

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 electronic/electric 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.

2.3 ELECTRICAL LINE VOLTAGE THERMOSTATS

- .1 Provide heavy duty type. Include backplate and bracket for mounting on standard size outlet box where required. Provide protective guards over stats in the following locations: stage rooms and mechanical rooms.
- .2 Provide heating/cooling type thermostat with deadband where sequencing of heating and cooling/ventilation is required.

2.4 ELECTRONIC ROOM TEMPERATURE CONTROLLERS

- .1 Electronic room temperature controllers with accessible limited adjustment range less thermometers. From each space, the occupant is to have the ability to adjust to $\pm 5^{\circ}\text{C}$ over or under setpoint. Provide protective guards over stats in the following locations: General purpose room, storage rooms, halls, washrooms and mechanical rooms.

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 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, normally open, spring return, properly sized and selected by the manufacturer in accordance with load requirements and characteristics of the systems to which they are applied. Do not provide, under any conditions, valves smaller than 20mm (3/4").
- .4 All valves shall be modulating, fully proportional and shall spring return to normal position on control system failure (i.e. rad valves full open, coil valves open to coil, see schematics). Drive open-drive close operation is not acceptable.
- .5 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.

- .6 Use positive positioning relays on valves that are sequenced with other actuators or where necessary for high shut-off rating.
- .7 Unless specifically mentioned otherwise, the design flow pressure drop shall be as follows:-
 - 3-way valves 20 kPa (3 psi)
 - 2-way valves 7 kPa (1 psi)

2.6 VALVE ACTUATORS

- .1 Control valves shall be provided with electronic/electric 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.

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:-
 - 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.)
 - 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 low temperature limit thermostats complete with 6.1 meters (20 ft.) of sensing capillary sensitive to 406 millimetres with manual reset. Provide one limit thermostat for approximately every 6 square meters (60 sq. ft.) of duct area.
- .2 Each freezestat shall be complete with two contacts. One contact is hardwired to fan starter, and the second for BAS interface.

2.10 SWITCHES

- .1 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.
- .2 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 must be CSA approved.
- .3 Install minimum positioning switches inside local cabinets and lock switches after system balancing.
- .4 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 platinum, 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 1000 ohm platinum 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 1000 ohm platinum RTD type temperature detectors. All space sensors are provided with vented protective covers, local temperature adjustment of +/-2°F from setpoint, 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 1000 ohm platinum RTD type temperature detectors. Each sensor shall be 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 1000 ohm platinum RTD type temperature detector. The RTD sensor is mounted in a weatherproof enclosure on a north-facing wall, complete with sun shield where required. 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.
- .8 For space temperature sensors in change rooms (and other high vandalism areas), provide an RTD type sensor in a recessed junction box fixed to a stainless steel wall plate cover with thermal paste.

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 lamicoid 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.

2.15 WIRING

- .1 Electrical wiring incidental to the control system conforms to Division 26 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.
- .2 Plenum cable may be used for 24V and less in accessible areas only, provided that said cable meets Code requirements for flame-spread rating and smoke developed classification. Use conduits in equipment rooms and non-accessible areas. Cable outer jacket shall be as per Board's Standards, use orange color for the jacket. The PDSB standard for BAS cabling is Plenum Shield

Cable, rated FT6. PR 18/7B SH.

- .3 Sensor wire for each analog input is colour coded #18 AWG twisted-shielded cable.
- .4 Control conductors are numbered with Brady or equal Z type markers at both the control and equipment ends. Labels shall be visible without removing through covers.

2.16 PANELS

- .1 Control panels are fully enclosed cabinets with minimum 16 gauge all steel construction. Cabinets have hinged door with locking latch. All cabinet locks are common keyed finished with two coats of enamel paint.
- .2 Panels are wall mounted or free standing.
- .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 USB drives storage devices.

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 SCU. Contacts are rated at 5A at 120 VAC.
- .3 Relays shall be Allen Bradley 700HF32A24-1-4 or equivalent (Eleco also acceptable).

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 TEMPERATURE INDICATION

- .1 Provide local temperature indication on all air handling systems supplying heating and/or cooling, mixed or 100% outdoor air as follows:
 - Supply air
 - Return air
 - Mixed air
 - Outdoor air
- .2 Provide above indication and outdoor air temperature indication on one air handling system per fan room and at Global Control Module (GCM) in Custodian's Room.
- .3 Provide, on each air handling system, 75mm (3") diameter direct reading dial type thermometers

with 1.8m (6') capillary. Locate thermometers so they can be viewed easily.

.4 Accuracy: $\pm 1\%$ at centre of scale.

.5 Required ranges ($^{\circ}\text{C}$):

- Outdoor air	-40 to 60
- Mixed air	-40 to 60
- Supply air	0 to 115
- Return air	-40 to 60

.6 In lieu of direct reading dial type thermometers provide permanent integral LCD keypad and display with above indications of each fan system per mechanical room.

2.20 LOCAL OVERRIDE

.1 Wall mounted override 'pushbutton' switch, red in colour, in the Custodian Room.

.2 Switch to incorporate momentary contact feature so that when button is pushed momentarily, contact is made, and then the switch resets when released.

.3 Provide lamacoid label over switch saying "EMCS Manual Override".

2.21 ENERGY MANAGEMENT CONTROL SYSTEM

.1 Provide a Direct Digital EMCS which can, without additional equipment and software, perform all the automatic temperature control and energy management functions as specified and shown on the drawings and to include, but not be limited to the following:

.1 Fully integrated modular direct digital control and installed as a complete package, including all software, hardware, operator input/output devices, filed processing units, sensors, and controls, wiring, relays, engineering, installation, supervision, and labour, calibration, software programming, and checkout necessary for a complete and fully operational DDC system. Refer to sequences of operation in this section for operational requirements.

.2 The system for the new school shall be connected via modem and wide area network to existing central DDC system and monitored by the existing main system. New DDC controllers shall be single or multiple. Controller failures will not cause loss of communication. All displays, programs and graphics to be accessible from direct connection in custodian's office or another location as directed at site and Peel District School Board location at the Maintenance Facility (two workstations).

.3 System Expansion:

.1 To facilitate large single facility expansion or to support large Wide Area Networks (WAN's) such as employed in large school systems, the Global Control Modules (GCM's) shall directly support a minimum of 4 logical networks using the same physical network (Ethernet or Echelon). Each logical network shall support up to 128 Local Control Modules. Future expansion shall be provided without requirements of upgrading existing system. The new system must be fully

backward compatible with existing system.

.4 Local Control Modules:

- .1 Microprocessor-based with all hardware and software to provide stand-alone operation and communication with other field processing units and each LCM containing plug-in type facility for a portable alpha-numeric keypad with LCD display. Each LCM to be 16-bit configured in a true distributed manner where input/output processing and operator command processing can be off-loaded from a front-end terminal.
- .2 To prevent single failure catastrophe, provide multiple field processing units. Failure of any single LCM is to have no effect on any other LCM.
- .3 Mounted and wired in a steel enclosure complete with all relays, digital to analog converters and terminal strips.
- .4 Capable of 8 universal inputs (digital or analog in any mix), 4 true analog outputs, 8 digital outputs and totalizers for pulse inputs where required.
- .5 Operate to provide any of the following modes:
 - Two-position
 - Proportional (P)
 - Proportional plus integral (PI)
 - Proportional, integral plus Derivative (PID)
- .6 Operate within the following limits:
 - Temperature -40°C to 60°C
 - Humidity 0 to 95% RM (non-condensing)
 - Voltage 24 VAC +10% to -15%, 50 or 60 HZ
 - Storage conditions:
 - Temperature -40°C to 60°C
 - Humidity 0 to 95% RM (non-condensing)
- .7 Utilize 64K bytes EPROM, 2K bytes EPROM memory with DDC algorithms and parameters RAM based for ready access for modification and adjustment. Provide copy of same data file in EPROM. Provide 8K bytes RAM memory with a minimum of 30 days battery backup for clock/RAM. All programmed information and clock operation to be maintained during battery backup period. If battery backup time exceeded, program shall not be affected. Clock shall automatically synchronize with master clock upon restoration of power.
- .8 Clock Operation:
 - Automatically synchronized throughout the system or one front-end clock for entire system. Calendar to have yearly memory with leap year capability.
- .9 Controller Software:
 - A complete menu driven operating system, standard energy management application packages, standard control algorithm application packages, and an Owner/user custom control and calculation application package

complete with interpreter and complete use documentation modules.

.10 Operating system software:

- EEPROM resident and operate independently of any central computer to control communications between operator's terminal, controllers and I/O modules, and provide control application packages, interface a variety of sensor and actuator types and contain built-in diagnostic routines. Software to allow for scaling and calibrating of sensor lead length variations to ensure display accuracy's of analog sensors.

.11 Memory error checking:

- Upon detection of memory error, correct the error or halt to prevent erroneous operation.

.5 I/O Module:

.1 Capable of directing interface to a variety of industry standard sensors and input/output devices such as:

- Analog inputs: 4-20MA; 0-10VDC; thermistors RTD, Balco RTD.
- Digital inputs: Dry contact closure; pulse accumulator.
- Analog outputs: 4-20MA; 0-16VDC.
- Digital outputs: 120VA, 120 Volt Form C (SPDT) isolated contacts with light emitting diode indication.

.6 Power Failure, System Re-start, System Start-up:

- .1 Provide, under any condition, automatic sequential restart of equipment based on current program time and program requirement without operator intervention. Refer to System Operation Summary at the end of this section for start-up priority.

.7 Transmission Network:

- .1 To operate via a single pair of twisted wires utilizing industry standard RS-485 protocol, electrically isolated from local control modules, operator's terminal and CPU by optical couplers at each interface to prevent damage to electronic circuitry by voltages beyond tolerable limits.
- .2 All local control modules to be coupled to bus to ensure that single or multiple LCM failures will not cause loss of communication.
- .3 To support 128 devices minimum.
- .4 To support true peer protocol allowing sensor sharing, inter-LCM event program sharing and global application program sharing, without need of a host computer.
- .5 Received data to be positively or negatively acknowledged. Negative acknowledgement to immediately force retransmissions.
- .6 To provide alarm on non-communication by any LCM.
- .7 All data streams to be automatically checked for errors.

- .8 Error recovery and communication initialization routings to be resident in each bus connected device.
- .9 Provide software counters for; cold starts, warm starts, privilege violation, illegal instructions, address and bus errors, and zero divide errors as a diagnostic tool. Error types to be operator accessible. A log of these errors shall be stored in the GCM.
- .8 System Interface (Front-end equipment):
 - .1 Display Monitor: Provide personal desktop computer with minimum specifications to include Pentium processor operating at current industry MHZ, 17" monitor, keyboard, mouse and CD Rom. Processor class and speed to meet Board's standard. Provide operating system software with terminal emulation software to Board's standard.
 - .2 Cabling: Provide all required connectors and cables for complete connection of all Host and Local Command Device Connections to peripherals. Shielded cabling with thumbscrew security connections.
- .9 Remote Support
 - .1 The supervisory controller will communicate over the Board's WAN to an existing EMS server. New points to be fully defined within the server database in keeping with the Board's naming convention. All site information will be accessible from any personal computer on the Board's WAN with the current versions of Internet Explorer software. The Client/Server software will operate over the Peel District Board's wide area network (WAN).
 - .2 Provide as a minimum, one unique dynamic colour graphic installed in central computer for each of the systems.
- .10 Alarms:
 - .1 Whenever a field point status exceeds preset limits or there are other indications of system exceptions, alarms, error or failures, a log shall be kept of the 64 most recent such exceptions in the GCM.

2.22 DIRECT DIGITAL CONTROL PROCESSOR SOFTWARE

- .1 Local control modules must operate totally standalone and independent of a central computer for all specified control applications. Include a complete operating system (O.S.), communications handler, point processing, energy management application packages as specified, standard control algorithms and specific control sequences (DDC), and a Board/user customer control and calculation package complete with interpreter.
- .2 Input/Output Point Processing Software:
 - .1 Perform continuous update of input and output values and conditions. Update all connected points at a minimum of one-second intervals.

- .2 Perform Analog to Digital conversion, scaling and offset, correction of sensor non-linearity, sensing no response or failed sensors, and conversion of values to 16 bit floating point format. Values sensed for each analog input to be retained in memory.
 - .3 Perform responsibility check on all analog inputs against previously read value; discard values falling Outside preprogrammed reasonability limits.
 - .4 Assign proper engineering units and status condition identifiers to all analog and digital inputs and outputs.
 - .5 Perform Analog input alarm comparison with ability to assign two individual sets of high and low limits (warning and actual alarm) to input or to assign a set of floating limits (alarm follows a reset schedule or DDC control point) to the input. Alarm to have unique differentials to prevent a point from oscillating into and out of alarm. Record such alarms in the GCM.
 - .6 Perform debounce of digital inputs to prevent nuisance alarms. Debounce timing to be adjustable from two seconds to two minutes in one-second increments.
- .3 Command Control Software:
- .1 Prevent simultaneous energizing of loads by using command delays. Delays must be programmable from 0 to 30 seconds.
 - .2 Commands to have command and residual priority to manage contentions create by multiple programs having access to same command point. Only commands with higher command priority will execute; their assigned residual priority to replace existing residual priority.
 - .3 A 'fixed mode' option will set inputs to, and outputs from, 'fixed mode' inputs and output will have a high residual command priority to prevent override by application programs.
 - .4 Maintain a last user record in the GCM to positively identify which program or manual command is in control of a given point.
 - .5 Provide alarm lockout software in the GCM to prevent nuisance alarms. A 'timed lockout' period will allow analog points to reach a stable condition before activating alarm comparison logic. Lockout period to be programmable on a per point basis from 0 to 90 minutes in one minute increments.
 - .6 Accumulate Run Time based on status of a digital input point in the GCM. Totalize either on time or off Time up to 30,000 hours with one-minute resolution.
 - .7 Count number of times a device has been cycled on or off in the GCM. Counter is to be non-volatile and be capable of accumulating 30,000 switching cycles. Assign limits to counts to provide maintenance alarm printouts.
 - .8 Provide custom DDC programs to meet control strategies called for in the sequence of operation sections Of these specifications. A full library of DDC algorithms, logic and relational operators for implementation of control sequences will be in each LCM.

- .9 All programs must be capable of being field changeable for owners' technician. Canned or preset programs are not permitted.
 - .10 Make DDC setpoints, gains and time constants associated with DDC programs available to the operator for display and modification via the global control module or portable operators terminal.
 - .11 The execution interval of each DDC loop to be adjustable from 2 to 120 seconds in one second increments.
 - .12 Include initialization values to all outputs to ensure that controlled devices assume a fail safe position on initial system start up.
- .4 Provide time and event programming (TEP) capability, which will initiate a controlled sequence of events for execution at a specific time or upon the occurrence of an event. Program features required as a minimum are:
- .1 Analog points to be commandable to a specific value.
 - .2 Digital points commandable to a specific state; i.e., on or off; fast, slow or off.
 - .3 Initiator to be specific day and time or a specific event; i.e., either analog or digital alarm occurrence.
 - .4 Manual initiation via operator's command.
 - .5 Commands must honour command delays and assigned minimum ON and OFF times.
 - .6 Commands must honour command and residual priority structures allowing higher priority commands (like smoke control) to override lower priority commands (like HVAC equipment cycling).
 - .7 Ability to chain time and event programs.
 - .8 Ability to enable and disable time and event programs individually.
 - .9 Ability to enable/disable TEP initiators.
- .5 Energy Management:
- .1 Application programs and associated data files to be non-volatile with 30 day battery backed up RAM memory. Individual programs must be accessed from the global control module or portable operator's terminal for enabling/disabling and program parameter modifications.
- .6 Time Programs:
- .1 Provide independent start and stop program time for each system identified in the System Operation Summary.
 - .2 Assign up to four independent start and stop times per day to any equipment connected to a controller.
-

.7 Exception Day Scheduling:

- .1 Provide an Exception Day program to accommodate Holiday and other planned exceptions to normal time programs. Exception schedules must be programmable up to one year in advance.
- .2 Allow definition of up to 32-exception time spans. Each span to be defined as to calendar start day and calendar stop day.
- .3 Exception Day Scheduling to apply to all time scheduled energy management programs like Optimum Start and Stop.
- .4 Provide a temporary scheduler to allow the operator to modify present time program control of equipment. Minimum features required are:
 - .1 Ability to alter time schedule changes as much as six days in advance. Ability to alter either start time, stop time or both for each day.
 - .2 Temporary schedule to be in effect for all days specified.
 - .3 Automatically delete the temporary schedule and restore program to normal schedule after execution.
 - .4 Ability to alter stop time for the current day.
 - .5 Ability to assign schedule changes as permanent as well as temporary.

.8 Optimum Start, Night Cycling and Night Purge (For Free Cooling):

- .1 To be integrated into a single coordinated software package. Each air handler is to be assigned an independent Unoccupied Period program which may include one or more of the following:
 - .1 Optimum Start Program to delay equipment startup based on outdoor temperature, space temperature, and system response to ensure comfort conditions are reached exactly at scheduled occupancy time. The program is to operate in both heating and cooling cycles. An adaptive algorithm is to be employed which automatically adjusts the program according to the previous day's actual start time and whether comfort conditions were reached prior to or after scheduled occupancy time. The program to automatically assign longer lead times for weekend and holiday shutdowns. Space temperature input is to be selectable from a representative room. Assign occupancy start times on a per air handler unit basis.
 - .2 Night Purge program to apply to cooling cycle only. Test both outdoor and space conditions to determine if a purge cycle is beneficial. Introduce 100% outdoor air anytime the following conditions are met:
 - Outdoor air is above 10°C.
 - Space temperature is above 24°C.
 - Outdoor air temperature is below space temperature.

- .3 Stop purging when one or more of the following conditions are met:
 - Outdoor air is below 10°C.
 - Space temperature is below 24°C.
 - Outdoor temperature is less than 3°C cooler than space temperature.
- .4 Space temperature input is to an average of zones served. Where multiple space sensors are used average, highest) invalid or erroneous inputs are to be ignored and only reasonable values from other sensors used for calculations.

.9 Optimum Stop Program:

- .1 Applicable to any primary or secondary system which supplies heating or cooling medium to the space (air handlers or water systems). Employ an adaptive algorithm to automatically accelerate the stop time as much as one hour based on external load conditions and the rate of temperature change of the occupied space with the energy source off (Drift Rate). Independent Drift Rate - calculations are required for heating and cooling. Calculate drift rate for heating on the basis of the zone having the greatest heating load while cooling Drift Rate is to be calculated on the basis of the zone having the greatest cooling load.
- .2 Provide an economizer program which will automatically select outdoor air, or return air, or mix of both; that presents the least total heat load to the cooling coil. Use measurement of outside air drybulb and return air drybulb to determine heat content. Calculation of heat content for each source is to be made and compared to determine if minimum outdoor air is to be used or a mix of outdoor and return air.

2.23 DIGITAL INPUTS

- .1 Wire to the digital input points specified on the input-output summary or shown on the Control Drawings. The remote device shall have one (1) set of dry contacts to provide the input signal. Provide all remote devices unless otherwise specified.

2.24 DIGITAL OUTPUTS

- .1 Each digital output from an ASC shall be provided with a relay with 24 volt rated contacts. These contacts shall be wired to the controlled device, such as the holding coil of a magnetic starter. Refer to the input/output summary and Control Drawings.

2.25 ANALOG INPUTS

- .1 Status on air handlers, main heating pumps, and exhaust fans over 1/3 HP to be provided via current metering relays with 4-20 MA output.

2.26 CARBON DIOXIDE SENSOR

- .1 Provide carbon dioxide (CO2) sensors with suitable duct mounting kits as required where shown, or specified in the Sequence 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.
- .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 Division 26.
- .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 26 of these Specifications, and in accordance with applicable sections of the current edition of the applicable local codes for signalling 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.
- .6 Mount all controllers and relays within control panel cubicles. Mount exposed components for easy access and protect from damage.
- .7 Identify all exposed components and equipment mounted on the control panel front with lamacoid nameplates. Identify instruments inside the cabinet with lamacoid nameplates. Co-operate with piping and ventilation subtrades in providing lists of all automatically operated equipment.
- .8 Locate all local control panels as shown on the drawings or as directed by the Consultant.

3.2 SYSTEM COMMISSIONING

- .1 Refer to the "System Commissioning" Article in Section 23 00 10.
- .2 Upon completion of the system this Section shall request, in writing, to the Owner that the commissioning procedure can commence.
- .3 The procedure is conducted with the Owner present and consists of:-
 - .1 Prior to on-line operation, a complete demonstration and read-out of computer real time responsibilities of surveillance and command shall be performed in presence of the Board's authorized maintenance representative and the Board's representative.
 - .2 Upon successful completion of on-line operation, Board's authorized representative shall be requested in writing to inspect and approve satisfactory operation of building automation system.

- .4 Complete all outstanding deficiencies as determined by the Board's representative in his inspection report after which a resubmission of formal acceptance shall be made. This procedure shall be repeated if necessary until acceptable performance has been established.

3.3 INSTRUCTION ADJUSTMENT AND "AS BUILT" DRAWINGS

- .1 On completion of the work calibrate and adjust all components to operate as required. Provide three digital copies of the complete instruction manuals with "as constructed" control drawings and instruct the Board's operating personnel in the operation and function of the system.
- .2 Provide three (3) digital copies of the complete sets of system documentation at time of completion.
- .3 Maintenance manuals describing maintenance on all system components including inspection, preventative maintenance, fault detection, and repair or replacement procedures.
- .4 All data specified in this Section of the specification in its final As-Built approved form.
- .5 As-Built interconnection wiring diagrams, or wire list, of the complete field-installed system with proper identification and ordering number of each system component and device.
- .6 As-Built single line diagrams for each floor level showing building outline, corridors, approximate room layout, etc. with location of central processor.
- .7 All final close-out documentations must be provided in "Digital Format" to include but not limited to the above.
- .8 Provide a minimum of twelve (12) hours (3-4 hour days) instruction on EMCS operation to Board's staff and 4 call-back sessions of 2 hours each during the first year of operation if required. This training to apply to schools with DDC components only.
- .9 Provide necessary software to the Board and required training in order that the Board's controls technicians will be able to make any necessary changes to the previously provided programs.

3.4 THERMOSTATS (ROOM TEMPERATURE SENSORS)

- .1 Mounting Heights:
- | | |
|----------------------------|-------------|
| - Office Areas | 1.68 meters |
| - Service Areas | 2.5 meters |
| - Classrooms and Corridors | 1.68 meters |
| - Vestibules | 2.5 meters |
- .2 Provide all thermostats in General Purpose Room, Public and Service Areas with locking cover guards. 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.

3.5 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.
- .8 All sensors in hallways, gymnasiums, change rooms and outside must have protective locking covers. Metal enclosures only, no plastic with vents for air flow.

3.6 WIRING

- .1 Install all wiring in conduit and conform to C.S.A., ULC and local Code requirements as well as requirements as specified in Division 26 and Board's requirements if applicable.
- .2 Extend wiring and provide all ancillaries from 15 amp/120 volt separately fused circuits provided by Division 26. Where none are provided this Division shall arrange (and pay) for Division 26 to extend a suitable service.

3.7 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.

3.8 FIRE ALARM , SMOKE DETECTORS , MOTORIZED SMOKE DAMPERS AND COMBINATION FIRE/SMOKE DAMPERS

- .1 As applicable and required by local Codes, Division 26 will wire the smoke detectors, motorized smoke dampers and combination fire/smoke dampers into the fire alarm system.

- .2 Mechanical Division shall arrange the motor starter control circuits wiring to allow the fire alarm system to shut down the fans and air handling systems.
- .3 Division 26 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.
- .4 Division 26 will provide 120 VAC power to all the motorized smoke dampers and combination fire/smoke dampers.

3.9 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.

3.10 MANUFACTURED EQUIPMENT

- .1 Coordinate with manufacturers and provide all required wiring and components as required to achieve sequences of operation.
- .2 Install the entire DDC system under supervision of factory-trained engineers fully capable of providing instruction, routine maintenance, programming, and emergency maintenance service on all system components.
- .3 At any time during commissioning procedures and during the training period, make at no extra cost, any program changes required to enable optimum system operation.
- .4 Provide 'status' confirmation by using auxiliary starter contacts. Use load side activated relays for single-phase motors except where otherwise indicated.
- .5 For start/stop operation wire only to starter 'Auto' circuit. Failure to stop or start to register as an alarm.
- .6 Provide a minimum of 2 spare inputs and 2 spare output points on each DDC controller (LCM).
- .7 Where motor operation is specified to provide enable/disable, permissive or sequential operation, use DDC software wherever possible or provide hardwire interlocks.

3.11 REMOTE SUPPORT (SOFTWARE)

- .1 Software and any necessary hardware including personal computers shall be provided and located at the Peel District School Board's Maintenance Facility (two workstations). This software shall have upload/download capabilities and the display shall use dynamic colour graphics with a Client/Server configuration at both locations noted above. This Client/Server software will operate over the Peel District School Board's Wide Area Network (WAN).
- .2 Provide as a minimum, one unique dynamic colour graphic installed in the central computer for

each of the systems and miscellaneous components with current versions of internet explorer software.

- .3 The system shall be capable of permitting programming, logging, status reporting, diagnostics and alarm reporting and all functions of a host computer over the School Board's Wide Area Network (WAN).
- .4 Provide a high speed Network Interface Module (NIM) to support both Local Area Network (LAN) controllers within the school and the Peel District School Board Wide Area Network (WAN). The LAN and WAN networks shall employ CSMA/CS contention type protocol that adheres to the industry standard format IEEE802.3. The content of messages shall be the manufacturer's standard available from third party vendors that utilize the same chip implementation as used by the manufacturer. In addition Ethernet NIM shall be fully Internet Protocol compliant allowing connection to currently installed IEEE802.3 compliant Ethernet Networks. The NIM shall utilize Ethernet 10BaseT (Twisted-Pair RJ-485 terminated UTO cabling) or 10Base2 (ThinNet RG-58 A/U Coaxial cabling with BNC connectors). The NIM shall directly support a minimum of 4 logical networks using the same physical network. Each logical network shall support up to 30 Global Control Modules (GCM).

3.12 HEATING BOILERS LOW WATER TEMPERATURE ALARM

- .1 Provide a digital output point to activate security system remote dialer. Output point shall be closed during normal operation and open if perimeter radiation return water temperature drops below 21°C, (70°F). Contact is to reset when temperature rises above 26°C, (78°F).
- .2 Provide wiring from EMCS to Security Panel. When circuit is open, activate remote dialer. Wiring to remote dialer by Division 26.

3.13 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 shall not be located in hallways, offices, classrooms or any other areas normally accessible to the public.
- .2 Ensure that all panels are mounted so as to provide ready access for servicing purposes.

3.14 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 percentage of fresh air for ventilation systems, as well as fan status. All status displays shall indicate "true status" achieved by wiring through current sensing/metering devices at equipment starters. Status signals to be AI for air handling systems (supply and return air fans) and pumps, and DI for all other equipment. 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.

3.15 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.

3.16 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 Division 26.
- .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 |
| 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 |
| Σ | - | Sum Of |
| * | - | Multiplied By |
| RH | - | Relative Humidity |
| GLS | - | Glycol Supply |
| GLR | - | Glycol Return |

- .3 Unless otherwise noted, the following are temperature setpoints for conditioned spaces:

.1	"Occupied" Heating	21.1°C	70.0°F
.2	"Unoccupied" Heating	17.0°C	62.6°F
.3	"Occupied" Cooling	23.9°C	75.0°F
.4	"Unoccupied" Cooling	27.0°C	80.6°F

2. HEATING PLANT

- .1 Applicable Equipment: Boilers B1 and B2; system heating water pumps P1 and P2; glycol heating pumps P3 and P4; heat exchanger, glycol feed systems, magnetic flow meter and control valves V-1 and V-2. Refer to Heating System Flow Diagrams on Drawing #M-6. Division 26 will provide a 120 VAC power source for controls in equipment rooms. Provide transformation.
- .2 System heating water pumps are enabled/disabled from the EMCS from an operator defined seasonal time schedule and ambient temperature and the following sequence. Upon enabling, pump (P1 or P2 as defined by the operator) starts, the boilers isolation valves V-1 & V-2 shall open and its status initiates an operator adjustable software timer. Timer expires, status from operating system heating water pump (P1 or P2) starts glycol heating pump (P3 or P4 as defined by the operator). Failure of any operating pump automatically starts associated stand-by pump and the condition is alarmed on the EMCS. Means of alternating pumps for even wear shall be provided.
- .3 Plant Disabled: All equipment Off. When outdoor temperature is greater than or equal to 12°C (53.6°F), boilers and heating pumps are disabled.
- .4 Plant Enabled: each of the two boilers shall run subject to its own internal safeties and controls. The lead boiler shall be switched automatically based on equal runtime. On a call for heating, the lead boiler associated automatic shut-off valve (V-1 or V-2) shall open, then the circulating pump (P-1 or P-2 as defined by the operator) shall be enabled. Once the circulating pump status has been received by the BAS, the boiler's demand signal will be modulated to satisfy the calculated primary hot water supply temperature. After the boiler is off, the associated automatic shut-off valve shall be closed after 30 minutes (adjustable). If the lead boiler cannot keep up with demand, second boiler is enabled. Each boiler burner modules are independently staged and modulated to maintain an operator defined common heating water temperature setpoint. Setpoint is scheduled according to ambient temperature and is operator adjustable. Maximum design temperature is 62.78°C (145°F).
- .5 When outdoor temperature is less than 12°C, and greater than or equal to 5°C, heating pumps will start and one boiler will be enabled when one room temperature sensor calls for heating. Heating pumps will remain on and boilers will remain enabled until all room temperature sensors have been satisfied.
- .6 When outdoor temperature is less than 5°C, and greater than or equal to minus 7°C, heating pumps will operate continuously and one boiler will be enabled. When outdoor air temperature is less than -7°C, heating pumps run continuously and both boilers are enabled.
- .7 On demand for heat in boiler supply line as sensed by common hot water temperature sensor, the lead boiler will be enabled. If the required boiler supply line temperature is not reached after 10 minutes of operation, then enable lag boiler operation. When boiler supply line temperature is satisfied, the heating pump (P1 or P2 as defined by the operator) continues to operate during

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- shutdown sequence (low fire operation) and for 1 minute after boiler stops operating (unless outdoor temperature is such that pump is running continuously, then do not stop the pump).
- .8 Differential pressure sensor to be installed on longest run to provide input to P-1 and P-2 to maintain via VFD's preset constant pressure in the system. Magnetic flow meter monitors heating water flow rate and to maintain a minimum flow rate for the boilers and the pumps.
- .9 Differential pressure sensor at the end of the glycol heating loop, through a variable frequency drive, varies glycol pump (P3 or P4) speed to maintain setpoint.
- .10 Manual switches shall be provided to select between "Local/BAS" control of the individual boilers to provide back-up in the event of a BAS failure.
- .11 Boiler supply temperature to be scheduled inversely with outdoor air temperature.

<u>OAT</u>	<u>HWS</u>
10°C, 50°F	48.89°C, 120°F
-21°C, 5.8°F	62.78°C, 145°F

- .12 Heating Night Setback: System to operate to maintain night setback temperature as sensed by room temperature sensors for all spaces (eg. lowest room temperature does not go lower than night setback temperature).
- .13 Provide a pressure sensor in the glycol system for alarm and monitoring purposes. Locate sensor in the common glycol return line at suction side of pumps P3/P4.
- .14 Provide a digital output point to activate security system remote dialer. Output point shall be closed during normal operation and open if perimeter radiation return water temperatures drops below 40°C. Contact to reset when temperature rises above 45°C (78.8°F). Provide wiring from EMCS to security panel when circuit is open, activate remote alarm. Termination at security panel by Owner.

3. AHU-3 SYSTEM (CV-DDC) – GYMNASIUM & STAGE

- .1 Applicable equipment: AHU-3, SA and RA fans, glycol heating coil, Air Sanitization Units UVA-3-1 to UVA-3-3, auxiliary exhaust fan F-21.
- .2 Refer to Sketch SK-M2 herein for damper and temperature references below. Note that the point count indicated on the sketch is incomplete. For actual points required refer to I/O Summary.
- .3 On System Start in Occupied Mode:
- .1 Supply fan AHU-3 to start and then return fan to start (operating at 100% recirculated air) and operate for 15 minutes. Air sanitization unit to be enabled. Heating to be provided by modulating the control valve on the heating coil.
- .2 After 15 minutes of AHU-3/RF operation, MA and RA dampers modulate to minimum outdoor air position. Heat recovery wheel speed control enabled. Auxiliary fan to start.

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- .3 Room sensor to initiate heating and cooling in sequence, in order to maintain room temperature setpoint. Heating shall be provided by modulating the glycol heating coil valve.. Cooling shall be provided by modulating dampers OA, EA and MA in sequence to maintain MAT setpoint when outdoor temperature is less than MAT setpoint, positioning dampers OA and RA to 100% outdoor air in economizer operation when outdoor air temperature is greater than MAT setpoint and less than room temperature and by positioning OA, MA and EA dampers to minimum outdoor air when outdoor air temperature is greater than room temperature. Heat recovery wheel bypass dampers will close when system is in minimum outdoor air operation and fully open when system is in economizer operation. Provide for BAS dirty filter status via interface with digihelic gauge provided by unit manufacturer.
- .4 The system is to have two (2) occupied modes: Classroom Occupied Mode and Assembly Occupied Mode. Modes of operation are operator selectable. In Classroom Occupied Mode (when economizer is not activated), MA and EA dampers modulate to below minimum OA position to maintain a minimum RA CO2 sensor setpoint of 900 PPM. In Assembly Occupied Mode (shall be activated on the date of event program), MA and EA dampers modulate to below minimum Assembly Mode OA position to maintain a minimum RA CO2 sensor setpoint of 900 PPM.
- .4 On System Stop to Unoccupied Mode:
- .1 Supply fan AHU-3 to stop and then return fan RF to stop. Air sanitization unit to be disabled. Auxiliary fan to stop.
- .2 Heat recovery wheel speed control OFF.
- .3 OA and EA dampers to close. MA damper open.
- .4 Room sensor on sensing below setback temperature, initiates startup of system per occupied mode (operating at 100% recirculated air) modulate the glycol heating coil control valve in order to maintain room setback temperature.
- .5 FAT sensor modulates heat reclaim wheel via VFD to obtain SAT setpoint with override from EAT sensor to maintain unit frost protection. At SAT < OAT and OAT < RAT heat reclaim wheel control is automatically reversed and FAT sensor modulates heat reclaim wheel in reverse to obtain SAT setpoint.
- .6 Safeties: System to be de-energized if smoke detector (Division 26) senses products of combustion, high and low limits, senses temperature below setpoint.
- .7 Low SAT protection is also alarmed on EMCS.

4. AHU-1 AND AHU-2 SYSTEMS (VAV-DDC) - CLASSROOMS

- .1 Applicable Equipment:
- AHU-1 System: SA & RA fans, ERV-1, Heating coil & heat recovery wheel, Air Sanitization Units UVA-1-1 to UVA-1-6.
 - AHU-2 System: SA & RA fans, ERV-2, Heating coil & heat recovery wheel, Air Sanitization Units UVA-2-1 to UVA-2-10.
 - Heat pump air cooled Condensing Units CU-AHU-1 and CU-AHU-2

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- .2 Refer to Sketch SK-M1 herein for damper and temperature references below. Note that the point count indicated on the sketch is incomplete. For actual points required refer to I/O Summary.
- .3 On System Start in Occupied Mode:
- .1 Supply fan to start and then return fan to start (operating at 100% recirculated air). Air sanitization units to be enabled. Operate in this manner for 15 minutes.
- .2 After 15 minutes of supply and return fan operation, ERV OA damper opens, main OA modulating damper, MA and EA dampers modulate to minimum outdoor air position. Heat recovery wheel speed control enabled.
- .3 Heating and cooling shall be initiated in sequence in order to maintain SA room temperature setpoint. In heating mode, at first stage SAT shall be set at 22.2°C (72°F) (adjustable) and heating shall be provided by modulating radiation valves in the room to open. If additional heating is required then run the heat pump air cooled condensing unit heating mode when outdoor air temperature allows, or modulate AHU heating control valves when the heat pump air cooled condensing unit cannot match the heating requirement. Cooling shall be provided by running the heat pump air cooled condensing unit cooling mode and modulating dampers OA, EA and MA in sequence to maintain MAT setpoint when outdoor temperature is less than MAT setpoint, positioning dampers OA and EA to 100% outdoor air in economizer operation when outdoor air temperature is greater than MAT setpoint and less than average room temperature and by positioning OA, MA and EA dampers to minimum outdoor air when outdoor air temperature is greater than room temperature. Heat recovery wheel bypass dampers will close when system is in minimum outdoor air operation and fully open when system is in economizer operation. SAT setpoint to be adjusted up if average room temperature is less than setpoint and adjusted down if average room temperature is greater than setpoint. SAT setpoint adjustment to be limited to minimum 13°C and maximum 23.9°C. Average room temperature to be determined based on room temperature as sensed by room temperature sensors within spaces served by this system and return air temperature sensor. Provide for BAS dirty filter status via interface with digihelic gauge provided by unit manufacturer.
- .4 On System Stop to Unoccupied Mode:
- .1 Heat recovery wheel speed control OFF, condensing unit OFF, supply fan to stop and then return fan to stop, ERV OA, main OA and EA dampers to close. Air sanitization units to be disabled.
- .5 HRW-DAT sensor modulates heat reclaim wheel via VFD to obtain SAT setpoint with override from HRW-EAT sensor to maintain unit frost protection. At SAT < OAT and OAT < RAT heat reclaim wheel control is automatically reversed and HRW-DAT sensor modulates heat reclaim wheel in reverse to obtain SAT setpoint.
- .6 BAS controls ERV exhaust fan from operator adjustable individual time schedule. An end switch on ERV exhaust damper "makes" on damper full open position which starts ERV exhaust fan. When ERV exhaust fan stops, the exhaust damper shall be fully closed. 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. ERV-DAT sensor modulates ERV tilt mechanism on heat reclaim coil to obtain SAT setpoint with override from ERV-EAT sensor to maintain unit frost protection. At SAT<OAT and OAT>RAT heat reclaim tilt control is automatically reversed and ERV-DAT sensor modulates tilt control mechanical in reverse to obtain SAT setpoint.
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- .7 Static pressure sensor in duct at most remote VAV terminal, through a variable frequency drive, varies SA fan speed to obtain operator defined setting (establish setting with air flow balancer of Section 23 00 30). RA fan speed (via VFD) tracks SA fan at an offset (set by the air balancer). Offset shall be field programmable to allow maximum flexibility for control. High SA discharge static pressure protection (manual reset) shuts down system upon activation and is hardwire interlocked to SA and RA fan VFDs.
 - .8 Safeties: System shall be de-energized if smoke detector (Division 26) senses products of combustion, high and low limits, senses temperature below setpoint.
 - .9 Low SAT protection is also alarmed on EMCS.
 - .10 Provide A2L refrigerant mitigation control. A mitigation sequence shall be enabled when a refrigerant leak is detected in the AHU including shutting down the compressor and activating the AHU SA and RA fans.

5. RTU-1 AND RTU-4 SYSTEMS (DDC)

- .1 Applicable Equipment:
 - RTU-1 (Administration Area) With VAV boxes, Air Sanitization Units UVA-4-1 and UVA-4-2
 - RTU-4 (Child Care) With VAV boxes, Air Sanitization Units UVA-7-1 and UVA-7-2
- .2 UNOCCUPIED mode (System OFF): all fans OFF, EA and OA dampers closed. Air sanitization units to be disabled. On a call for heat from the space temperature sensor, the perimeter radiation shall provide the heat to maintain the operator defined setback space temperature.
- .3 On System Start in Occupied Mode:
 - .1 SA fan starts and runs continuously. Air sanitization units to be enabled. OA and EA dampers proceed to minimum OA position.
 - .2 The BAS shall initiate free cooling; mechanical cooling and heat pump heating and gas heating in sequence to maintain the space temperature sensor setpoints. Provide deadband between heating and cooling space temperature setpoints. Between setpoints, space temperature floats.
 - .3 On a call for cooling from space temperature sensor, energize unit cooling relays in sequence to obtain cooling setpoint.
 - .4 On a call for heating from space temperature sensor, the perimeter control valve shall modulate open to obtain heating setpoint. On a further drop in space temperature, energize heat pump heating mode when outdoor air temperature allows, and modulate gas furnace when the heat pump heating cannot match the heating requirement.
- .3 Safeties: System to be de-energized if smoke detector (Division 26) senses products of combustion.
- .4 This Section shall provide a current sensing relay for fan status indication on the BAS. Low SAT protection is alarmed on BAS.

6. RTU-2 (CV-DDC) – LIBRARY

- .1 Applicable Equipment:
 - RTU-2 (Library), Air Sanitization Units UVA-5-1 and UVA-5-2.
- .2 On System Stop to Unoccupied Mode:
 - .1 SA fan OFF, OA dampers closed, EA damper closed, air sanitization units to be disabled.
 - .2 On a call for heat from the space temperature sensor, the perimeter radiation shall provide the heat to maintain the operator defined setback space temperature. On a further drop in space temperature, energize unit heating relays in sequence to obtain heating setpoint. When RTU is started, air sanitization units to be enabled.
- .3 On System Start in Occupied Mode:
 - .1 SA fan starts and runs continuously. Air sanitization units to be enabled. OA and EA dampers proceed to minimum OA position.
 - .2 The BAS shall initiate free cooling; mechanical cooling and heating in sequence to maintain the space temperature sensor setpoints. Provide deadband between heating and cooling space temperature setpoints. Between setpoints, space temperature floats.
 - .3 On a call for cooling from space temperature sensor, energize unit cooling relays in sequence to obtain cooling setpoint.
 - .4 On a call for heating from space temperature sensor, the perimeter control valve shall modulate open to obtain heating setpoint. On a further drop in space temperature, energize heat pump heating mode when outdoor air temperature allows, and modulate gas furnace when the heat pump heating cannot match the heating requirement.
- .4 Safeties: System to be de-energized if smoke detector (Division 26) senses products of combustion.
- .5 This Section shall provide a current sensing relay for fan status indication on the BAS. Low SAT protection is alarmed on BAS.

7. RTU-3 (CV-DDC) – CLASSROOM 117

- .1 Applicable Equipment:
 - RTU-3 (Classroom 117), Air Sanitization Unit UVA-6.
- .2 On System Stop to Unoccupied Mode:
 - .1 SA fan OFF, OA dampers closed, EA damper closed. Air sanitization units to be disabled.
 - .2 On a call for heat from the space temperature sensor, the perimeter radiation shall provide the heat to maintain the operator defined setback space temperature.

- .3 On System Start in Occupied Mode:
 - .1 SA fan starts and runs continuously. Air sanitization unit to be enabled. OA and EA dampers proceed to minimum OA position.
 - .2 The BAS shall initiate free cooling; mechanical cooling and heating in sequence to maintain the space temperature sensor setpoints. Provide deadband between heating and cooling space temperature setpoints. Between setpoints, space temperature floats.
 - .3 On a call for cooling from space temperature sensor, energize unit cooling relays in sequence to obtain cooling setpoint.
 - .4 On a call for heating from space temperature sensor, the perimeter control valve shall modulate open to obtain heating setpoint. On a further drop in space temperature, energize heat pump heating mode when outdoor air temperature allows, and modulate gas furnace when the heat pump heating cannot match the heating requirement.
- .4 Safeties: System to be de-energized if smoke detector (Division 26) senses products of combustion.
- .5 This Section shall provide a current sensing relay for fan status indication on the BAS. Low SAT

8. TERMINAL UNITS (DDC)

- .1 Applicable for VAV boxes.
- .2 Space temperature sensor maintains operator defined setpoint by modulating terminal unit primary air damper beyond minimum position on a call for cooling.

9. TERMINAL UNITS WITH AUXILIARY HEATING (DDC)

- .1 Applicable for VAV boxes with reheat (when equipped) and perimeter (or panel) radiation.
- .2 Space temperature sensor maintains operator defined setpoint by modulating terminal unit primary air damper beyond minimum position on a call for cooling with heating control valves on reheat coil and perimeter/panel radiation closed.
- .3 On a call for heating, temperature sensor positions terminal unit primary air damper to minimum setting and modulates heating control valves on reheat coil and perimeter/panel radiation in sequence to maintain operator defined setpoint. Valve on reheat coil is first in sequence. Provide "deadband" between full open position of first valve in sequence and start open of second valve.

10. BY-PASS VAV BOX (DDC)

- .1 Cooling: Space temperature sensor maintains setpoint by modulating box damper beyond minimum airflow position when SAT is less than space temperature, and towards minimum airflow position when SAT is greater than space temperature.

11. BY-PASS VAV BOX WITH PERIMETER RADIATION (DDC)

- .1 Cooling: Space temperature sensor maintains setpoint by modulating box damper beyond minimum airflow position when SAT is less than space temperature, and towards minimum airflow position when SAT is greater than space temperature.
- .2 Heating: Space temperature sensor maintains setpoint by modulating box damper beyond minimum airflow position (when SAT is greater than space temperature) and heating control valve on perimeter radiation in sequence. When SAT is less than space temperature, the room thermostat shall modulate box damper towards minimum airflow position.

12. PERIMETER RADIATION (SEPARATE ROOM) (DDC)

- .1 Temperature Controller: Space temperature sensor will modulate the radiation valve closed on a temperature rise. On a temperature drop, the radiation valve will modulate open. Radiation valves will spring return to open for full heat on fail situation. (Valve to have union connection).

13. MANUAL UNOCCUPIED OVERRIDE/DDC

- .1 When momentarily depressed, this switch will cause all automatically controlled equipment to go to its occupied mode for an operator adjustable period. (Initial setting 4 hours, adjustable). When released, switch will reset itself so that when pushed again, the timeout period will return to 4 hours.

14. CABINET HEATERS (DDC)

- .1 Space temperature sensor energizes unit fan on a call for heat to maintain setpoint.
- .2 Division 26 will provide contactors on each circuit and wire line and load sides of each contactor. Interface with the control side of the contactors to enable remote control. Refer to Division 26 documents for number and location of contactors. Co-ordinate exact requirements with Division 26.

15. 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.

16. EXHAUST FANS (DDC)

- .1 Applicable equipment: F-14, F-20.
- .2 BAS controls from operator adjustable individual time schedule.

17. MISCELLANEOUS VENTILATION (DDC)

- .1 Applicable for areas ventilated with building air: On a temperature rise above setpoint, space temperature sensor energizes exhaust fan to maintain an operator adjustable setpoint.

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- .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.
 - .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.

18. 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 heater fan (and heater coil in case of electric heat) 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 heater fan (and heater coil in case of electric heat) 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 heater fan (and heater coil in case of electric heat) to maintain an operator adjustable heating setpoint.
- .4 Provide a deadband between heating and cooling space temperature setpoints. Between the setpoints, space temperature floats.

19. ELECTRIC PIPE TRACING

- .1 Tracing circuits are enabled/disabled from an operator defined OAT. Design: OAT $\leq$ 5°C (41°F) circuits enabled, OAT 5°C (41°F) circuits disabled.
- .2 Division 26 will provide contactors and wire line and load sides of the contactors for the tracing systems. Connect to the control side of these contactors. Provide current sensing relays for system status indication (ON/OFF). Co-ordinate with Division 26 to ensure compatibility.
- .3 Refer to Division 26 documents for quantity and location of contactors.

20. LIGHTING CONTROL

- .1 Exterior and Parking Lighting: Control (ON/OFF) is from the BAS from an operator defined time schedule and input from photocell. Division 26 will provide contactors on each circuit and wire line and load sides of contactors for the lighting systems. Connect to the control side of these contactors. Co-ordinate with Division 26 to ensure compatibility. Refer to Division 26 documents for quantity and location of contactors. Division 26 will provide a photocell, including power wiring. Interface with this device for status indication on the BAS.
- .2 Corridor and Stairs Lighting: Control (on/off) is from an operator defined time schedule. Division 26 will provide contactors on each circuit and wire line and load sides of contactors for the lighting systems. Connect to the control side of these contactors. Co-ordinate with Division 26 to ensure compatibility. Refer to Division 26 documents for quantity and location of contactors.

21. DOMESTIC HOT WATER SYSTEM

- .1 Circulator control (ON/OFF) and heater control (enable/disable) on time schedule. Temperature sensor in main domestic hot water line alarms an operator defined high and low supply water temperature (default 140°F high, 100°F low). Section 25 00 00 to supply sensor well to Section 22 00 00 for installation.
- .2 Thermostatic mixing valve MV-1 (by Section 22 00 00) to maintain hot water temperature at setpoint (41°C).

22. BUILDING POWER/GAS/WATER USAGE

- .1 Building Power/Gas/Water consumption information will be provided by a contractor hired by the School Board from Cash Allowance.

23. EXCESS PRESSURE PUMP (SEPARATE LOOP)

- .1 The excess pressure pump will cycle in response to the pressure controller.

24. HEATING BOILERS LOW WATER TEMPERATURE ALARM

- .1 Provide a digital output point to activate security system remote dialer. Output point shall be closed during normal operation and open if perimeter radiation return water temperature drops below 21°C, (70°F). Contact is to reset when temperature rises above 26°C, (78°F).
- .2 Provide wiring from EMCS to Security Panel. When circuit is open, activate remote dialler. Wiring to remote dialler by Division 26.

25. CEILING FANS (DDC)

- .1 The lights and ceiling fans in Gym and Stage shall be on/off by occupancy sensors from an operator defined time schedule. On unoccupied, the lights are off, and each group of fans are disabled. On occupied, the lights are on, and each group of fans is enabled. Occupancy sensors will be provided by Division 26. Division 26 will provide a contactor for each group of fans and will

wire line and load sides of these contactors. Division 25 to provide control side wiring of the contactors to enable/disable fan circuits. Co-ordinate with Division 26.

.2 A contactor will be provided for groups of fans as follows:

- Gym Fans F22, F23 and F24.
- Gym Fans F25, F26 and F27.
- Stage F28

26. SECURITY SWITCH CONNECTION

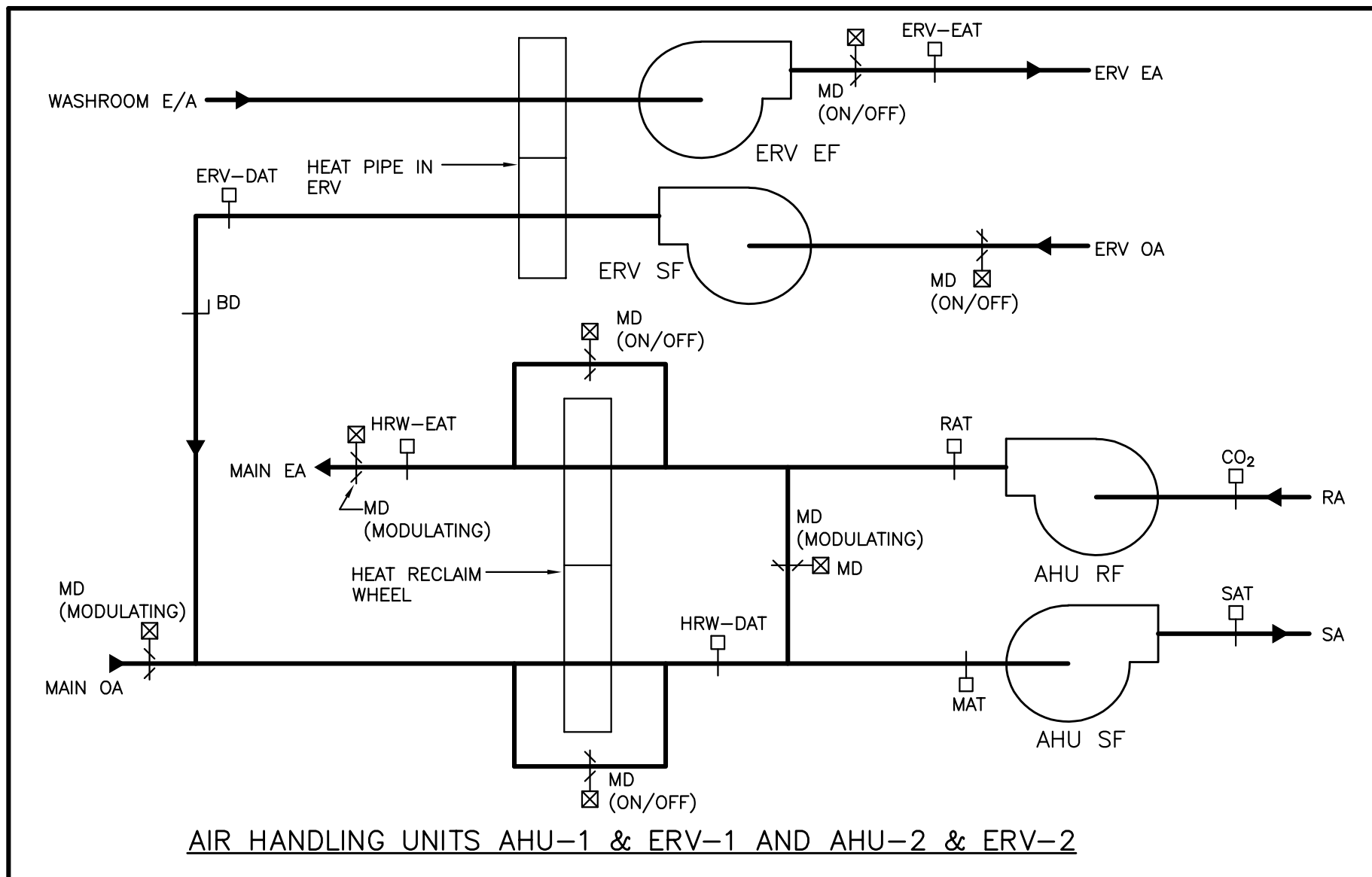
.1 Add a security switch connection to the BAS. When security is on, program the interior and exterior lights and all air handling units and all miscellaneous fans shall be off. When security is off, the interior and exterior lights and miscellaneous fans to be on/off.

.2 Provide a system intrusion point which shall command all lighting points on.

27. INPUT/OUTPUT SUMMARY

.1 I/O summary is appended hereto.

END OF SECTION 25 00 00



DRAWING TITLE:

MAYFIELD WEST #2 PUBLIC SCHOOL

CALEDON, ON



23 Leslie Road, Unit 410
Toronto, ON, Canada M3B 3P6

800.971.1311 905.840.2158

DRAWN BY:

J.Y.

CHECKED BY:

S.W.

SCALE:

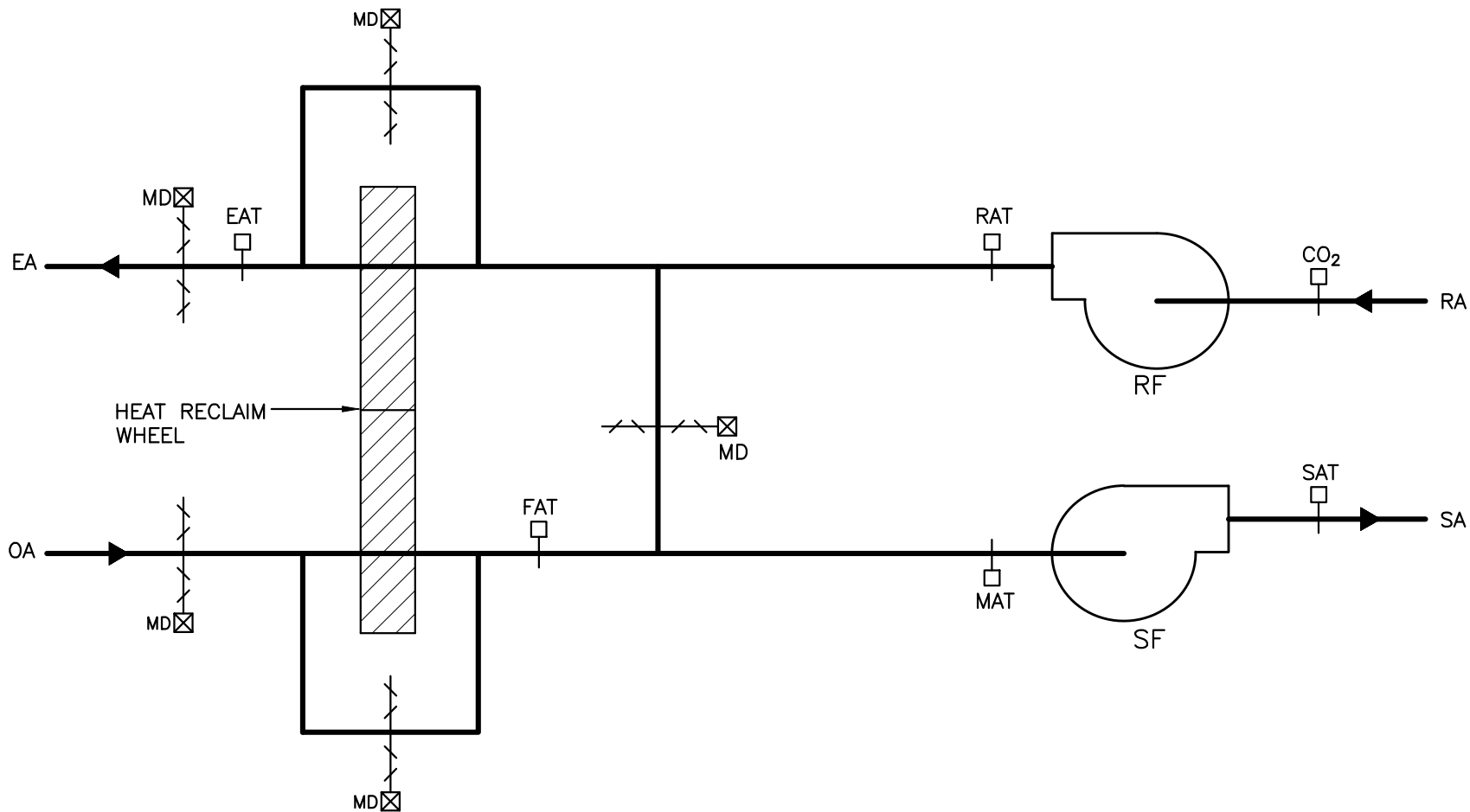
N.T.S.

DATE:

JUNE 2026

DRAWING No.

SK-M1



AIR HANDLING UNITS AHU-3

DRAWING TITLE:

MAYFIELD WEST #2 PUBLIC SCHOOL
CALEDON, ON



23 Lesmill Road, Unit 410
Toronto, ON, Canada M3B 3P6
905.940.3100 905.940.2139

DRAWN BY:
J.Y.

CHECKED BY:
S.W.

SCALE:
N.T.S.

DATE:
JUNE 2026

DRAWING No.

SK-M2

PROJECT MAYFIELD WEST #2 PUBLIC SCHOOL	GEN	PROGRAMS												DO		DI		AO		AI										
BAS SYSTEM & POINT DESCRIPTION HEATING PLANT	Graphic (Colour) Intercom	Totalize R. 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	Enable/Disable	Remote/Local.	Open/Close	Start/Stop	Alarm	Alarm (Low)	Alarm (High)	Status	3-13 PSIG	0-10 Volts	4-20 mA	AMPS (STATUS)	Temperature	Pressure	Rel. Humidity	Minimum Flow	Flow
SYSTEM	X																													
PUMPS P1 & P2 VFD (EACH)		X										X				X					X					X			XX	
PUMPS P3 & P4 VFD (EACH)		X										X				X					X					X			XX	
B1 & B2 MODULATION(EA Modular Burner)		X				X						X		X							X		XX							
B1 & B2 REMOTE/LOCAL (EACH)															X						X									
VALVE CONTROL (V-1, V-2, EACH)												X											XX							
B1 & B2 HWS TEMP. (EACH)																										X				
B1 & B2 FAILURE (EA Individual module)																			X											
B1 & B2 HWR TEMP (EACH)																										X				
PERIMETER RAD HWR TEMP																										X				
COMMON HWS TEMP																										X				
* COMMON HWR TEMP																										X				
COMMON GLS TEMP																										X				
COMMON GLR TEMP																										X				
HWR TEMP AT HEAT EXCHANGER																										X				
GLYCOL SYSTEM PRESSURE			XX																								X			
DIFFERENTIAL SYSTEM PRESSURE (Each)			XX																								X			
SECURITY REMOTE DIALER																X														
MAGNETIC FLOW METER													X											XX					XX	
VALVE CONTROL (V-3) HEAT EXCHANGER													X											XX						

* ALARM LIMIT AS RECOMMENDED BY BOILER MANUFACTURER

PROJECT MAYFIELD WEST #2 PUBLIC SCHOOL	GEN	PROGRAMS	DO	DI	AO	AI																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																	
						Concentration	KW	Velocity	Flow	Rel. humidity	Pressure	Temperature	Amps (status)	Drive Pos. (0-10)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									

** ALARM LIMIT AS RECOMMENDED BY HEAT WHEEL MANUFACTURER

* Terminal strip interface at manufacturer's control panel

PROJECT MAYFIELD WEST #2 PUBLIC SCHOOL	GEN	PROGRAMS	DO	DI	AO	AI																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
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BAS SYSTEM & POINT DESCRIPTION AHU-3 SYSTEM GYMNASIUM & STAGE	Graphic (Colour)	P-I-D	Start/Stop	Status	4-20 mA																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																							

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PROJECT MAYFIELD WEST #2 PUBLIC SCHOOL	GEN	PROGRAMS												DO			DI			AO			AI												
BAS SYSTEM & POINT DESCRIPTION RTU-4 SYSTEM CHILD CARE	Graphic (Colour) Intercom	Totalize R. 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	Enable/Disable	Occ./Unocc.	Open/Close	Start/Stop	HEAT PUMP MODE	Alarm	Alarm (Low)	Alarm (High)	Status		3-13 PSIG	0-10 Volts	4-20 mA	Drive Pos. (0-10)	Amps (status)	Temperature	Pressure	Rel. Humidity	Flow	Velocity	KW	
SYSTEM	X																																		
RA FAN		X									X					X												X							
SA FAN		X									X					X												X							
VFD (EACH FOR RA & SA FAN)												X													X		X								
SA, RA & MA TEMP (EA)																												X							
OA, MA & EA DAMPER (EA)												X													X	X									
HEAT PUMP CONDENSING UNIT															X			X																	
COOLING CONTROL (EA STAGE)															X						X														
HEATING CONTROL (EA STAGE)												X			X							X													
DIFFERENTIAL PRESSURE																													X						
DIRTY FILTER																				X															
UNIT FAILURE																		X																	
SPACE TEMP																												X							
VAV BOXES												X													X	X		X							
AIR SANITIZATION UNITS (Each)														X								X													
Freezestat																				X															

PROJECT MAYFIELD WEST #2 PUBLIC SCHOOL	GEN											DO	DI	AO	AI																		
BAS SYSTEM & POINT DESCRIPTION	Graphic (Colour)	Totalize R. 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	Enable/Disable	Occ./Unocc.	Open/Close	Start/Stop	ON/OFF	Consum. monitor	Alarm (Low)	Alarm (High)	Status	3-13 PSIG	0-10 Volts	4-20 mA	Amps (status)	Temperature	Pressure	Rel. Humidity	Flow (L/S)	Velocity	KW	
	Intercom																																
<u>BLDG POWER/GAS/WATER USAGE</u>																																	
POWER CONSUMPTION			X																	X													
POWER DEMAND																			X														
GAS CONSUMPTION			X																X														
WATER CONSUMPTION			X																X														
WATER CONSUMP. (Make-up & Check meter)			X																X														
<u>ELECTRIC PIPE TRACING</u>																																	
EACH CIRCUIT						X								X							X												
ELECTRICAL PANEL LP-1LB														X																			
ELECTRICAL PANEL LP-1G (EA.)														X																			
<u>TERMINAL UNITS</u>																																	
SYSTEM	X																																
SPACE TEMP.																											X						
AIR FLOW																															X		
DAMPER CONTROL													X												X								
VALVE CONTROL (RAD.) *												X												X									
<u>SECURITY SWITCH CONNECTION</u>																																	
INTRUSION																					X												
SECURITY														X																			

* WHERE APPLICABLE

PROJECT MAYFIELD WEST #2 PUBLIC SCHOOL	GEN	PROGRAMS	DO	DI	AO	AI						
						KW	Velocity	Flow (L/S)	Rel. Humidity	Pressure	Temperature	Amps (status)
BAS SYSTEM & POINT DESCRIPTION	Graphic (Colour) Intercom	P-I-D Time Schedule Opt. Start/Stop Opt. Enthalpy Duty Cycle Demand Limits Reset Event Program Maintenance Analog Limit (Hi) Analog Limit (Lo) Totalize R. Time	ON/OFF Start/Stop Open/Close Occ./Unocc. Enable/Disable	Status Alarm (High) Alarm (Low) Consum. monitor	4-20 mA 0-10 Volts 3-13 PSIG							
MISC. VENT. & HTG.												
SPACE TEMP.												
UNIT HEATER				X								
EXH. FAN				X								
CABINET HEATERS												
SPACE TEMP.												
HEATER FAN (EA.)			X									
UNIT HEATERS												
SPACE TEMP.												
UNIT HEATER				X								
PERIMETER RAD /PANEL RAD												
SYSTEM	X											
SPACE TEMP.												
VALVE CONTROL					X							
					X							
EXHAUST FANS												
SYSTEM	X											
FAN		X		X								
SMOKE DAMPERS, COMBINATION FIRE/SMOKE DAMPERS												
DAMPER "CLOSED" POSITION					X							

I N D E X

<u>SECTION NO.</u>	<u>DESCRIPTION</u>
26 00 01	Electrical Supplementary Information Form
26 00 10	General Electrical Provisions
26 01 10	Conduits
26 01 20	Wires and Cables
26 01 30	Outlet Boxes
26 01 32	Metal Cabinets
26 01 40	Wiring Devices
26 01 41	Lighting Control Devices
26 01 42	Two Cell Wireway System
26 01 43	Floor Outlets
26 01 45	Classroom Control Panel Module
26 01 50	Motors, Starters and Variable Frequency Drives
26 01 60	Lighting Panels
26 01 62	Power Panels
26 01 70	Disconnect Switches
26 01 72	Contactors
26 01 80	Fuses
26 01 92	Access Panels
26 02 10	Emergency Lighting
26 03 10	Emergency Generator
26 03 20	Transfer Switch
26 04 01	Coordination & Short Circuit Study
26 04 02	Calibration & Verification
26 04 03	Thermography
26 04 20	Switchboards
26 04 21	Digital Metering System
26 04 24	Distribution Panels
26 04 40	Transformers
26 04 50	Grounding
26 05 00	Lighting
26 05 10	Lighting Fixture Schedule
26 06 00	Theatre Lighting System
26 07 20	Fire Alarm System
26 07 21	Fire Alarm Verification & Testing of Integrated Fire Protection and Life Safety System
26 07 40	Telephone System Provisions
26 07 42	Security System
26 07 44	Computer System Provisions
26 08 50	Electric Heating System
26 08 70	Pipe Tracing System
26 08 90	Building Automation System
26 09 10	Integrated P.A./Telephone System Provisions
26 09 11	Gymnasium Sound System
26 09 15	Clocks
26 09 30	Hand Dryers
26 09 60	Assistive Listening System
26 09 70	Cable Tray System

INSTRUCTIONS TO BIDDERS

Complete the Electrical Supplementary Information Form in its entirety for perusal and acceptance by the Owner. Submit completed form to the Consultant named hereunder within twenty-four (24) hours of Tender closing. Do not submit to Bid Depository.

PROJECT:

MAYFIELD WEST #2 PUBLIC SCHOOL

TENDER NO.

CALEDON, ONTARIO

FOR THE PEEL DISTRICT SCHOOL BOARD

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

ENGINEER:

rybka Ellard Willson Incorporated
23 Lesmill Road
Unit 410
TORONTO, ONTARIO
M3B 3P6
(647) 479-3785 - PHONE
(905) 940-2139 - FAX

Further to our Bid dated _____, 20_____.

1. SUBCONTRACTORS

I/We enclose herewith a List of Subcontractors to the Electrical 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.

Section of Work (Fill in as Applicable)

Name

Emergency Generator – 26 03 10

Transfer Switch – 26 03 20

Coordination Study – 26 04 01

Thermography – 26 04 03

Fire Alarm System – 26 07 20

Fire Alarm Verification & Testing of Integrated
Fire Protection and Life Safety System – 26 07 21

Security System – 26 07 42

Theatre Lighting – 26 06 00

Gymnasium Sound System – 26 09 11

2. UNIT PRICES AND LABOUR RATES

I/We enclose herewith Unit Prices and Labour Rates which are an integral part of the Bid. Unit prices and labour rates are, in effect, for the duration of this Project's construction period. Owner is not obligated to accept labour rates and unit prices quoted.

.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.

Journeyman \$ _____ Per Hour

Foreman \$ _____ Per Hour

.2 Unit Prices

.2.1 The following unit costs will apply to all additional or deleted work from the Contract and should include their proportional share of all labour equipment, materials, accessories, profits, overhead and taxes for a job completely installed. Applications of unit prices will be to the net difference of quantities of individual products and materials in each contemplated Change Notice or Revision Notice.

.2.2 The unit prices will be used for additions and deletions. Credit rate for deletions shall be at 80%

.2.3 Conduit and Cable:

Supply and install the following conduit and cables including fastenings, clips, connectors, coupling boxes, etc. as required based on length as shown.

MORE WORK

25mm EC/3500mm Length	\$ _____
2 #12-12mm C/3500mm Length	\$ _____
3 #12-12mm C/3500mm Length	\$ _____
2 #10-19mm C/3500mm Length	\$ _____
3 #10-19mm C/3500mm Length	\$ _____
3 #8- 19mm C/3500mm Length	\$ _____

.2.4 Receptacles:

Supply and installation of one duplex receptacle, shall include the receptacle box, cover plate, 5000mm of conduit and wiring, including connection to adjacent receptacle and/or outlet box.

.1 Supply and installation of one duplex receptacle. \$ _____

2. **UNIT PRICES AND LABOUR RATES (Cont'd)**

2.5 **Light Switches:**

Supply and installation of light switch shall include the switch box, cover plate, conduit, wiring and connection to box containing the lighting circuit.

.1 Supply and installation of one
120 volt light switch. \$ _____

.2.6 **Fire Alarm System:**

.1 Supply and installation of one fire alarm
pull station, including conduits, wiring and
connections to the nearest fire alarm pull
station. (Base conduit and wiring on
15000mm length). \$ _____

.2 Supply and installation of one fire alarm
cone speaker including conduit, wiring and
connections to nearest fire alarm cone
speaker. (Base conduit and wiring on
15000mm length). \$ _____

.2.7 **Lighting Fixtures:**

Supply and installation of the following lighting fixtures. The supply and installation of lighting fixtures shall include the fixtures, flexible conduit, wiring and connection to nearest outlet box containing 347 and/or 120 volt circuits and the supply and installation of the lamps. (Base conduit and wiring on 4500mm length).

MORE WORK

.1 Supply and installation of one type 'A' fixture. \$ _____

.2 Supply and installation of one type 'B' fixture. \$ _____

.3 Supply and installation of one type 'BB' fixture. \$ _____

.4 Supply and installation of one type 'G' fixture. \$ _____

.5 Supply and installation of one type 'E' fixture. \$ _____

.6 Supply and installation of one type 'H' fixture. \$ _____

.7 Supply and installation of one type 'L' fixture. \$ _____

.8 Supply and installation of one type 'U' fixture. \$ _____

.9 Supply and installation of one type 'U1' fixture. \$ _____

.10 Supply and installation of one type 'U2' fixture. \$ _____

3. **ALTERNATIVES**

The bid is based on the suppliers, subcontractors and manufacturers listed in the specifications and in the Supplementary Tender Form.

The following alternatives are for equipment and materials of manufacturers other than those named and offered, for consideration.

(Note that equipment offered as an alternative must be equivalent to the base bid equipment in respect to capacity, performance, quality, maintenance and must fit into space allocated.)

<u>Equipment</u>	<u>Alternative Manufacturer</u>	<u>Reduction in Tender Price</u>
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

4. **ITEMIZED PRICES**

These Itemized Prices will be used to identify the cost of components within the total Bid Sum required for the Owner's own internal auditing.

- .1 Supply and installation of Fire Alarm System complete with associated components, conduit and wiring as shown on Drawing and described in Specification.
_____ Dollars (\$_____)
- .2 Supply and installation of Security System complete with associated components, conduit and wiring as shown on drawing and described in specification.
_____ Dollars (\$_____)
- .3 Supply and installation of Theatrical Lighting System complete with associated components, conduit and wiring as shown on drawing and described in specification.
_____ Dollars (\$_____)
- .4 Supply and installation of Gymnasium Sound System complete with associated components, conduit and wiring as shown on drawing and described in specification.
_____ Dollars (\$_____)

5. LIST OF MANUFACTURERS AND/OR SUPPLIERS

- 5.1 The following are the names of the manufacturers and/or suppliers whose bids were used by us or our Sub-Contractors in our tender for the above project. If awarded the Contract for this portion of the work, these are the manufacturers and/or suppliers whose products and services we would use to execute the work of the Contract.

Materials or Equipment

Approved Suppliers or Manufacturers

Switchboards and Panels

Siemens
Eaton
Square 'D'

Dry Type Transformers

Marcus
Powersmith
Delta

Contactors

Eaton
Square 'D'
Siemens
Allen-Bradley

Disconnect Switches

Eaton
Siemens
Square 'D'

Emergency Generator

Total Power
Cummins
Kohler

Emergency Transfer Switch

Asco

Fire Alarm System

Chubb Edwards
Simplex/Grinnell
Notifier

Wiring Devices

Hubbell
Leviton
Pass & Seymour

5. **LIST OF MANUFACTURERS AND/OR SUPPLIERS (Cont'd)**

Materials or Equipment

Approved Suppliers or Manufacturers

LED Fixtures

Signify
Cooper
Hubbell
Lithonia
Peerless

Lighting Control

Watt Stopper
Cooper
Hubbell
Acuity Brands

Security System

Barrie Communications Equipment Ltd.
Underwriters Security Controls Inc.
Altel Integration Systems
Detson Integrated Security Systems
Gems Security Systems Inc.

Gymnasium Sound System

Barrie Communications Equipment Ltd.
Jack A. Frost
Audio Operations Ltd

Theatre Lighting System

Scenework
Jack A. Frost
Christie Lites Sales

SIGNING

This Supplementary Bid Form is executed under seal at _____

This _____ day of _____, 20____

Name of Firm _____

Address _____

FOR INDIVIDUAL OR PARTNERSHIP:

SIGNED, SEALED AND DELIVERED BY

_____(SEAL) _____
(Bidder - please print) (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.

1.1 GENERAL REQUIREMENTS

- .1 The General Conditions, Supplementary Conditions and Division 1 are a part of this Specification and shall apply to this Division.

2.1 REGULATIONS

- .1 All work shall conform to the latest Codes, requirements and approval of the Authorities having jurisdiction and shall be subject to acceptance by the Consultant.

3.1 INTENT

- .1 Mention herein, or indication on the Drawings of articles, materials, operations or methods requires that all such items shall be provided in the quality and quantity required, and that the operations shall be performed according to the methods prescribed, complete with all necessary labour and incidentals.
- .2 These Specifications shall be considered as an integral part of the accompanying Drawings. Any item or subject omitted from either the Specifications or the Drawings but which is mentioned or reasonably specified in the other shall be considered as properly and sufficiently specified and shall be provided.

4.1 BONDING, PERMITS, FEES AND INSPECTIONS

- .1 As part of their Bid, Bidders shall submit an Agreement to provide a Performance Bond and a Labour and Materials Payment Bond, duly signed and sealed by an Owner approved surety company, stating that if awarded the Contract the Bidder will execute and enter into a formal agreement within the time required. Each Bond shall be in the amount of 50% of the Tender Price. Refer to Division 1, Item 1.1.4 for additional information, including list of Owner approved surety companies.
- .2 Apply for all permits, provide all test certificates and pay all fees to Authorities having jurisdiction regarding the installation, inspection and operation of the electrical system.
- .3 A submission has been made by the Consultant to the Electrical Safety Authority for review of this project. The payment of the required review costs will be co-ordinated by the Consultant. A copy of the Electrical Safety Authority review report will be forwarded to the successful Contractor for information and action.
- .4 The Contractor is required to include in his tender all required inspection costs by the Electrical Safety Authority. Permit application is the responsibility of the Contractor.
- .5 Reproduce drawings and specifications required by Electrical Safety Authority at no cost.
- .6 Notify Consultant of changes required by Electrical Safety Authority prior to making changes.

- .7 Furnish Certificates of Acceptance to Engineer from Electrical Safety Authority and other Authorities having jurisdiction upon completion of work.
- .8 This Contractor must furnish any certificates required to indicate that the work completed conforms with laws and regulations of Authorities having jurisdiction.

5.1 DEFINITIONS AND INTERPRETATIONS

- .1 Where the term "Provide" is used, it shall be understood to include labour, materials and services necessary to supply and install items or work referred to.
- .2 Where the term "Instructions" or "As Instructed" or "Where Instructed" is used, it shall be understood to mean as instructed by the Consultant including supplementary instruction notices and job site instruction notices.
- .3 Where the term "Listed" is used, it shall be understood to mean that the materials or equipment has been tested in accordance with applicable standards and methods and has been approved and listed for the intended use by a testing company approved by the Authorities having jurisdiction.
- .4 Where the term "Approved" or "Approval" is used, it shall be understood to mean approved by Authorities having jurisdiction as conforming to Codes, Standards, By-Laws, etc.
- .5 Where the term "Acceptable" or "Acceptance" is used, it shall be understood to mean acceptable to the Consultant as conforming together to the requirements of the contract documents.
- .6 Where the term "Submit for Review" or "Submit Notice" is used, it shall be understood to mean submit to the Consultant.
- .7 Where the term "Subject to Review" is used, it shall be understood to mean work shall be laid out for review by the Consultant. No work shall proceed until instructions have been obtained from the Consultant. Submit further information, shop drawings, samples etc. as specified and as may be requested by the Consultants.
- .8 Where the term "Accessible" is used, it shall be understood to mean reachable by person with tools as required and where obstacles may be removed and replaced without cutting or breaking out materials.

6.1 EXISTING CONDITIONS

- .1 Visit the site and examine the existing conditions affecting the work of this Division.
- .2 No claim for extra payment shall be made for extra work made necessary by circumstances encountered due to conditions which were visible upon, or reasonably inferrable from an examination of the site prior to submission of the tender.

7.1 STANDARDS

- .1 Makes and quality of the materials used shall be approved by the Consultants having jurisdiction.
- .2 Products and materials provided shall be new and free from all defects. Related materials shall be of the same manufacturer throughout the Project.
- .3 Products and materials called for on the drawings or in the specifications by trade names, manufacturer names and catalogue reference are those which shall be used on the basis of the Tender.
- .4 Alternative products and materials to those specified shall only be considered if they are shown in the Tender as a material variation with an appropriate price adjustment. The Consultant reserves the right to accept or reject any alternative without explanation.
- .5 Assume full responsibility for ensuring that when providing alternative products or materials, all space, weight, connections, power and wiring requirements, etc., are considered. Any costs incurred for additional components, changes to services, structural or space requirements, layouts and plans, etc., that may be necessary will be borne by this Division.
- .6 Materials or equipment rejected by the Consultants shall be immediately removed from the project and suitable materials shall be provided.

8.1 WORKMANSHIP

1. All work shall be executed in a workmanlike manner and present a neat mechanical appearance.

9.1 CO-ORDINATION

- .1 Fully understand the functions of the systems specified and have no doubts with regard to the extent of the Contract.
- .2 Examine the Architectural, Structural, Mechanical and Electrical drawings and become fully familiar with the work of other Divisions.
- .3 Co-ordinate with all Divisions providing equipment and services and ensure that there is no confliction.
- .4 Arrange equipment in proper relation with other apparatus, the building construction, the Architectural finish and with all work specified.
- .5 Provide all equipment in time to co-ordinate with the overall progress of the project and proceed with the work as quickly as conditions permit.
- .6 Where space is shown for future equipment leave such space clear and ensure that the necessary connections can be made to the future equipment.
- .7 Failure to fully understand Drawings and allow for the work of other Divisions or where relocations are necessary due to lack of co-ordination between Divisions shall be remedied at the expense of this Division.

10.1 SHOP DRAWINGS, PRODUCT DATA AND SAMPLES

- .1 Submit shop drawing, product data and samples in accordance with the sections of the specification detailing the shop drawing, product data and samples requirements for review by the Consultant.
- .2 Only those drawings that have been checked and approved by this Division shall be submitted for review by the Consultant and each drawing shall be stamped or marked with the following:-

Name of Project;
Specification section and article number;
Approved;
Name of company making submission;
Signature of person making approval;
Date of approval.

- .3 Drawings that are submitted by this Division without the specified approval or information shall not be reviewed by the Consultant and shall be returned for proper submission.

- .4 Approval of a drawing by this Division implies the following:-

The drawing has been checked by the person making the approval;
The equipment or material complies in all respects with the requirements of the specifications and drawings;
The quantities, if indicated on the drawing, are correct;
The physical dimensions of the components are such that they can be installed without interference with the building structure or other equipment, and that, after installation, there are sufficient clearances on all sides for the maintenance, servicing and operation of the equipment.

- .5 Approved drawings submitted for review by the Consultant shall be stamped, with appropriate notations, as follows:-

REVIEWED ()
REVIEWED AS MODIFIED ()
REVISE AND RE-SUBMIT ()

"This review by Ellard-Willson Limited is for the sole purpose of ascertaining conformance with the general design concept. This review shall not mean that Ellard-Willson Engineering Limited approves the detail design inherent in the shop drawings, responsibility for which shall remain with the Contractor submitting same, and such review shall not relieve the Contractor of his responsibility for 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 such sub-trades."

ELLARD-WILLSON ENGINEERING LIMITED

BY: _____

DATE: _____

- .6 Should the vacant space on the drawing not permit the application of the above, the following shall be applied and it shall be understood to mean that all wording of the above shall apply.

REVIEWED ()
REVIEWED AS MODIFIED ()
REVISE AND RE-SUBMIT ()

ELLARD-WILLSON ENGINEERING LIMITED

BY: _____

DATE: _____

- .7 Resubmit any drawing on which notations have been made, after it has been modified or corrected.
- .8 Drawings that are re-submitted shall have a distinct notation of the fact made on each drawing.
- .9 Work shall not proceed on any equipment, material or installation until the drawings have been reviewed by the Consultant.

11.1 PROTECTION

- .1 Protect all finished and unfinished work from damage due to carrying out the work specified.
- .2 Repair all damage resulting from execution of the work to the satisfaction of the Consultant.
- .3 Should the project be stopped for any cause, provide all necessary protection to prevent damage by weather or other causes while such stoppage exists.

12.1 HANDLING AND STORAGE

- .1 Materials and equipment shall be handled and stored in such a manner so that no damage shall be done to the materials, the structure of the building or surrounding property.
- .2 Packaged or bundled materials and equipment shall be stored in dry weathertight secure enclosures in original undamaged condition with manufacturer's seals and labels intact.
- .3 All metals shall be protected against corrosion and bending.
- .4 Storage of materials, equipment, etc., in the building structure shall not be permitted, unless otherwise noted.

13.1 DRAYAGE, HOISTING & SCAFFOLDING

- .1 Provide the drayage, hoisting, scaffolding, warehousing and demurrage for the equipment and materials provided by this Division.

14.1 MINOR FIELD CHANGES

- .1 The location, arrangement and connection of equipment and materials as shown on the drawings represents a close approximation to the intent and requirements of the Contract.
- .2 The right is reserved to make reasonable changes required to accommodate conditions arising during the progress of the work. Such changes, if made prior to the installation, shall be done at no additional cost, unless the location, arrangement or connection is more than ten (10) feet from that shown on the drawings.

15.1 ADDITIONAL WORK

- .1 Refer to Section of Architectural Specification.

16.1 FIELD DRAWINGS

- .1 Prepare field drawings showing electrical and equipment rooms layouts, sizes and locations of holes, openings, sleeves, bases, anchors, supports, etc. for this Division's work.
- .2 Prepare interference drawings showing work within the ceiling spaces and other locations, for this Division's work. These drawings shall include the space requirements of all other Divisions.
- .3 After the drawings have been co-ordinated with all Divisions they shall be submitted for review by the Consultant.

17.1 FIRE PROTECTION OF ELECTRICAL CONDUCTORS

- .1 Fire rated enclosures shall be provided to form service spaces for conduits containing electrical conductors for emergency power, elevators and life safety equipment in accordance with the requirements of the Authorities having jurisdiction.
- .2 Fire rated access panels shall be provided in the enclosures where required.
- .3 The fire rated enclosures required by this Division shall, unless otherwise noted, be provided by this Division and shall be in accordance with the sections of the specification detailing the fire rated enclosures requirements.
- .4 Advise the extent of the fire rated enclosures required and supply all information and details as to size and locations within thirty days after the award of the contract.
- .5 Failure to comply with the above requirements shall be remedied at this Division's expense.
- .6 Where fire rated cables, that comply with the requirements of the Authorities having jurisdiction, are provided it shall not be required that they be installed in fire rated enclosures.

18.1 SPRINKLER PROOF EQUIPMENT

- .1 Electrical equipment installed where sprinklers are also installed shall be constructed so that water from the sprinkler heads shall not impair the effectiveness of the equipment.
- .2 A separate and complete roof shall be provided on free standing or surface mounted equipment. An overhang at the front, rear and sides shall prevent the entrance of water either at the top or through projecting face plates, meters, etc. (Provide complete gaskets to suit).
- .3 Where openings are required in the roofs or sides of incoming and outgoing conduits and cables, removable gasketed plates shall be provided and the conduits and cables shall be installed using waterproof fittings. The plates are to be grounded by a separate copper strap to the equipment.
- .4 Distribution and power panels, lighting panelboards, motor control centres, etc. and switchboards shall be complete with doors.
- .5 Louvres shall be of the outdoor type.

19.1 COLOURS OF MATERIALS AND EQUIPMENT

- .1 Where materials and equipment are specified to be a specific colour, a sample of the colour proposed by the manufacturer shall be submitted with the shop drawing.
- .2 Where materials and equipment are specified to be of colours as selected by the Consultant, these shall be determined during the course of the Contract. Obtain the colour requirements from the Consultant prior to submitting shop drawings so that the appropriate sample of the colour can be submitted with the shop drawings.

20.1 EXCAVATION AND BACKFILL

- .1 Refer to Architectural Specification.
- .2 The excavation and backfill required by this Division shall, unless otherwise noted, be provided by this Division and shall be in accordance with the Sections of the Specification detailing the excavation and backfill requirements.
- .3 Advise the extent of the excavation and backfill work required by this Division and supply all information and details as to size and locations within thirty days after the award of the Contract.
- .4 Failure to comply with the above requirements shall be remedied at this Division's expense.

21.1 CONCRETE

- .1 Refer to Architectural Specification.
- .2 The concrete and reinforcing required by this Division shall, unless otherwise noted, be provided by this Division and shall be in accordance with the Sections of the Specifications detailing the concrete and reinforcing requirements.

- .3 Advise the extent of the concrete and reinforcing work required by this Division and supply all information and details as to size and locations within thirty days after the award of the Contract.
- .4 Failure to comply with the above requirements shall be remedied at this Division's expense.

22.1 HOUSEKEEPING PADS

- .1 Refer to Architectural Specification.
- .2 All floor mounted electrical equipment installed by this Division shall be mounted on concrete housekeeping pads which shall, unless otherwise noted, be provided by this Division.
- .3 Advise the extent of the housekeeping pads required by this Division and supply all information and details as to size and location within thirty days after the award of the Contract.
- .4 Failure to comply with the above requirements shall be remedied at this Division's expense.

23.1 SLEEVES

- .1 Provide sleeves of galvanized steel pipe with machine cut ends of ample size to accommodate conduits passing through walls, partitions, ceilings, floors, etc.
- .2 For wall partitions and ceilings the ends of the sleeves shall be flush with the finish on both sides. For floors they shall extend 50mm above and below finished floor level.
- .3 The space between the sleeve and the conduit and spare sleeves shall be filled with Dow Corning silicone RTV foam for fire stop. Caulk around the top and bottom with approved permanently resilient, non-flammable and weatherproof silicone base compound.
- .4 Locate and position sleeves exactly prior to construction of walls, floors, etc.
- .5 Failure to comply with the above requirements shall be remedied at this Division's expense.

24.1 CHASES AND OPENINGS

- .1 Chases, openings, cutting, patching, etc. shall be provided in accordance with those sections of the specification detailing the requirements.
- .2 Flashing required for openings in walls, floors and roofs will be provided by the General Contractor unless noted otherwise on the drawings or specified as part of electrical equipment being installed.
- .3 Drilling for hangers, rods, inserts and work of a similar nature shall be provided by this Division.
- .4 Provide all necessary sleeves, inserts, anchor bolts, goosenecks, etc., prior to pouring of concrete or building of walls, roofs, etc.
- .5 Advise the extent of such work and supply all information and details as to sizes and locations within thirty days after the award of the Contract.
- .6 Failure to comply with the above requirements shall be remedied at this Division's expense.

25.1 PAINTING

- .1 All equipment shall be supplied with manufacturer's standard finish coat, unless otherwise noted.
- .2 All supports, hangers, etc. provided or fabricated by this Division shall be painted with two coats of zinc chromate primer.
- .3 Where the finish on any materials or equipment installed by this Division is damaged, it shall be touched-up, completely repainted or replaced to the satisfaction of the Consultant.

26.1 CLEANING

- .1 Clean the interior and exterior of all equipment and remove any debris during construction.
- .2 Inspect and clean all systems and equipment prior to energizing and ensure that they are safe.
- .3 Perform a complete and thorough clean-up to the exterior and interiors of all systems and equipment before the final inspection. The interiors shall be cleaned using an industrial vacuum cleaner.

27.1 CO-ORDINATION STUDY

- .1 Provide a co-ordination study and report for the complete electrical system and ground fault protection system.
- .2 The co-ordination study shall include, but is not limited to, the following:-
 - H.V. protection device.
 - L.V. protection device.
 - Feeder protective devices.
 - Transformer damage curve.
 - Ground fault system.
 - Short circuit calculations for switchboards, power panels and lighting panels.
 - Confirmation of adequacy of interrupting rating of protective devices in switchboards, power panels and lighting panels.
- .3 The co-ordination study and report shall be complete by an independent company specializing in this type of work and which is approved by the Consultant.
- .4 The co-ordination study and report shall be submitted for review by the Consultant.

28.1 IDENTIFICATIONS

- .1 Identify each item of equipment installed by this Division, whether supplied by it or not.
- .2 Metal surfaces shall be thoroughly cleaned before application of identification.
- .3 Identification shall be installed after painting has been completed and shall be secured with self-tapping screws or rivets except when installed on the inside of doors when gluing will be acceptable.

-
- .4 Manufacturer's nameplates shall be affixed to each item supplied showing the size, name of equipment, serial number and all information usually provided including voltage, cycle, phase, horsepower, etc., and the name of the Manufacturer and his address. Ensure that all stamped, etched or engraved lettering on plates is perfectly legible. Do not paint over nameplates and where equipment is to be concealed attach the nameplates in an accessible location.
- .5 Panels and all other equipment which have exposed faces in finished areas shall not have any visible trade marks or other identifying symbols. Nameplates shall be mounted on the inside of the doors.
- .6 Each lighting panel shall have a directory mounted on the inside of the door behind a protective plastic screen. The directories shall be typewritten and shall identify each branch circuit used. Spares and spaces shall be noted in pencil.
- .7 The nameplates for switchboards, distribution panels, power panels, etc. shall be Lamicoid with 13mm high letters with typical identification of "PP`AA, 600V 3 PH., 4W, fed from Switchboard `A".
- .8 The nameplates for lighting panels shall be Lamicoid with 9.5mm high letters with typical identification of "LP`B', 208V, 3Ph., 4W, fed from PP`A".
- .9 Each breaker, switch, instrument, meter, maximum fuse rating, etc. in switchboards, distribution panels, power panels, etc. shall have a Lamicoid nameplate with 6.4mm high letters with typical identification of "Escalator #15".
- .10 The nameplates for disconnect switches, starters, time clocks, dimmers etc. shall be Lamicoid with 6.4mm high letters with typical identification of "Supply Fan "S4", 5 HP, 600V, 3Ph., 3W, fed from `PP.1".
- .11 Each feeder cable and feeder conduit shall be identified with 25mm high letters with typical identification of "208V. 3Ph. 4W. to LP`B". The identification shall be provided at each access door, each change of direction, each junction box, at each floor or platform for vertically exposed conduits or cables at 2 metres above floor, at not more than 15 metres apart in straight runs, and on both sides of sleeves through walls.
- .12 The interior, exterior and lids of all outlet boxes shall be neatly identified with different colours of paint. The colours shall be consistent throughout the project and shall be as follows:-
- | | |
|--|--------|
| 120/208 Volt Lighting | Orange |
| 120/208 Volt System | Black |
| 347/600 Volt Emergency Power System | White |
| 120/208 Volt Emergency Lighting/Power System | Yellow |
| P.A./Telephone System | Brown |
| Fire Alarm System | Red |
| Security System | Green |
| Computer System | Blue |
- * For colours co-ordinate with School Board.
- .13 Outlet boxes/junction boxes provided for lighting or power connections shall be identified on the box cover with circuits contained in the box, the panels from which they are fed, the voltage and the purpose of the outlet.
- .14 Provide all signs and marking of equipment as required by the Authorities having jurisdiction.
-

29.1 MOCK-UP

- .1 A mock-up of the ceiling shall be provided by another Division of the Specification.
- .2 Provide samples of the lighting fixtures, fire alarm devices and all other items of equipment mounted in or on the ceiling and obtain acceptance for the samples and their installation.

30.1 TEMPORARY AND TRIAL USAGE

- .1 When it is claimed that a portion of the work is completed and in accordance with the Drawings and Specifications, the Owner shall have the privilege of temporary and trial usage for a reasonable length of time for making a complete and thorough test of the portion of the work completed.
- .2 Temporary or trial usage by the Owner of any electrical device, machinery, apparatus, equipment or any other work or materials supplied under this Contract before final completion and written acceptance, is not to be construed as evidence of acceptance of same.

31.1 RECORD DRAWINGS

- .1 Refer to General Specification.
- .2 Obtain two sets of white prints and mark clearly and neatly all changes in conduit runs, locations of equipment or fixtures and revisions made by Addendums, Change Orders, Site Instructions at no extra charge.
- .3 The record drawings shall be kept on site and shall be available for review by the Consultant.
- .4 The record drawings shall show all conduit, ducts, wiring and conductor runs for all systems including sizes, types of components, circuit numbers, etc. exactly as installed. Locate, with dimensions to the building grid and datum lines, all buried and concealed services, pull boxes, junction boxes, etc. for all systems. Room names and numbering, equipment names, etc. shall be in accordance with the Owner's designation and may not necessarily be those shown on the drawings.
- .5 Prior to requesting final inspection submit one set of marked-up prints for review by the Consultant.
- .6 Review of the record drawings by the Consultant shall be for general conformance only and is not an approval of the accuracy of the drawings. This Division shall be responsible for the accuracy of the record drawings.
- .7 After review by the Consultant, request one set of CADD disks for Tender Drawings and to pay REW an administrative fee of \$150.00 per drawing or \$750.00 (whichever is greater) per issuance (plus HST) for the provision of the electronic files, and transfer all the recorded information, and changes issued during construction, from the white prints to the disks.
- .8 Submit the CADD format drawings in one (1) USB complete with three sets of updated white prints, and the original marked-up prints of the record drawings.

32.1 TESTING AND COMMISSIONING

- .1 All systems, equipment and installation shall be inspected, tested, adjusted and commissioned to ensure compliance with the Drawings, Specifications and the Requirements of the Authorities having jurisdiction.
- .2 Provide testing equipment, instruments, material and labour for all testing and commissioning.
- .3 Submit reports of all testing and commissioning for review by the Consultants.
- .4 This Division shall include for the cost of one qualified servicemen, 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 30 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.

33.1 SYSTEMS ACCEPTANCES

- .1 Prior to requesting final inspection, submit, for review by the Consultant, letters from the manufacturers of equipment and systems indicating that their Technical Service Representatives have inspected and tested the equipment and systems and are satisfied with the methods of installation, connections and operation.
- .2 Acceptance letters shall be submitted for the following, when applicable:
Switchgear
Distribution and Power Panels
Lighting Panels
Transformers
Fire Alarm System
Security System
Assistive Listening System
Emergency Generator
Emergency Transfer Switch
Gym Sound System

34.1 SYSTEM INSTRUCTIONS AND DEMONSTRATIONS

- .1 Instruct the Owner's designated personnel during construction and prior to requesting final inspection so that they are fully familiar with all aspects in the function, installation, operation and maintenance of all systems and equipment.
- .2 Arrange for and pay for the services of manufacturer's service technicians, engineers and other personnel required for instruction on specialized systems or installation.
- .3 After commissioning of the systems, equipment and installation they shall be fully demonstrated by this Division and representatives of the manufacturers to the Authorities having jurisdiction.

- .4 Prior to requesting final inspection submit, for each system, the following:
- Dates and durations of instructions given to designated personnel and the names of persons instructed.
 - Signature of each person instructed stating that they understand and are familiar with the function, installation, operation and maintenance of the system.
 - Dates and durations of demonstrations to Authorities having jurisdiction and names of all persons present.

35.1 GUARANTEE

- .1 Prior to requesting final inspection, submit a written guarantee stating that all system and equipment provided are in full accordance with the Drawings, Specifications and the requirements of the Authorities having jurisdiction and that for one year from the date of acceptance, any defects in materials, equipment or workmanship shall be corrected at no charge.
- .2 The period of this guarantee shall in no way supplant any other contract guarantee of longer period.
- .3 A copy of the guarantee shall be incorporated in the manuals.

36.1 MANUALS

- .1 Prior to requesting final inspection submit three manuals in 8½" x 11" looseleaf, 3-ring binders which shall include the following:-
- Title sheet.
 - Index sheet.
 - Divider sheets for the following sections, where applicable:-
 - Main Switchboard
 - Distribution and Power Panels
 - Lighting Panels and Panel Directories
 - Transformers
 - Fuses
 - Contactors
 - Co-ordination Study
 - Wiring Devices
 - Light Fixtures
 - Emergency Generator and Transfer Switch
 - Fire Alarm System
 - Security System
 - Assistive Listening System
 - Theatre Lighting System
 - Miscellaneous Systems Reports
 - Hydro Certificate
 - Guarantee
 - Emergency Lighting Certificate
 - Occupancy Sensor Installation, Testing, Time Adjustment and Commissioning
 - Fire Alarm Certification – Testing of Integrated Fire Protection and Life Safety System

.2 Each Section of the manual shall include the following:-

- Name, address and telephone number of Service Personnel.
- Testing and Commissioning Report.
- System Acceptance Letter.
- Demonstration and Instruction Certificate.
- Operating Instructions.
- Maintenance Instructions.
- Trouble Finding Procedures.
- Testing Procedures.
- Catalogue Sheets for all components.
- Spare Parts List.
- Wiring Diagram.
- Approved Shop Drawings.

37.1 FINAL INSPECTION

.1 Confirm in writing, two weeks prior to when the final inspection can be performed, the following:-

- All defects and deficiencies have been corrected.
- All systems are completed, tested, operated and commissioned in accordance with the requirements of the Drawings and Specifications.
- The manuals have been submitted.
- The record drawings have been submitted.
- The Owner's designated personnel have been instructed and are fully familiar with all aspects of the installation and systems.
- All systems have been demonstrated to, and accepted by, the Authorities having jurisdiction.

.2 Defects or deficiencies found during the final inspection shall be corrected immediately.

END OF SECTION 26 00 10

1.1 GENERAL

- .1 Refer to Section 26 00 10, General Electrical Provisions.

2.1 PRODUCTS

- .1 Except for those items as may be specified in Part 3, of this Section, refer to Part 2 of the various Sections of Specification, Division 26 Electrical.
- .2 Rigid metal conduit shall be electro-galvanized and made of standard weight steel pipe and connected with electro-galvanized threaded couplings.
- .3 Electrical metallic tubing shall be a metal raceway which has a wall thinner than that of rigid metal conduit and an outside diameter sufficiently different from that of rigid metal conduit to render it impracticable for anyone to thread it with a standard pipe thread.
- .4 Rigid P.V.C. conduit shall be a rigid non-metallic conduit of unplasticized polyvinyl chloride.
- .5 Rigid Type I shall be similar to rigid P.V.C. duct, Type EB1, to C.S.A. Standard B196.1 requiring encasement in concrete.
- .6 Rigid Type II shall be similar to Type I except of heavier construction and suitable for direct burial.
- .7 Flexible conduits shall be liquid-tight flexible metal conduit.
- .8 Rigid metal conduits entering boxes in dry locations shall be secured with galvanized steel locknuts and nylon insulated steel bushings.
- .9 Rigid metal conduits entering boxes in wet locations shall be secured with steel bullet hub connectors, nylon insulated with neoprene 'O' ring.
- .10 Connectors for EMT surface mounted conduit shall be steel, set screw and nylon insulated.
- .11 Connectors for EMT conduit in concrete shall be steel, raintight, concrete tight and nylon insulated.
- .12 Couplings for EMT conduit surface mounted shall be steel set screw type.
- .13 Couplings for EMT conduit in concrete shall be steel, rain tight and concrete tight.
- .14 Connectors for flexible conduit shall be steel, liquid-tight, nylon insulated with neoprene 'O' ring.

3.1 EXECUTION

- .1 Except for those items as may be specified in Part 2 of this Section refer to Part 3 of the various sections of Specification Division 26 Electrical.
- .2 Raceways shall be as shown on the Drawings and as detailed in the Specification.
- .3 The size of conduit shall be in accordance with the requirements of the Authorities having jurisdiction.

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- .4 All conduits inside the building shall, unless otherwise noted, be electrical metallic tubing.
 - .5 Unless otherwise noted branch circuit conduits shall be concealed in wall and ceilings or exposed in unfinished areas mounted and shall not be installed in any concrete slab. Where it is noted that branch circuit conduits can be installed in a concrete slab that is not on grade the conduit shall be electrical metallic tubing with a copper ground wire.
 - .6 Conduits exposed to the weather, in wet locations, subject to mechanical injury or in any hazardous locations, shall be rigid metal conduit.
 - .7 Conduit in plenums shall be rigid metal conduit.
 - .8 Telephone zone conduits shall be PVC conduit when installed in concrete and EMT in other locations.
 - .9 Telephone distribution conduits shall be rigid P.V.C. conduit when installed in concrete or underground and EMT conduit in other locations.
 - .10 Motor feeder drops shall be in rigid conduit with a maximum 910mm of flexible liquid-light conduit. Rigid conduit for the drops shall start at least 910mm ahead of the actual bend and have two additional clips over normal requirements. The minimum conduit size for the drops shall be 19mm.
 - .11 Conduits in finished areas shall be concealed and those in unfinished areas shall be surface mounted unless otherwise noted.
 - .12 Feeder conduits shall not be installed in any concrete slab. Also, feeder shall not be installed below slab unless approved by consultant. If accepted feeder conduit shall be installed minimum 450mm below slab complete with proper protection above conduit.
 - .13 Conduits shall be installed so that the conductors can be drawn in without strain or injury.
 - .14 Expansion fittings shall be installed in conduits crossing expansion joints.
 - .15 Conduits shall be installed to provide for expansion and expansion fittings shall be provided where required.
 - .16 Conduits shall not be installed within 75mm of water, sprinkler, drain or waste piping.
 - .17 Exposed conduits shall run parallel to or horizontally on the walls of the building.
 - .18 Conduit ends shall be carefully plugged during construction with steel capped bushings.
 - .19 The use of running threads shall not be permitted. Ericson couplings shall be used where required.
 - .20 Conduit shall not pass through structural members without the approval of the Consultants.
 - .21 Powder activated fastenings can only be used if approved by the Consultant.
 - .22 Conduits shall be fastened with approved clips. Supporting of conduits with tie wires, perforated straps, etc. shall not be permitted. If a conduit rests on structural steel, etc., this will not be considered as a support. Provide proper supports, hangers, etc. and supports conduits from the top of structural beams/trusses/joists.
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- .23 Conduit supports shall be spaced in accordance with the requirements of the Authorities having jurisdiction.
 - .24 An adequate number and size of pull boxes shall be installed where required in all conduit runs to facilitate the installation of the conductors.
 - .25 Fish wires shall be installed in all empty conduits, including telephone conduits.
 - .26 Excessive lengths of flexible conduit shall not be accepted.
 - .27 Proper metallic contact shall be made between conduit, boxes, etc.
 - .28 Maximum size of conduit on which ground bushings can be used is 32mm.
 - .29 A separate ground wire shall be installed in flexible conduits, EMT conduits and conduits in or below a concrete slab, and in all non-metallic conduits or ducts.
 - .30 Installation of conduit in oversize knockouts shall not be accepted.
 - .31 Joints in conduits installed underground, in concrete slab on grade or in a concrete duct bank shall be pitched on the outside and made completely watertight.
 - .32 Minimum concrete thicknesses over a conduit in a concrete slab where applicable shall be 50mm.
 - .33 Spare or unused conduits that terminate in an enclosure shall be capped.

END OF SECTION 26 01 10

1.1 GENERAL

- .1 Refer to Section 26 01 20, General Electrical Provisions.

2.1 PRODUCTS

- .1 Except for those items as may be specified in Part 3 of this Section, refer to Part 2 of the various Sections of Specification, Division 26 Electrical.
- .2 Low voltage wires and cables up to 4/0 shall, unless otherwise noted, have copper conductors with T90 (90 degrees C.) 600 volt insulation.
- .3 Low voltage wires and cables 250 MCM and larger shall, unless otherwise noted, have copper conductors with RW90 X-Link minus 40 degrees F. 1000 volt insulation.
- .4 Aluminum sheathed feeder cables shall, unless otherwise noted, have a corrugated seamless aluminum sheath, copper conductors, RA90 X-Link minus 40 degrees F. 1000 volt insulation and without P.V.C. jacket.
- .5 M.I.C.C./Vitalink cables shall have solid copper conductors insulated with magnesium oxide and enclosed in a seamless copper sheath with a protective jacket where required.
- .6 All outdoor wiring shall have copper conductors with RWU-90, X-Link, minus 40 degrees F. 1000 volt insulation.

3.1 EXECUTION

- .1 Except for those items as may be specified in Part 3 of this Section, refer to Part 2 of the various Sections of Specification, Division 26 Electrical.
- .2 Wires and cables shall be selected so that their current carrying capacity conforms with the standards of the Authorities having jurisdiction.
- .3 Feeders and branch circuits shall be as indicated on the drawings. Supporting of wires and cables with tie wires, perforated straps, etc., shall not be permitted. Electrical Contractor shall use approved clips.
- .4 Unless otherwise indicated on the drawings no wire smaller than #12 AWG shall be used except for internal wiring of lighting fixtures which can be #14.
- .5 BX90 aluminum sheathed cable, unless otherwise noted, may be used in accessible ceiling space and where concealed only. Install BX cables with anti-short bushings. Installation of excessive lengths of BX cables shall not be acceptable (maximum 10'-0" length).
- .6 Aluminum sheathed and M.I.C.C./Vitalink cables shall be installed with horizontal supports at not more than 1220mm intervals and shall be spaced, bonded and grounded in accordance with the requirements of the Authorities having jurisdiction.
- .7 Aluminum sheathed and M.I.C.C./Vitalink cables shall be terminated with moisture proof connectors.

- .8 Where single conductor cables enter a ferrous box, provide the required non-ferrous plates. Slotting between the knockouts shall not be accepted.
- .9 Aluminum sheathed and M.I.C.C./Vitalink cables shall be suitably protected, when installed within 5 feet of the floor and in all locations where they might be subject to mechanical injury.
- .10 Joints in feeder cables shall not be permitted.
- .11 Joints in branch circuit wiring shall only occur where such circuits divide at a junction box and shall be mechanically and electrically sound and shall be securely fastened by means of "Ideal" 600V special service wire nut connectors.
- .12 Conductors shall be colour coded and the colour coding shall be consistent throughout the project.
- .13 Conductors shall be identified with self-sticking wire markers, indicating circuit number at all terminations and joints, at panels, pull boxes, junction boxes, etc.
- .14 Termination lugs for feeder cables shall be compression type.
- .15 Provide zip tie identification label to M.I.C.C./Vitalink cables located in ceiling space. Install label every 5'-0" to avoid misguided as copper pipe. Label shall read **"Danger – Live Electric High Voltage Cables"**.
- .16 Wiring terminated in an outlet box for future lighting or power shall have 250mm of slack and each cable shall be terminated in a connector.
- .17 Exposed cable runs shall be installed parallel to, or horizontally on, the walls of the building.
- .18 Loads shall be circuited to provide fully balanced feeders.
- .19 Only lubricants approved by the Authorities having jurisdiction shall be used and they shall be suitable for the type of cables installed.
- .20 Wiring for exterior lights shall be minimum #10 AWG.
- .21 BX cables are allowed only between luminaires and outlet box in recessed ceilings.

END OF SECTION 26 01 20

1.1 GENERAL

- .1 Refer to Section 26 00 10, General Electrical Provisions.

2.1 PRODUCTS

- .1 Except for those items as may be specified in Part 3 of this Section, refer to Part 2 of the various Sections of Specification, Division 26 Electrical.
- .2 Outlet boxes used with rigid steel conduit shall be 'FS' or 'FD' Feraloy condulets.
- .3 Outlet boxes used with EMT conduit shall be electro-galvanized and made of code gauge steel except when they are surface mounted on walls when they shall be 'FS' or 'FD' Feraloy condulets.
- .4 Outlet boxes installed outside the building shall be weatherproof type, with neoprene gasket and cast cover.

3.1 EXECUTION

- .1 Except for those items as may be specified in Part 2 of this Section, refer to Part 3 of the various Sections of Specification, Division 26 Electrical.
- .2 Outlet boxes shall have adequate knockouts, but only those knockouts actually required shall be opened.
- .3 Outlet boxes shall be securely fastened to the surface on which they are mounted. If the boxes are not mounted on a surface then adequate and independent supports must be provided.
- .4 Outlet boxes shall be provided for each surface mounted lighting fixture.
- .5 Outlet boxes shall be provided for each recessed mounted lighting fixture.
- .6 Multi-gang outlet boxes with single cover plate shall be used where switches are grouped.
- .7 Unused opened knockouts shall be closed with steel knockout plugs.

END OF SECTION 26 01 30

1.1 GENERAL

- .1 Refer to Section 26 00 10, General Electrical Provisions.

2.1 PRODUCTS

- .1 Except for those items as may be specified in Part 3 of this Section, refer to Part 2 of the various Sections of Specification, Division 26 Electrical.
- .2 Type 'C', 'D', 'T' and 'E' pull boxes, junction boxes and cabinets shall be made of code gauge steel with corners lapped and welded and shall be painted and identified as noted in this specification.
- .3 Cabinets shall provide proper space for conduits, wires and connections and their size shall be in accordance with the requirements of the Authorities having jurisdiction.
- .4 The trim and cover shall be as required by the service and location.
- .5 The metal cabinets shall be as manufactured by F.P.E., Cutler Hammer, Square 'D', Pursley or Hammond.

3.1 EXECUTION

- .1 Except for those items as may be specified in Part 2 of this Section, refer to Part 2 of the various Sections of Specification, Division 26 Electrical.
- .2 Pull boxes, junction boxes and cabinets shall be independently supported from the conduit connected to them.
- .3 The cabinets shall be suitable for the installation and location.

END OF SECTION 26 01 32

1.1 GENERAL

- .1 Refer to Section 26 00 10, General Electrical Provisions.

2.1 PRODUCTS

- .1 Except for those items as may be specified in Part 3 of this Section, refer to Part 2 of the various Sections of Specification, Division 26 Electrical.
- .2 Light switches on 120 volt circuits under 1200 watts shall be 15 amp. and above 1200 watts shall be 20 amp.
- .3 Light switches on 347 volt circuits under 3500 watts shall be 15 amp. and above 3500 watts shall be 20 amp.
- .4 Light switches shall be premium specification grade, A.C., toggle type switches.
- .5 Receptacles shall be of the type shown on the drawings with the standard C.S.A. configurations and shall be premium specification grade, Hubbell #5262.
- .6 Light switches and receptacles on normal power shall be white unless noted otherwise.
- .7 Light switches and receptacles on emergency power shall be Red.
- .8 Dimmer switches shall be Acuity Controls nLight, Cat. #nPODM-DX-WH complete with nlight power pack, Cat. #nPP16-D-347. Provide Cat. 5e cables complete with T568B pin/pair assignment for connections between dimmer switches and between dimmer switch and power pack as per manufacturer's specifications and wiring diagram.
- .9 Service receptacles for Caretaker's equipment located in corridors, service area and plug-in classroom control panels shall be grey colour for easy recognition.
- .10 Receptacles in Child Care Area shall be tamper proof, Hubbell #5G-62-H.
- .11 Wall plates for flush mounted devices shall be multiple gang super stainless steel type 302.
- .12 Wall plates for surface mounted devices in unfinished areas shall be metal covers for F.S. type boxes.
- .13 The weatherproof plates shall be cast aluminum with lift cover for F.S. type boxes.
- .14 The T.V. and computer outlet wall plates shall be complete with blank coverplate unless otherwise noted.
- .15 The telephone outlet wall plates shall be complete with blank coverplate unless otherwise noted.
- .16 Receptacle mounted on the exterior walls of the building and roof shall be with ground fault protection mounted in an F.S. type box with a Hubbell #MX3200 in-use cover plate.
- .17 50A/208V 1 phase 3W receptacle, range receptacle Smith & Stone #1-8450 complete with plug and cord set.

- .18 30A, 120/208V receptacle Smith & Stone #1-8430 dryer receptacle complete with plug and cord set.
- .19 Wiring devices shall, unless otherwise noted, be of Hubbell, Smith & Stone, Circle 'F' or Arrow-Hart manufacture and the dimmers shall be Lutron manufacture.
- .20 Receptacle controlled by occupancy sensor through switchpack/room controller shall be complete with engraved label/permanent marking (sticker and lamacoid label is not acceptable) similar to Hubbell Cat. #BR15C2GRY.

3.1 **EXECUTION**

- .1 Except for those items as may be specified in Part 2 of this Section, refer to Part 3 of the various Sections of Specification, Division 26 Electrical.
- .2 Symbols on drawings show approximate locations. Care shall be taken to locate each device to ensure that it is in the appropriate location to suit the Architectural finishes.
- .3 Mounting heights are referred to finished floor or finished ceiling unless related to bench mark elevations.
- .4 Provide cover plates for flush mounted manual starters.
- .5 Light switches, except where noted, shall be mounted 1000mm to 1100mm above finished floor on the lock side of the door. (Coordinate with Consultants).
- .6 Receptacle, telephone, etc. outlets shall, unless otherwise noted, be mounted vertically 350mm above finished floor in the finished areas and 1370mm in all unfinished areas. Thermostats shall be mounted 1200mm, unless otherwise noted.
- .7 Telephone, P.A., etc. wall outlets shall be spaced 100mm from power outlet.

END OF SECTION 26 01 40

1.1 GENERAL

- .1 Refer to Section 26 00 10, General Electrical Provisions.

2.1 PRODUCTS

- .1 Except for those items as may be specified in Part 3 of this Section, refer to Part 2 of the various Sections of Specification, Division 26 Electrical.
- .2 Provide lighting control device(s) including occupancy sensors, room controllers, daylight sensors, dimmers, etc. as specified on the drawings.

- Provide associated power and relay packs.
- Provide all associated mounting accessories.

- .3 Electrical Contractor shall include in tender price for installation, testing, time adjustment, functional testing and commissioning of occupancy sensors, room controllers, daylight sensors, and programming of Auto-On sequence of all lighting control devices for light fixtures on a room by room basis in entire building by manufacturer. Submit verification/commissioning report after completion of work.

- .4 Lighting Control Devices Commissioning:

- .1 Functional testing: lighting control devices and control systems shall be tested to ensure that control hardware and software are calibrated, adjusted, programmed, and in proper working condition in accordance with the construction documents and manufacturer's installation instructions. Where occupancy sensors, time switches, programmable schedule controls, or photo sensors are installed, the following procedures shall be performed.

Occupancy sensors:

- Certify that the sensor has been located and aimed in accordance with manufacturer recommendations.
- For each sensor to be tested, verify the following:
 - Status indicator (as applicable) operates correctly.
 - Controlled lights turn 'off' or down to the permitted level within the required time.
 - For auto-on occupancy sensors, the lights turn 'on' to the permitted level when someone enters the space.
 - For manual-on sensors, the lights turn 'on' only when manually activated
 - The lights are not incorrectly turned 'on' by movement in nearby areas or by HVAC operation.
- Simulate occupied condition. Verify and document the following:
 - All lights can be turned 'on' and 'off' by their respective area control switch.
 - The switch only operates lighting in the enclosed space in which the switch is located.

- Simulate unoccupied condition. Verify and document the following:
 - All non-exempt lighting turns 'off'.
 - Manual override switch (where applicable) allows only the lights in enclosed space where the override switch is located to turn 'on' or remain 'on' until the next scheduled shut off occurs.
 - Daylight controls
 - All control devices (photocontrols) have been properly located, field-calibrated, and set for appropriate setpoints and threshold light levels.
 - Daylight controlled lighting loads adjust to appropriate light levels in response to available daylight.
 - The location where calibration adjustments are made is readily accessible only to authorized personnel.
- .2 Functional testing report/documentation shall certify that the installed lighting control of each respective space in entire building meets all requirements as specified in the contract documents.
- .5 Acceptable manufacturer of lighting control devices: Watt Stopper, Eaton, Hubbell.

3.1 **EXECUTION**

- .1 Except for those items as may be specified in Part 2 of this Section, refer to Part 3 of the various Sections of Specification, Division 26 Electrical.
- .2 Install all lighting control devices as shown on electrical drawings. Provide all components to suit.
- .3 Exact location of occupancy sensors shall be co-ordinated on site and shall comply with the manufacturer's recommendations.
- .4 Install number of power packs and associated relays to suit the number of circuits in the respective spaces. Installation shall comply with the manufacturer's recommendations. Co-ordinate with the manufacturer.

END OF SECTION 26 01 41

1.1 GENERAL

- .1 Refer to Section 26 00 10, General Electrical Provisions.

2.1 PRODUCTS

- .1 Supply and install a surface raceway system. The raceway is to be wall mounted or otherwise supported as indicated. It is to be used as a flexible wiring system and for the installation of receptacle outlets and computer in heavily serviced areas, as shown on the drawings.
- .2 The raceway is to be two channels with removable cover to provide access to wiring and to permit the easy addition or alteration of circuits and devices at any time. (Finish to be selected by the Architect).
- .3 The raceway is to be provided with a barrier to form separate compartments for power circuits and computer wiring as indicated.
- .4 The system shall be suitable for 120/208V, 3 phase, 4 wire distribution.
- .5 The system shall be Wiremold DS4000 Series - two (2) cells with length as shown on the drawings.
- .6 Fabricate raceway and cover from high impact resistant material. Colour to be selected by Architect. Furnish in Standard 1828mm (6ft.) lengths.
- .7 Provide all fittings and covers necessary for the installation. Fittings and covers shall be tamper resistant to prevent unauthorized access to the wiring. This shall include but not be limited to the following items (model number for receptacles and data outlets shall be confirmed by the Owner before ordering):
- Raceway cover.
 - Divider wall
 - Mounting bracket.
 - Connector clip.
 - Wire retainer.
 - End cap.
 - Inside corner base
 - Outside corner base.
 - Outside corner cover.
 - T hanging device bracket for standard data/communication and electrical devices.
 - Coverplates for standard data/communication and electrical receptacles shall be DS4047C.
 - Duplex receptacle outlets
- .8 Receptacles shall be as specified in Section 26 01 40.
- .9 Devices shall be flush mounted inside the raceway.

3.1 EXECUTION

- .1 Install the raceway and accessories in a neat and orderly manner.
- .2 Raceway shall be installed horizontally on walls above counters, baseboards and splashbacks, fixed to drywall or masonry wall surfaces, at mounting heights indicated on the drawings.
- .3 Arrange for the installation of backing in drywall partitions to ensure the raceway is securely fastened. Horizontal metal studs mounted with sheet metal screws are satisfactory. Fasten raceway base to backing.
- .4 Use continuous lengths for runs less than 1830mm (6ft.). For shorter lengths, field cut to suit. Carefully cut all barriers, covers and bases. Make cuts at right angles. Cut edges to be free from burrs, sharp edges, bends and other distortions. Use a floor mounted power hacksaw or similar device for cuts.
- .5 In-feeds are to be conduit run concealed in walls and ceiling space.
- .6 Install wire and devices as required.
- .7 Mount lamacoid nameplate on raceway device plate, above or below each outlet. Attach with screws. Adhesive fasteners are not acceptable. Engrave with circuit number, including panel designation, and computer outlet number.
- .8 Provide in standard factory boxes. Larger items not normally boxed shall be provided with a heavy wrapping and suitably identified.

END OF SECTION 26 01 42

1.1 GENERAL

- .1 Refer to Section 26 00 10, General Electrical Provisions.

2.1 PRODUCTS

- .1 Except for those items as may be specified in Part 3 of this Section, refer to Part 2 of the various Sections of Specification, Division 26 Electrical.
- .2 Floor outlets in slab on grade shall consist of the following components depending on location and function. The basis floor box unit shall be Hubbell Multi-Service concrete floor box series.
- .3 Floor outlets shall be Hubbell, Base Cat. #HBL-CFB7G, Carpet Flange and Cover Plate Cat. #HBL-CFB7CVRXX and complete with all other associated components. Cover finish to be selected by the Architects.
- .4 Poke-thru floor outlets shall be one-piece 50/50 split, 6" fire-rated poke-thru for third party devices. 6" flange and cover assembly, Cat. #S1R6CVRXX, complete with right 50% sub-plate for 4-20A pre-wired receptacles, Cat. #S1R6SPH, and left 50% sub-plate for decorator device (data outlet plate with 4-data jacks), Cat. #S1R6SPK

3.1 EXECUTION

- .1 Except for those items as may be specified in Part 2 of this Section, refer to Part 3 of the various sections of specification, Division 26 Electrical.
- .2 The exact locations and quantities of the floor outlets shall be determined on site at a later date during the course of the contract.
- .3 The floor outlets in slab on grade floors shall be installed prior to the concrete for the floor being poured.
- .4 The floor outlets in poured floor slab shall be installed after the concrete floor is poured. The slab shall be drilled by this Division for the floor outlets.
- .5 Where floor outlets are grouped together they shall be spaced at 6" (150mm) centre to centre either next to each other or in a triangle configuration.
- .6 For installations of all floor outlets in poured floor slab, Electrical Contractor shall include in tender price for all necessary drilling of concrete slab.
- .7 All "isolated ground", floor outlets and wall outlets must have an isolated separate ground, and each circuit must have its own separate neutral. Note that the same neutral cannot be used for three circuits in the usual manner.
- .8 Where conduit sizes larger than 1" (25mm) is indicated supply special boxes to accommodate the conduit.

END OF SECTION 26 01 43

1.1 GENERAL

- .1 Refer to Section 26 00 10, General Electrical Provisions.

2.1 PRODUCTS

- .1 Except for those items as may be specified in Part 3 of this Section, refer to Part 2 of the various Sections of Specification, Division 26 Electrical.
- .2 Classroom control panel modules will be supplied and installed by another Section of the Specification. (Refer to Architectural Specification).

3.1 EXECUTION

- .1 Except for those items as may be specified in Part 2 of this Section, refer to Part 3 of the various Sections of Specification, Division 26 Electrical.
- .2 Install wiring devices, P.A. speakers, etc., as shown on the drawings.
- .3 Co-ordinate work with architectural details, clock, P.A. system and wiring device sections of the specifications.
- .4 Co-ordinate with manufacturer (supplier) location of devices, speakers, etc. for a complete system.
- .5 All work shall be done in accordance with manufacturers requirements and recommendations.

END OF SECTION 26 01 45

1.1 GENERAL

- .1 Refer to Section 26 00 10, General Electrical Provisions

2.1 PRODUCTS

- .1 Except for those items as may be specified in Part 3 of this Section, refer to Part 2 of the various Sections of Specification, Division 26 Electrical.
- .2 The motors shall be provided and adjusted by Division 23.
- .3 The starters shall be supplied by Division 23.
- .4 The Variable Frequency Drives and associated input/output Reactors shall be supplied by Division 23.
- .5 The motor control centres shall be supplied by Division 23.

3.1 EXECUTION

- .1 Except for those items as may be specified in Part 2 of this Section, refer to Part 3 of the various Sections of Specification, Division 26 Electrical.
- .2 Provide and connect conduit and power wiring to the motors. Conduit and wiring for low voltage thermostats shall, unless otherwise noted, be provided by another Division of the Specification. Wiring and conduit for line voltage thermostats shall be by this Division. Co-ordinate with Division 23 drawings.
- .3 Take delivery of and install the starters and motor control centre and provide and connect conduit and power wiring to the starters and motor control centres. Control wiring and conduit shall, unless otherwise noted, be provided by Division 23.
- .4 Variable Frequency Drives (VFD) complete with associated remote input & output reactors supplied by Division 23 and wired & installed by Division 26. Coordinate the wiring and installation of VFD and associated remote input & output reactors with Division 23 and on site.
- .5 Fuses for the fused combination magnetic starters shall be supplied and installed by Division 23.
- .6 Prepare a schedule of each motor connected which shall include the following:-
- Purpose of motor.
- Full load current.
- Horsepower.
- Phase.
- Voltage.
- Overload heater size and type.
- Fuse size and type.
- .7 Submit the motor schedule for review by the Consultant and include the schedule in the manuals.

END OF SECTION 26 01 50

1.1 GENERAL

- .1 Refer to Section 26 00 10, General Electrical Provisions.

2.1 PRODUCTS

- .1 Except for those items as may be specified in Part 3 of this Section, refer to Part 2 of the various Sections of Specification, Division 26 Electrical.
- .2 Lighting panels shall be of the size, capacity and type as shown on the drawings.
- .3 Lighting panels shall be of the sprinklerproof, dead front type enclosed in code gauge steel equipped with door, lock and directory and shall be suitable for surface or flush mounting as required.
- .4 Bussing in each panel shall be copper and shall extend the full length of the panel.
- .5 Breakers shall be ambient compensated type, calibrated at 40 degrees C. and be of the bolt-on type. Multi-pole breakers shall have common trip.
- .6 Lighting panels for use on 208 volt system shall, unless otherwise noted be of the "NBLP" type with NB breakers.
- .7 Lighting panels for use on 600 volt system shall, unless otherwise noted be of the "NHDP" type with CED6 breakers.
- .8 Panels, including tubs, shall have two coats of primer paint and two coats of ANSI49 grey paint.
- .9 Lighting panels shall be of the same manufacturer as the switchboard.

3.1 EXECUTION

- .1 Except for those items as may be specified in Part 2 of this Section, refer to Part 3 of the various Sections of Specification, Division 26 Electrical.
- .2 Locate lighting panels where indicated and mount securely and plumb true and square to adjoining surfaces.
- .3 Panels are to be mounted so that the top of the panels are 1800mm above finished floor for panels up to 54 circuits, and 1980mm above finished for panels larger than 54 circuits.
- .4 Provide 1-25mm empty conduit from each flush mounted panel to the ceiling spaces above and below for future installation.
- .5 Provide wireways above multi-section panels to avoid cross-wiring.
- .6 Numbering of breakers in multi-panel assemblies shall be consecutive. If necessary provide narrow Dymomite strips with the required numberings.

- .7 Prior to energizing or commissioning the panels, they shall be fully inspected, tested, checked and adjusted to include, but not limited to, the following:-
- Grounding.
 - Bus torque, supports, clearance, general mechanical conditions and insulation resistance.
 - Breaker operation.
 - Breaker settings.
 - Continuity of feeder cables.
 - Phase resistance of feeder cables.
 - Insulation resistance of feeder cables.
 - Proper phasing of incoming and feeder cables.
 - Equal division of load between parallel conductors.
- .8 30% of all breakers in panels shall be equipped with locking devices. These locking devices shall be installed as directed by the Consultant on completion of work and the unused units shall be handed over to the Owners.

END OF SECTION 26 01 60

1.1 GENERAL

- .1 Refer to Section 26 00 10, General Electrical Provisions.

2.1 PRODUCTS

- .1 Except for those items as may be specified in Part 3 of this Section, refer to Part 2 of the various Sections of Specification, Division 26 Electrical.
- .2 Power panels shall be factory assembled, sprinklerproof, free standing, dead front type, suitable for use on the system as specified on the drawings, and shall be braced to block wall to suit seismic requirements.
- .3 Fusible panels shall be of the "QMQB" type consisting of a fully convertible chassis to permit assembly of units in any desired arrangement. The fusible units shall have visible blades, integral handle mechanism, cover interlock, quick-make, quick-break mechanism, front operation, high pressure fuse holders and recessed live parts. The units shall be floor mounted and shall, unless otherwise noted, be 92" in height.
- .4 Breaker panel shall be of the "CDP" type with the sizes and type of breakers as shown on the drawings. The panels shall be wall mounted, surface or flush as specified on the drawings.
- .5 Splitter troughs shall be complete with copper bus bars the length of the trough. The covers shall be bottom hinged with retained securing screws at the top.
- .6 Bussing in each panel shall be copper and shall extend the full length of the panel.
- .7 Panels shall be provided with the non-ferrous plates for aluminum sheathed cables.
- .8 Panels, including tubs, shall have two coats of primer paint and two finish coats of ANSI49 grey paint.
- .9 Power panels shall be of the same manufacturer as the main switchboard.

3.1 EXECUTION

- .1 Except for those items as may be specified in Part 2 of this Section, refer to Part 3 of the various Sections of Specification, Division 26 Electrical.
- .2 Locate power panels where indicated and mount securely and plumb true and square to adjoining surfaces.
- .3 All panels less than 1520mm are to be wall mounted so that the top of the panel is 1980mm above finished floor.
- .4 Connect loads to the circuits as shown on the drawings.
- .5 Openings in panels shall be cut or punched. Burning of holes shall not be permitted.
- .6 Each panel and switches or breakers mounted in them, shall be identified.

- .7 Prior to energizing or commissioning the panels, they shall be fully inspected, tested, checked and adjusted to include, but not limited to, the following:-
- Grounding.
 - Bus torque, supports, clearance, general mechanical conditions and insulation resistance.
 - Breaker and switches operation.
 - Trip units tested and calibrated to the settings provided by the Co-ordination Study.
 - Breaker settings and fuses.
 - Ground fault system operation.
 - Continuity of feeder cables.
 - Phase resistance of feeder cables.
 - Insulation resistance of feeder cables.
 - Proper phasing of incoming and feeder cables.
 - Equal division of load between parallel conductors.

END OF SECTION 26 01 62

1.1 GENERAL

- .1 Refer to Section 26 00 10, General Electrical Provisions.

2.1 PRODUCTS

- .1 Except for those items as may be specified in Part 3 of this Section, refer to Part 2 of the various Sections of Specification, Division 26 Electrical.
- .2 The disconnect switches shall have the operating handle interlocked with the switch cover so that it can only be opened when the switch is in the "Off" position, and the handle cannot be put in the "On" position unless the cover is closed.
- .3 The fused switches shall have steel reinforced clips and fuses shall be easily removable when the switch is in the "Off" position.
- .4 Switches shall have ample gutter space for top or bottom wiring and shall have fully visible blades when in the "Off" position, quick-make, quick-break mechanism and be horse-power rated.
- .5 Switches used outdoors shall be in a weatherproof enclosure.
- .6 Switches shall have provision for padlocking in the "Off" position and interlock defeat.
- .7 All motors shall be provided with a disconnect switch by this Division unless otherwise noted.
- .8 The disconnect switches shall be as manufactured by F.P.E., Cutler Hammer, Siemens, or Square 'D'.
- .9 All disconnect switches shown in dotted line on the drawings are supplied and installed by another division of this specification.

3.1 EXECUTION

- .1 Except for those items as may be specified in Part 2 of this Section, refer to Part 3 of the various Sections of Specification, Division 26 Electrical.

END OF SECTION 26 01 70

1.1 GENERAL

- .1 Refer to Section 26 00 10, General Electrical Provisions.

2.1 PRODUCTS

- .1 Except for those items as may be specified in Part 3 of this Section, refer to Part 2 of the various Sections of Specification, Division 26 Electrical.
- .2 Contactors controlling lighting panels or branch circuits shall be tungsten rated, electrically operated, electrically held with coil clearing contacts of the size and rating specified, complete with control transformer, control circuit fuses, pilot light warning label and On/Off/Auto selector switch.
- .3 Contactors shall be in sprinkler proof enclosure and shall be designed and manufactured in accordance with Nema standards and sizes.
- .4 The contactors ampere rating shown on the drawings is the minimum continuous enclosed derated rating of the contactors.
- .5 Contactors controlling branch circuits shall be mounted above the lighting panel from which they are fed, unless otherwise noted.
- .6 Contactors shall be of Allen-Bradley, Eaton, Siemens and Square 'D' manufacture.

3.1 EXECUTION

- .1 Except for those items as may be specified in Part 2 of this Section, refer to Part 3 of the various Sections of Specification, Division 26 Electrical.
- .2 Field designed and assembled contactor assemblies will not be accepted.

END OF SECTION 26 01 72

1.1 GENERAL

- .1 Refer to Section 26 00 10, General Electrical Provisions.

2.1 PRODUCTS

- .1 Except for those items as may be specified in Part 3 of this Section, refer to Part 2 of the various Sections of Specification, Division 26 Electrical.
- .2 Fuses protecting motor circuits shall be Form I Class `J' time delay.
- .3 Other fuses up to 600A shall be Form I Class `J'.
- .4 Other fuses above 600A shall be Form I Class `L'.
- .5 All fuses shall be of Gould Shawmut, Bussman, G.L.E. Inc. or G.E.C.

3.1 EXECUTION

- .1 Except for those items as may be specified in Part 2 of this Section, refer to Part 3 of the various Sections of Specification, Division 26 Electrical.
- .2 Provide fuses for the complete electrical installation.
- .3 Supply three (3) spare fuses of each size and type installed.
- .4 Provide in the main electrical room a wall mounted metal cabinet complete with doors and lock, and an adequate quantity of pigeon holes to accommodate the spare fuses.
- .5 To avoid confusion and possible loss the fuses shall not be stored in the cabinets until they are physically counted by the Owner's representative and a written receipt obtained for them. A copy of the receipt shall be included in the manuals.

END OF SECTION 26 01 80

1.1 GENERAL

- .1 Refer to Section 26 00 10, General Electrical Provisions.

2.1 PRODUCTS

- .1 Except for those items as may be specified in Part 3 of this Section, refer to Part 2 of the various Sections of Specification, Division 26 Electrical.
- .2 Access panels for walls and ceiling shall be of the flush type with concealed flanges constructed from 12 gauge minimum bonderized steel and shall be complete with anchor straps, rust resistant concealed hinges and positive locking, self-opening screwdriver operated lock.
(Co-ordinate with Division 23).
- .3 Access panels in tiled walls shall be stainless steel with recessed door panel to accept wall finish and shall be of a size to suit tile pattern.
- .4 Access panels installed in fire rated walls, partitions or ceilings shall have a fire resistance rating equal to the materials in which they are installed.
- .5 Access panels shall be as manufactured by LeHage, SMS, Pedlar or approved equal.

3.1 EXECUTION

- .1 Except for those items as may be specified in Part 2 of this Section, refer to Part 3 of the various Sections of Division 26 Specification.
- .2 All parts of the installation including, but not limited to, pull-in, junction and outlet boxes, cabinets, gutters, etc. shall be accessible.
- .3 Supply access panels as required to provide complete access to all equipment and connections. The access panels shall be installed by other Sections of the specification.
- .4 Provide drawings showing size, type and location of all access panels and submit for review by the Consultant.

END OF SECTION 26 01 92

1.1 GENERAL

- .1 Refer to Section 26 00 10, General Electrical Provisions.

2.1 PRODUCTS

- .1 Except for those items as may be specified in Part 3 of this Section, refer to Part 2 of the various Sections of Specification, Division 26 Electrical.
- .2 Emergency battery lighting units Type "X" shall be as manufactured by Lumacell and shall be CSA C22.2.141 Performance approved and shall be connected to a 120 volt A.C. 60 cycle, single phase power source and shall provide automatically and instantaneously emergency lighting upon failure or interruption of normal electric power. Batteries shall be sealed lead, 12 volt, 72 watt complete with two (2) emergency heads. Charger shall be completely automatic solid state type, with inverse temperature compensation. The control panel shall contain the following:-
- A.C. pilot light.
 - Test button.
 - On-Off switch.
 - Provision for conduit connection.
 - Burn-out protection.
- .3 The battery units shall be Lumacell "RG24S-72", Emergi-Lite, Ready-Lite or BeLuce.
- .4 The complete system shall have a one year unconditional guarantee and a 5-year pro-rata guarantee on workmanship and parts and 10 years pro-rata on batteries.
- .5 Emergency lighting consists of LED fixtures connected to emergency generator.
- .6 Exit signs are connected to emergency generator.

3.1 EXECUTION

- .1 Except for those items as may be specified in Part 2 of this Section, refer to Part 3 of the various Sections of Division 26 Specification.
- .2 Install units where shown on the drawings and provide all necessary mounting hardware.
- .3 Emergency lighting level test, with on-site readings to show lighting levels in all areas with emergency lighting fixtures, shall be performed by qualified emergency lighting manufacturer/vendor representative, and report shall be submitted to Architect/Consultant for review. Also provide emergency lighting certificate.

END OF SECTION 26 02 10

1.1 **GENERAL**

.1 Refer to Section 26 00 10, General Electrical Provisions.

.2 **Work Included**

- .1 Supply and install an emergency electrical power supply for the School, comprised of one natural gas driven electric generator set with all auxiliaries to comprise an independent, fully automatic power plant for generation of 600/347 volts, 3 phase, 4 wire electrical power.
- .2 Provide connections from the emergency electrical power system to equipment shown on the drawings, utilizing an entirely independent wiring system.
- .3 The unit shall provide standby power for essential electrical loads in the building and shall automatically start in the event of a power failure.
- .4 The unit shall be SG080 Generac by Total Power Ltd. or approved equal.
- .5 Emergency generator remote trouble panel shall be sprinkler-proof.

.3 **Code Requirements**

- .1 Ontario Building Code (latest edition).
- .2 The latest edition of the CSA Standard "Emergency Electrical Power Supply for Buildings", C282.
- .3 National Board of Fire Underwriters for the Installation and Use of Combustion Engines and Gas Turbines.
- .4 Electrical Safety Code, 21st. Edition.
- .5 The latest edition of the CSA Standard, "Natural Gas and Propane Installation Code" B149.1.
- .6 All other standards referred to in the above.
- .7 Where applicable, equipment is to bear CSA approval and ULC approval.

.4 **Description of System**

- .1 Provide a standby power system to supply electrical power in the event of failure of normal supply, consisting of a liquid cooled engine, an AC alternator and system controls with all necessary accessories for a complete operating system, including but not limited to the items as specified hereinafter.

.5 Requirements of Regulatory Agencies

- .1 An electric generating system, consisting of a prime mover, generator, governor, coupling and all controls, must have been tested, as a complete unit, on a representative engineering prototype model of the equipment to be sold.
- .2 The generator set(s) must conform to applicable CSA standards.
- .3 The unit(s) shall be supplied with Canadian Standards Association certification.
- .4 The generator set(s) must meet EPA federal emission guidelines for stationary standby power generation, as applicable for natural gas engines.

.6 Manufacturer Qualifications

- .1 This system shall be supplied by **Total Power Ltd., phone 888-870-9152, fax 905-670-1317** or an approved equal who has been regularly engaged in the production of engine-alternator sets, automatic transfer switches, and associated controls for a minimum of twenty years, thereby identifying one source of supply and responsibility.
- .2 To be classified as a manufacturer, the builder of the generator set must manufacture, at minimum, engines or alternators.
- .3 The manufacturer shall have printed literature and brochures describing the standard series specified, not a one of a kind fabrication.

2.1 PRODUCTS

- .1 Except for those items as may be specified in Part 3 of this Section, refer to Part 2 of the various Sections of the Specification, Division 26 Electrical.

.2 Engine

- .1 The prime mover shall be a liquid cooled, natural gas fueled, naturally aspirated engine of 4-cycle design. It will have 10 cylinders with a minimum displacement of 6.8 liters (417 cubic inches), with a minimum rating of 128 BHP. The unit requires a minimum rated output of 80 kW at an operating speed of 2300 RPM.
- .2 The engine is to be cooled with a unit mounted radiator, fan, water pump, and closed coolant recovery system providing visual diagnostic means to determine if the system is operating with a normal engine coolant level. The radiator shall be designed for operation in 122 degrees f, 50 degrees c ambient temperature.
- .3 The intake air filter(s) with replaceable element must be mounted on the unit. Full pressure lubrication shall be supplied by a positive displacement lube oil pump. The engine shall have a replaceable oil filter(s) with internal bypass and replaceable element(s). Engine coolant and oil drain extensions, equipped with pipe plugs, must be provided to outside of the mounting base for cleaner and more convenient engine servicing. A fan guard must be installed for personnel safety.

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- .4 The engine shall have a battery charging DC alternator with a transistorized voltage regulator. Remote 2-wire starting shall be by a solenoid shift, electric starter.
 - .5 The engine fuel system shall be designed for primary operation on natural gas having a BTU content of 1000 BTU per cubic foot delivered to the unit in a vapor state. A carburetor, secondary regulator, fuel lock-off solenoid and all piping must be installed at the point of manufacturing, terminating at a single pipe opening external to the mounting base.
 - .6 The engine shall have (a) unit mounted, thermostatically controlled water jacket heater(s) to aid in quick starting. The wattage shall be as recommended by the manufacturer. The contractor shall provide proper branch circuit from normal utility power source.
 - .7 Sensing elements to be located on the engine for low oil pressure shutdown, high coolant temperature shutdown, low coolant level shutdown, overspeed shutdown and overcrank shutdown. These sensors are to be connected to the control panel using a wiring harness with the following features: wire number labeling on each end of the wire run for easy identification, each sensor connection shall be sealed to prevent corrosion and all wiring to be run in flexible conduit for protection from the environment and any moving objects.
 - .8 Provide the following items installed at the factory:
 - The manufacturer shall supply its recommended stainless steel, flexible connector to couple the engine exhaust manifold to the exhaust system.
 - The manufacturer shall provide exhaust system catalytic converter.
 - The engine oil pan will contain a 120VAC, 150 watt, thermostatically controlled crankcase oil heater. The operating temperature to be set at 80 deg. on and 100 deg. off.
 - .9 The following equipment is to be provided by the engine-generator set manufacturer and shipped loose with the unit:
 - The manufacturer will supply an approved flexible fuel line to connect the engine to the external natural gas fuel supply line. On stationary applications the fuel line shall match the fuel fitting on the unit and have braided stainless steel covering with brass fittings.
 - .10 Engine speed shall be controlled by isochronous governor with no change in alternator frequency from no load to full load. Steady state regulation is to be 0.25%.
 - .11 One step load acceptance shall be 100% of engine-generator set nameplate rating and meet the requirements of NFPA 110 paragraph 7.13.7
 - .12 The generator system shall support generator start-up and load transfer within 10 seconds.

.3 Alternator

- .1 The alternator shall be a 4 pole revolving field type, 6 lead, wired for 600 VAC 3 phase, 60 Hz, rated at 80 kW with a permanent magnet driven exciter. Photosensitive components will not be permitted in the rotating exciter. The stator shall be gear drive connected to the engine to ensure permanent alignment. The generator shall meet temperature rise standards for Class "H" insulation, operate within Class "F" standards for extended life. All leads must be extended into an AC connection panel. The alternator shall be protected by internal thermal overload protection and an automatic reset field circuit breaker.
- .2 One step load acceptance shall be 100% of engine-generator set nameplate rating and meet the requirements of NFPA 110 paragraph 5-13.2.6. The generator set and regulator must sustain at least 300% short circuit current for 10 seconds during 3 phase fault.
- .3 A NEMA 1 panel (120/208V, 1Ø, 3W) that is an integral part of the generator set must be provided to allow the installer a convenient location in which to make electrical output connections. A fully rated, isolated neutral must be included by the generator set manufacturer to insure proper sizing.
- .4 The electric plant (engine and alternator) shall be mounted with internal vibration isolation onto a welded steel base. External vibration isolation shall not be required for normal pad mounted applications.
- .5 Provide the following items installed at the factory:
 - A main line circuit breaker carrying the UL/CSA mark shall be factory installed. The breaker shall be rated as per the manufacturer's recommendations. The line side connections are to be made at the factory. Output lugs shall be provided for load side connections. A system utilizing manual reset field circuit breakers and current transformers is unacceptable. The breaker must be equipped with position indicating contacts and wired for alarm as per CSA C282, Table 1.

.4 Controls

- .1 The generator control system shall be a fully integrated microprocessor based control system for standby emergency engine generators meeting all requirements of CSA C282, latest edition.
- .2 The generator control system shall be a fully integrated control system enabling remote diagnostics and easy building management integration of all generator functions. The generator controller shall provide integrated and digital control over all generator functions including: engine protection, alternator protection, speed governing, voltage regulation and all related generator operations. The generator controller must also provide seamless digital integration with the engine's electronic management system if so equipped. Generator controller's that utilize separate voltage regulators and speed governors or do not provide seamless integration with the engine management system are considered less desirable.
- .3 Communications shall be supported with building automation via the Modbus protocol without network cards or protocol exchangers. Optional internet and intranet connectivity shall be available.

- .4 The control system shall provide an environmentally sealed design including encapsulated circuit boards and sealed automotive style plugs for all sensors and circuit board connections. The use of non-encapsulated boards, edge cards, and pc ribbon cable connections are considered unacceptable.
- .5 Circuit boards shall utilize surface mount technology to provide vibration durability. Circuit boards that utilize large capacitors or heat sinks must utilize encapsulation methods to securely support these components.
- .6 A predictive maintenance algorithm that alarms when maintenance is required. The controller shall have the capability to call out to the local servicing dealer when maintenance is required.
- .7 Diagnostic capabilities should include time-stamped event and alarm logs, ability to capture operational parameters during events, simultaneous monitoring of all input or output parameters, callout capabilities, support for multi-channel digital strip chart functionality and .1msec data logging capabilities.
- .8 The control system shall provide pre-wired customer use I/O: 4 contact inputs, 2 analog inputs, 4 relay outputs, and communications support via RS232, RS485, and an optional modem. Customer I/O shall be software configurable providing full access to all alarm, event, data logging, and shutdown functionality. In addition, custom ladder logic functionality shall be supported to provide application support flexibility. The ladder logic function shall have access to all the controller inputs and customer assignable outputs.
- .9 The control panel will display all user pertinent unit parameters including:
 - Engine and alternator operating conditions
 - Oil pressure and optional oil temperature
 - Coolant temperature and level alarm
 - Fuel level (where applicable)
 - Engine speed
 - DC battery voltage
 - Run time hours
 - Generator voltages, amps, frequency, kilowatts, and power factor
 - Alarm Status
 - Current alarm(s) condition per CSA C282, latest edition
 - Alarm Log of last twenty alarm events (date and time stamped)
- .10 For system reliability and security concerns, access to and manipulation of the internal operating parameters and alarm limits shall be conducted via password protected PC based software by trained personnel. System configuration support shall be provided locally or remotely by the manufacturers servicing representatives.
- .11 The following equipment is to be installed at the engine-generator set manufacturer's facility:
 - A DPDT relay shall be socket mounted in the generator control panel and operate on engine start and run for customer connection.

.12 The following equipment is to be provided by the engine-generator set manufacturer and shipped loose with the unit:

- Provide a CSA C282 compliant alarm annunciator panel for remote indication per local and national code requirements. The annunciator shall be controlled using RS485 communications from the generator controller. Annunciators requiring individual contacts and wires per indication point are not preferred. The panel shall have an ALARM switch that when moved to the OFF position silences the audible alarm. A TEST/RESET switch must be included to verify the lights are functional and reset any condition after it has cleared. The remote annunciator shall have provision for installing a switch with the capability of starting, and stopping the standby generator set from the annunciator panel.

3.1 EXECUTION

.1 Except for those items as may be specified in Part 3 of this Section refer to Part 3 of the various Sections of the Specifications, Division 26 Electrical.

.2 Unit Accessories

.1 The following equipment is to be installed at the engine-generator set manufacturer's facility:

- Supply a weather protective sound attenuating enclosure: The engine-generator set shall be factory enclosed in a 14 gauge steel enclosure constructed with corner posts, uprights and headers. The roof shall be made of aluminum, aid in the runoff of water and include a drip edge. The enclosure shall be coated with electro-statically applied power paint, baked and finished to manufacturer's specifications. The color will be tan-standard. The enclosure shall be completely lined with 1" thick, UL 94 HF-1 listed, sound deadening material. This material must be of a self extinguishing design. The enclosure is to have large, hinged, removable doors to allow access to the engine, alternator and control panel. The hinges shall allow for door fit adjustment. Hinges and all exposed fasteners will be stainless steel or JS5000. The use of pop rivets weakens the paint system and not allowed on external painted surfaces. Each door will have lockable hardware with identical keys. Padlocks do not meet this specification. The enclosure shall include an air discharge hood that protects the radiator core and directs the hot discharge air upward preventing re-circulating hot air. Sound level of the enclosed unit shall not exceed 70 dbA at 7m in any direction around the unit.
- The enclosure shall be equipped with a space heater/thermostat designed to maintain a minimum of 10°C temperature at all times. Motorized damper(s) shall be fitted as required to maintain the ambient temperature specified. Provide a suitable emergency lighting unit to comply with requirements of CSA C282, clause 6.11. Provide a main lug type load centre for all AC accessories and wire in accordance with local codes, with CSA/ESA approval. Submittal drawings must reflect all items provided.

- The exhaust silencer(s) shall be provided of the size as recommended by the manufacturer and shall be of critical grade. The silencer(s) shall be mounted within the weather protective enclosure for reduced exhaust noise and provide a clean, smooth exterior design. It shall be connected to the engine with a flexible, seamless, stainless steel exhaust connection. A rain cap will terminate the exhaust pipe. All components must be properly sized to assure operation without excessive back pressure when installed.
- A heavy duty, lead acid 12VDC battery set rated at 925 CCA, BCI group 31 shall be installed by the generator set manufacturer. Provide all inter-cell and connecting battery cables as required.
- Provide an automatic dual rate battery charger. The automatic equalizer system shall monitor and limit the charge current to 10 amps. The output voltage is to be determined by the charge current rate. The charger must be protected against a reverse polarity connection. The battery charger is to be factory installed on the generator set. Due to line voltage drop concerns, a battery charger mounted in the transfer switch will be unacceptable.

.3 Applied Standards

- .1 The unit shall be Canadian Standards Association certified.
- .2 The equipment shall be installed strictly in accordance with the manufacturer's requirements and recommendations and the requirements of the Authorities having jurisdiction.
 - Canadian Electrical Code.
 - Canadian, Provincial and Local Building Codes.
 - Local Authorities having jurisdiction.
 - ULC, BSA.
 - Underwriters Laboratories of Canada Inc.

.4 Factory Testing

- 1 Before shipment of the equipment, the engine-generator set shall be tested under rated load for performance and proper functioning of control and interfacing circuits. Tests shall include:
 - Verifying all safety shutdowns are functioning properly.
 - Verify single step load pick-up per NFPA 110-1996, Paragraph 5-13.2.6.
 - Verify transient and voltage dip responses and steady state voltage and speed (frequency) checks.

.5 Owner's Manuals

- .1 Three (3) sets of owner's manuals specific to the product supplied must accompany delivery of the equipment. General operating instruction, preventive maintenance, wiring diagrams, schematics and parts exploded views specific to this model must be included.

.6 Service

- .1 Supplier of the electric plant and associated items shall have permanent service facilities in this trade area. These facilities shall comprise a permanent force of factory trained service personnel on 24 hour call, experienced in servicing this type of equipment, providing warranty and routine maintenance service to afford the owner maximum protection. Delegation of this service responsibility for any of the equipment listed herein will not be considered fulfillment of these specifications. Service contracts shall also be available.

.7 Warranty

- .1 The standby electric generating system components, complete engine-generator and instrumentation panel shall be warranted by the manufacturer against defective materials and factory workmanship for a period of 24 months. Such defective parts shall be repaired or replaced at the manufacturer's option, free of charge. Travel and labor shall be included for the first 12 months.
- .2 The warranty period shall commence when the standby power system is first placed into service. Multiple warranties for individual components (engine, alternator, controls, etc.) will not be acceptable. Satisfactory warranty documents must be provided. Also, in the judgment of the specifying authority, the manufacturer supplying the warranty for the complete system must have the necessary financial strength and technical expertise with all components supplied to provide adequate warranty support.

.8 Start-Up and Check-Out

- .1 The supplier of the electric generating plant and associated items covered herein shall provide factory trained technicians to checkout the completed installation and to perform an initial startup inspection to include:
 - Ensuring the engine starts (both hot and cold) within the specified time.
 - Verification of engine parameters within specification.
 - Verify no load frequency and voltage, adjusting if required.
 - Test all automatic shutdowns of the engine-generator.
 - Perform a load test of the electric plant, ensuring full load frequency and voltage are within specification by using building load.
- .2 Provide all testing per CSA C282 latest edition (Clause 10 – all parts), including load bank testing, and provide copies of all reports to the consultant promptly.

.9 Submittals

- .1 Provide shop drawings of Engineering Submittal for approval, prior to production release, showing all components, in addition to the engine and generator. Submittals shall include compliance with these specifications.

.10 Substitutions

- .1 The emergency power system has been designed to the specified manufacturer's electrical and physical characteristics. The equipment sizing, spacing, amounts, electrical wiring, ventilation equipment, fuel and exhaust components have all been sized and designed around Generac Power System's equipment. Should any substitutions be made, the contractor shall bear responsibility for the installation, coordination and operation of the system as well as any engineering and redesign costs which may result from such substitutions. Alternate equipment suppliers shall furnish equipment submittals 14 days prior to bid date for approval to bid. As part of the submittals, the substitute manufacturer shall supply as a minimum engine, alternator and control panel wiring diagrams and schematics. A separate list of all printed circuit boards with part numbers and current pricing must also be included.

.11 Installation

- .1 Move the equipment into place and connect. Contractor shall install the complete electrical generating system including all fuel connections in accordance with the manufacturer's recommendations as reviewed by the Engineer.
- .2 Supply and install anchors for the engine/generator base in the pad and connect to isolating devices on base.
- .3 Install batteries, fill with electrolyte, charge and connect.
- .4 Install control panel. Supply and install interconnecting wiring between control panel, engine/generator, transfer switch, remote annunciator, dampers and other equipment.
- .5 Provide 120V, 1 Phase normal power connection to all accessories. Use a separate suitably sized branch circuit for each separate component. Label load centre accordingly.
- .6 Dampers to be fail safe in the open position.

.12 Periodic Testing Procedures

- .1 The essential electrical system shall be completely tested weekly to assure reliability of operation. The weekly test of system operation shall:
 - Simulate a failure of the normal supply.
 - Be arranged so that an engine generator set operates under at least 50% of rated load for 2 hours, and automatic transfer switch is operated under load.
 - Include an inspection for correct function of all auxiliary equipment such as radiator shutter control, coolant pumps, fuel transfer pumps, oil coolers and engine room ventilation controls.
 - Include recording the readings of all instruments associated with the engine generator and a verification that they are normal.
 - Be carried out, logged and reported as further prescribed in the manual of instructions for operation and maintenance.

- .2 Immediately following takeover and instruction of the Owner's operating staff, the owner shall carry out the system operational test described above, one week after takeover and for the following three weeks, in conjunction with the maintenance program. Supplier to return to site to conduct this test after 6 months and also after one year. Provide all required components.
- .3 Electrical contractor shall co-ordinate with generator manufacturer/supplier and bring them on site to fix the on-going oil leakage issue which is covered under one year warranty.

.13 Essential Electrical System Maintenance Schedule

- .1 Provide a maintenance program for the essential electrical system for the first year immediately following completion of the work.
- .2 The program shall be in accordance with the recommendations of the various equipment suppliers.
- .3 Immediately following takeover and instruction of the Owner's operating staff, carry out the maintenance program four times, ie: for the first month following takeover. Make the first review in company with the Owner and Architect, and the remaining three with the Owner.
- .4 Provide written records of each maintenance service.
- .5 Use qualified service staff authorized by each manufacturer.

.14 Applications

- .1 Specialized Consultant in M.O.E. applications shall apply to Ministry of the Environment for approval of generator exhaust system to suit Code requirements, as part of Cash Allowance (not by Electrical Contractor).

- .15 Emergency lighting level test report, with on-site readings to show lighting levels in all areas with emergency lighting fixtures, shall be performed by a qualified emergency lighting manufacturer/vendor representative and submitted to the Consultant for review. Also provide emergency lighting certificate.

END OF SECTION 26 03 10

1.1 GENERAL

.1 Refer to Section 26 00 10, General Electrical Provisions.

.2 Work Included

.1 Supply and install automatic transfer switches (total of 2) designed to satisfactorily disconnect the load from one power source and reconnect it to another source. Transfer switch shall be suitable for use in the system in which it is to be installed.

.3 Codes

.1 The transfer switch shall, as a minimum, comply with C.S.A. Standard C22.2 No. 178.

.2 The transfer switch shall be type A, ie: a unit that does not employ integral overcurrent devices, and shall be equipped with a bypass isolation switch.

2.1 PRODUCTS

.1 Enclosure

.1 The transfer switch shall be enclosed in a wall-mounted cabinet of dust tight construction. The cabinet shall be constructed for code gauge painted steel with engraved nameplates for all indicating and control devices.

.2 The transfer switch shall be of sprinkler-proof construction complete with drip hood and gaskets.

.2 Rating

.1 The transfer switch shall be suitable for resistive or inductive loads. It shall have a short circuit capacity such that it can be used safely on the system in which it is to be installed.

.2 It shall be capable of handling the starting and in-rush currents of the load, capable of withstanding fault current available at transfer switch from Utility source.

.3 The ampere rating shall be nominally as indicated or larger if required by the load or electrical system characteristics.

.4 The switch shall be rated for 600V at 60 hertz, 3 pole complete with single side by-pass.

.3 Mechanism

.1 The transfer switch shall be electrically operated mechanically-held contactor type having arc-protected open contactors complete with copper bussing.

.2 The inductive loads connected to the transfer switch are to be switched from the normal and emergency power sources without damage to the loads and without disruption, failure or tripping of the power supply. In the case of fast-acting transfer switches, a form of phase sensing shall be used to ensure in-phase transfers.

.3 Provide an integral by-pass feature for maintenance or emergency operation.

.4 Operating Features

- .1 Provide for the operation specified. It is intended that the transfer switch signal for engine start-up on normal power failure, switch the load to the emergency power supply during the outage, retransfer back to normal power following restoration, and then allow for no-load running prior to shutting off. Provision for other specified features shall be provided for, including full manual operation.

.5 Voltage Sensing

- .1 The transfer switch shall obtain control and transfer power from the source to which it is being transferred.
- .2 The preferred source shall be the source designated as normal.
- .3 Provide one solid state voltage sensing relay per phase. The relays shall be adjustable type, with drop out and pick-up independently adjustable.
- .4 The transfer switch shall initiate transfer of the load when the normal power supply drops to a pre-set value on any phase.
- .5 An auxiliary contact shall be provided to initiate generator start-up.
- .6 The transfer shall not occur until the voltage and frequency have reached pre-set values and are stable.

.6 Retransfer Time Delay

- .1 Provide a time delay relay to provide a delay on the retransfer of power from emergency to normal after the restoration of normal power. This is to prevent subsequent restarts of the engine in the event of continued short-duration normal power outages. The relay is to be adjustable between 1 minute and 30 minutes.

.7 Engine Shut Down Delay

- .1 Provide a time delay relay to allow the engine to run unloaded for a pre-set interval following transfer to normal power. This to prevent multiple restarts should the normal power supply fail more than once over the delay period. The relay is to be adjustable from approximately 0 minutes to 30 minutes.

.8 Control and Indicating Devices

- .1 Provide the following devices, cover mounted:
 - Green "normal power on" pilot light
 - Red "emergency on" pilot light
 - "Test" pushbutton (momentary contact) which will simulate a failure of emergency power and cause engine start-up, transfer to emergency, and retransfer to normal, via all standard time delays.

.9 Frequency Sensing

- .1 Provide an adjustable frequency sensing device which will control the transfer to sources operating within acceptable frequency limits, with a range of 90 to 100%.

.10 Manufacturer

- .1 The transfer switch shall be ASCO 7000 Series, combining an ASCO 940 transfer switch with a single bypass isolation switch, with the accessories and features described herein, or approved equal providing they meet the specifications.

3.1 EXECUTION

.1 Installation

- .1 Install the transfer switch and all accessories to provide the required operation all in accordance with the applicable codes, these specifications, and the manufacturer's recommendations.
- .2 Provide an engraved nameplate on the outside of the cabinet which completely describes the system operation, especially the effect of the various time-delay relays.

.2 Settings

- .1 Set all relays. Provide an engraved nameplate attached to the relay which properly identifies the relay by name and function and indicates the recommended setting.
- .2 Set the voltage sensing relay at 85% of the nominal supply voltage.
- .3 Set the retransfer time delay relay at 3 minutes.
- .4 Set the engine shut down delay relay at 5 minutes.
- .5 Set the frequency control device at 95%.

.3 Wiring

- .1 Install and connect all associated control wiring between the transfer switch and remote mounted devices.
- .2 Install and connect the normal, emergency and load feeder cables.

.4 Testing

- .1 Pay for the services of a factory trained technician employed by the transfer switch manufacturer to supervise and check the installation. This person shall conduct a complete test of the system and demonstrate to the Owner that the system is in perfect operating condition, and provide suitable certification of such operation.

- .2 During commissioning process of automatic transfer switches and generator, weekly engine exerciser for both automatic transfer switches shall be disabled. School custodian is to manually test the generator on a weekly basis.

END OF SECTION 26 03 20

1.1 GENERAL

- .1 Refer to Section 26 00 10, General Electrical Provisions.

2.1 PRODUCTS

- .1 Except for those items as may be specified in Part 3 of this section, refer to Part 2 of the various sections of specification, Division 26 Electrical.
- .2 Provide a coordination/protective system study and short circuit study of all equipment specified herein and submit for review.
- .3 Include the following:
- .1 Utility system characteristics, including available fault levels, feeder, current time curves.
 - .2 600V main circuit breaker overcurrent, overload, and ground fault devices.
 - .3 347/600 and 120/208V panelboards, MCC's, switchgear, connecting feeder cables and bus duct.
 - .4 120/208V transformer damage curves, magnetizing currents for all transformers 150 kVA and larger.
 - .5 Locked rotor currents, acceleration times and damage curves for motors 75 kW and larger.
 - .6 Any additional data necessary for successful completion of the coordination and short circuit study.
- .4 Data shall clearly state the operating time in cycles of each breaker and indicate whether the time current curves for relays are inclusive of breaker tripping time or otherwise.
- .5 Prepare a summation chart showing all ratings and settings with easy reference to the appropriate curve.
- .6 Symmetrical and asymmetrical fault current calculations shall be submitted to verify the correct choice of the protective elements of the system.
- .7 Prepare a systems single line diagram on which the resultant short circuit values, device numbers and equipment ratings are shown.
- .8 This study shall be provided by the distribution equipment vendor.
- .9 This study shall be performed by and bear the stamp of a Professional Engineer registered in the Province of Ontario.
- .10 Submit the complete study for review prior to submitting shop drawings of equipment.
- .11 Relay styles, CT ratios and fuse sizes have been selected on a preliminary basis for design purposes. Final selection shall be based on the results of this study and shall be included at no extra cost.

3.1 EXECUTION

- .1 Except for those items as may be specified in Part 2 of this Section, refer to Part 3 of the various sections of specification, Division 26 Electrical.
- .2 ARC Flash Study shall be performed/produced by the distribution equipment manufacturer.
- .3 Provide the distribution equipment vendor with all relevant data for equipment not provided by that supplier.

END OF SECTION 26 04 01

1.1 GENERAL

- .1 Refer to Section 26 00 10, General Electrical Provisions.

2.1 PRODUCTS

- .1 Except for those items as may be specified in Part 3 of this section, refer to Part 2 of the various sections of specification, Division 26 Electrical.
- .2 Calibrate and verify the following equipment items supplied under this Contract:
 - 600V switchboard.
 - 120/208V distribution.
 - 347/600V distribution.
- .3 The calibration and verification shall be carried out in the field after installation and connection of equipment but prior to energization, in the presence of the Owner and Consultant.
- .4 Submit details of all test procedures and instruments, together with technicians names, to the Consultant prior to proceeding.
- .5 Submit written verification report after installation is completed to reflect as-built conditions.
- .6 Work shall be performed by the distribution equipment supplier.

3.1 EXECUTION

- .1 Except for those items as may be specified in Part 2 of this section, refer to Part 3 of the various sections of specification, Division 26 Electrical.
- .2 Advise well in advance when each stage is ready for the calibration and verification, and complete the following:
- .1 Ensure that all equipment is installed, connected, and cleaned inside and out.
- .2 Ensure that the specified tests required to be done by the Contractor have been carried out.
- .3 The electrical rooms are cleaned and are adequately illuminated and heated.
- .4 Provide 120V convenience receptacles.
- .5 Provide one qualified electrician to assist in the calibration and verification.
- .6 Provide all other facilities, equipment, and personnel as reasonably required to assist in the calibration and verification.
- .3 For each circuit breaker, calibrate all protective relays and overcurrent device time and instantaneous trips in accordance with requirements of the protected equipment and the overall coordination scheme. Field set each relay according to the recommended settings.

- .4 Verify all transformer ratios, insulation values, fuse sizes, C.T. and P.T. ratios, etc. and certify that the installation is in accordance with the requirements of the manufacturer and the Coordination/Short Circuit Study. Submit a written report on this verification to the Consultant.
- .5 Carry out the tests required of calibration and verification as specified in the other related sections.
- .6 Ensure all bus and cable connections are tightened to manufacturers' specifications.
- .7 All relays are to be cleaned with dry, dust free compressed air.

END OF SECTION 26 04 02

1.1 GENERAL

- .1 Refer to Section 26 00 10, General Electrical Provisions.

2.1 PRODUCTS

- .1 Except for those items as may be specified in Part 3 of this Section, refer to Part 2 of the various sections of specification, Division 26 Electrical.
- .2 Carry out an inspection of the equipment connections immediately after the plant is energized and operating under load and two months prior to expiration of the guarantee period, by means of thermography.
- .3 Inspect for loose connections at terminators, including mechanical and compression type connectors, bus joints, bolted connections, splices and other fittings.
- .4 Check for poor connections caused by oxidation on contact surfaces.
- .5 Check for hot spots caused by overloading, phase unbalance, broken conductor strands or cable defects, and ground leakage.
- .6 Tighten, repair, or replace connections found to be marginal or unacceptable as a result of the Thermography Report.
- .7 The work shall be carried out by a firm specializing in and with relevant experience in thermography of 600V and 208V equipment or by the distribution equipment supplier.
- .8 AGA 782 Thermovision Infrared Portable Scanner or equivalent, capable of direct non-contact temperature measurement from minus 20°C to 1600°C with plus or minus .1°C resolution at 30°C and related photographic equipment, capable of producing the required thermograms.
- .9 Record all thermal anomalies or faults on polaroid pictures (thermograms) and corresponding real-image photographs of the areas concerned.

3.1 EXECUTION

- .1 Except for those items as may be specified in Part 2 of this Section, refer to Part 3 of the various sections of specification, Division 26 Electrical.
- .2 Inspect the following:
 - .1 600V switchboard and distribution panelboards, line and load terminations.
 - .2 600V/120/208V transformers including line and load terminations, bushings.
 - .3 600V motor control centres, line and load connections and motor terminals of all motors 75 kW and larger.
 - .4 208V distribution panelboards.

- .3 Provide thermograms and real image photographs of all anomalies, including the temperature differential of the hot phase to a normal phase on preprinted forms showing location of circuit, date and time of inspection, technician's name, component, phase, load, temperature rise and problem identification. Submit in loose-leaf binder format, 3 copies.

- .4 Report under the following classification:

Temperature Rise -
Phase to Phase

Classification

1°C - 10°C
10°C - 35°C
35°C plus

Minor problem
Intermediate problem
Major problem repair as soon as possible

- .5 All inspections to be carried out in the presence of a designated Owners/Consultant representative. Provide 1 weeks notice of such inspections.

END OF SECTION 26 04 03

1.1 GENERAL

- .1 Refer to Section 26 00 10, General Electrical Provisions.

2.1 PRODUCTS

- .1 Except for those items as may be specified in Part 3 of this Section, refer to Part 2 of the various Sections of Specification, Division 26 Electrical.
- .2 The main switchboard shall be of the free standing totally enclosed sprinkler-proof design and shall consist of individual dead front type cells bolted together to form a complete switchgear assembly as shown on the drawings, and shall be braced to block wall to suit seismic requirements.
- .3 The equipment shall be constructed of formed dished steel panels on the front with flat steel covers on the sides, rear and top. A suitable channel base shall be supplied along the entire length of the switchgear assembly.
- .4 The switchboard shall be complete with provision for the incoming service as shown on the drawings.
- .5 The main secondary breaker shall be 100% rated, 600 volt, 3 phase, quick make, quick break manually operated circuit breaker with an interrupting capacity of 50 KA amps. Symmetrical (co-ordinate with Hydro and Co-ordination Study), with stored energy tripping mechanism. The breaker shall be trip free in operation. The breaker shall be equipped with 3 phase solid state overcurrent relay with instantaneous short time and long time elements, each working independently of the others. Relay pick-up and time delay settings shall be field adjustable. Breaker shall be complete with ground fault to suit co-ordination study, and current limiting fuses. Unit shall be SSB type or approved equal.
- .6 Provide auxiliary contacts for building automation system.
- .7 The feeder switches shall be fused Q.M.Q.B. switches.
- .8 An ammeter and a volt meter with selector switches shall be provided in the switchboard.
- .9 All bussing shall be copper and shall extend the full length of the switchboard with provision for future extension.
- .10 A full length ground bus shall be provided.
- .11 The switchboard shall be constructed so that, if necessary, it can be shipped in sections for reassembly on site by this Division.
- .12 Cable lugs for outgoing feeder cables shall be two hole compression type.
- .13 Openings in the switchgear are to be cut or punched. Burning of holes will not be permitted.
- .14 Each switchboard, breaker, instrument, meter, etc. shall be identified with a black Lamicoid nameplate with engraved white letters.
- .15 The switchboard shall be supplied complete with all necessary and required identifications and warning signs.
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- .16 The switchgear shall have two coats of primer and two finish coats of ANSI49 grey paint.
- .17 The switchboard shall be designated, manufactured and tested in accordance with C.S.A. and C.E.M.A. standards and shall meet the requirements of all Authorities having jurisdiction.
- .18 The switchboard shall be as manufactured by Federal Pioneer, Siemens or Square 'D'. The specification and layouts shown have been based upon Federal Pioneer equipment. However, it shall be the responsibility of this Division to ensure prior to submission of the tender, that the equipment proposed can fit in the allocated space.

3.1 **EXECUTION**

- .1 Except for those items as may be specified in Part 2 of this Section, refer to Part 3 of the various Sections of Specification, Division 26 Electrical.
- .2 Install the main switchboard in accordance with the manufacturer's requirements and recommendations and the requirements of the Authorities having jurisdiction and Hydro One/ Ontario Hydro.
- .3 Cable lugs for outgoing feeder cables shall be two hole compression type.
- .4 Openings in the switchgear are to be cut or punched. Burning of holes will not be permitted.
- .5 Provide the necessary plates for the outgoing aluminum sheathed and MICC cables.
- .6 Prior to energizing or commissioning the switchboard it shall be fully inspected, tested, checked and adjusted to include, but not limited to, the following:-
- Grounding.
 - Bus torque, supports, clearance, general mechanical conditions and insulation resistance.
 - Breaker and switches operation.
 - Trip units tested and calibrated to the settings provided by the co-ordination study.
 - Breaker settings and fuses.
 - Ground fault system operation.
 - Continuity of feeder cables.
 - Phase resistance of feeder cables.
 - Insulation resistance of feeder cables.
 - Proper phasing of incoming service and feeder cables.
 - Equal division of load between parallel conductors.

END OF SECTION 26 04 20

1.1 GENERAL

- .1 Refer to Section 26 00 10, General Electrical Provisions.

2.1 PRODUCTS

- .1 Supply and install an integrated micro-processor based metering package (power, natural gas and water). The system shall measure R.M.S. values and display voltage and current for each phase as well as kVA, kVAR, kW, PF, Hz. It shall also measure and accumulate MWH, and monitor and store minimum values of volts and PF and the maximum values of Amps, kW, kVA, kVAR and kWD. The unit shall be field programmable. Accumulated and programmed parameters shall be stored in non-volatile memory and shall not be lost in case of control power failure. Package shall be by Carma Submetering and Billing Solutions. Division 26 shall contact: info@carmacorp.com, Tel.# 1-888-298-3336, 132 Walsh Road, Lindsay, Ontario, K9V 4R3 for complete Carma System to suit PDSB Standard.
- .2 System shall utilize a DMS panel mounted three phase digital AC meter for use on a 600V 3 phase system, a control module located in the interior of the switchboard, together with all other accessories required for system operation.
- .3 The unit shall provide 4 - 20ma analog output to interface with the HVAC control system. Use 8 channel POD-8 programmable output adapter.

3.1 EXECUTION

- .1 Employ the services of a factory trained technician to initially program the system. Train the Owner's staff.
- .2 The installation shall be in accordance with the manufacturer's requirements/recommendations. Provide all associated conduits, wires, etc. as required by the manufacturer.
- .3 Measure all parameters during a one week period prior to take-over by the Owner. Record all readings. Use an approved record sheet. Provide a clip-board in the electrical room and use for recording data. Leave sufficient blank sheets for 12 months use by the Owner.
- .4 Provide complete commissioning of the Carma Metering System (power, natural gas and water).

END OF SECTION 26 04 21

1.1 GENERAL

- .1 Refer to Section 26 00 10, General Electrical Provisions.

2.1 PRODUCTS

- .1 Except for those items as may be specified in Part 3 of this Section, refer to Part 2 of the various Sections of Specification, Division 26 Electrical.
- .2 The distribution panels shall be of the free standing and/or wall mounted type as described on the drawings, totally enclosed sprinkler proof design and shall consist of individual dead front type cells bolted together to form a complete panel assembly as shown on the drawings. Also panels shall be braced to block walls to suit seismic requirements.
- .3 The equipment shall be constructed of formed dished steel panels on the front with flat steel covers on the sides, rear and top. A suitable channel base shall be supplied along the entire length of the panel assembly.
- .4 The feeder switches shall be fused QMQB switches.
- .5 All bussing shall be copper and shall extend the full length of the panel with provision for future extension.
- .6 A full length ground bus shall be provided.
- .7 The distribution panel shall be constructed so that, if necessary, it can be shipped in sections for reassembly on site by this Division.
- .8 Cable lugs for outgoing feeder cables shall be two hole compression type.
- .9 Openings in the distribution panels are to be cut or punched. Burning holes will not be permitted.
- .10 Each distribution panel, switch unit, instrument, meter, etc. shall be identified with a black Lamicoid nameplate with engraved white letters.
- .11 The distribution panel shall be supplied complete with all necessary and required identification and warning signs.
- .12 The distribution panels shall be provided with the necessary plates for the outgoing aluminum sheathed and MICC cables.
- .13 The distribution panel shall have two coats of primer and two finish coats of ANSI49 grey paint.
- .14 The distribution panels shall be designed, manufactured and tested in accordance with C.S.A. and C.E.M.A. Standards and shall meet the requirements of all Authorities having jurisdiction.
- .15 The distribution panels shall be as manufactured by Federal Pioneer, Siemens or Square 'D'. The specification and layouts shown have been based upon Federal Pioneer equipment, however it shall be the responsibility of this Division to ensure prior to submission of the tender, that the equipment proposed can fit in the allocated space.

3.1 EXECUTION

- .1 Except for those items as may be specified in Part 2 of this Section, refer to Part 3 of the various Sections of Specification, Division 26 Electrical.
- .2 Install the distribution panels in accordance with the manufacturers requirements and recommendations and the requirements of the Authorities having jurisdiction and Hydro One/ Ontario Hydro.
- .3 Cable lugs for outgoing feeder cables shall be two hole compression type.
- .4 Openings in the distribution panels are to be cut or punched. Burning of holes will not be permitted.
- .5 Provide necessary plates for the outgoing aluminum sheathed and MICC/Vitalink cables.
- .6 Prior to energizing or commissioning the distribution panels, they shall be fully inspected, tested, checked and adjusted to include, but not limited to the following:-
 - Grounding.
 - Bus torque, supports, clearance, general mechanical conditions and insulation resistance.
 - Breaker settings and fuses.
 - Continuity of feeder cables.
 - Phase resistance of feeder cables.
 - Insulation resistance of feeder cables.
 - Proper phasing of incoming service and feeder cables.
 - Equal division of load between parallel conductors.

END OF SECTION 26 04 24

1.1 GENERAL

- .1 Refer to Section 26 00 10, General Electrical Provisions.

2.1 PRODUCTS

- .1 Except for those items as may be specified in Part 3 of this Section, refer to Part 2 of the various Sections of Specification, Division 26 Electrical.
- .2 Dry type transformers shall, unless otherwise noted, be of the indoor air cooled dry type of the size, rating and capacities as shown on the drawings and shall be sprinkler-proof.
- .3 Transformers shall be of the 1.2 KV Class 10 KV B.I.L. 220°C insulation, copper wire, temperature rise above a maximum ambient temperature of 130 degrees C.
- .4 Transformers shall have 4 - 2½% full capacity taps, 2 above and 2 below normal.
- .5 Ample ventilation openings at top, bottom, front and sides shall be provided but these shall be shielded to prevent access to the live parts.
- .6 Transformers shall be equipped as required with eye bolts, braces, etc. to enable them to be wall mounted, floor mounted or suspended.
- .7 External anti-vibration isolation mountings shall be supplied and installed for all transformers.
- .8 Transformers shall have two coats of primer and two finish coats of ASA61 grey paint.
- .9 Transformer nominal efficiency of different KVA ratings must be in compliance with ASHRAE Standard 90.1-2013.
- .10 Transformers shall be Harmonic Mitigator and similar to Powersmiths Model T1000-C3, Mitigator e-silver, Marcus Supreme or approved equal by the Board/Consultant.

3.1 EXECUTION

- .1 Except for those items as may be specified in Part 2 of this Section refer to Part 3 of the various sections of Specifications Division 26 Electrical.
- .2 Locate the dry type transformers where shown on the drawings and ensure that there is adequate ventilation so that they operate as specified and that there is no transfer of heat to adjacent surfaces or equipment.
- .3 Prior to energizing or commissioning any transformer it shall be fully inspected, tested, checked and adjusted to include, but not limited to the following:-
- Grounding.
 - Ratio.
 - Polarity.
 - Insulation resistance.
 - Taps adjusted to give rated voltage specified at 50% of rated capacity during normal working hours.

END OF SECTION 26 04 40

1.1 GENERAL

- .1 Refer to Section 26 00 10, General Electrical Provisions.

2.1 PRODUCTS

- .1 Except for those items as may be specified in Part 3 of this Section, refer to Part 2 of the various Sections of Specification, Division 26 Electrical.
- .2 The grounding equipment shall be in accordance with CSA C22.2 and the copper grounding conductors in accordance with ASA G7.1.
- .3 Provide non corroding accessories necessary for the grounding system.
- .4 Building ground system to consist of a grid of copper welded ground rods (minimum 4' to 10' (1.2m to 3m) long spaced minimum of 10' (3m) apart, interconnected with bare minimum No. 3/0 AWG copper loop. Ground rods shall be driven sufficiently to contact permanent water table. Provide minimum No. 3/0 AWG copper ground loop inside electrical room and vaults for grounding of equipment enclosures and connect to ground grid. Connect building water service pipes (both street and building sides), gas service pipes and sprinkler system pipes to ground system with minimum No. 3/0 AWG copper ground conductor in conduit. Perform resistivity test on soil to determine exact quantity of rods (minimum of 4).
- .5 All buried ground connections shall be thermetic weld type.
- .6 Provide one (1) No. 3/0 AWG insulated green copper ground conductor in conduit from the main building ground to the main Telephone/LAN Room. Provide a minimum 24" (600mm) long x 2" (50mm) high x 3/8" (10mm) thick copper ground bus and install on wall with stand off isolators and connect to 3/0 cable. Ground bus to have eight drilled taps. Provide one (1) #6 AWG green ground conductor in conduit from this ground bus and extend to each satellite LAN Room and coil for future connection to computer cable termination rack.
- .7 Where cable trays are used for the data cabling pathways, ensure that they are grounded and bonded in accordance with the Ontario Electrical Safety Code.
- .8 Continuous rows of fluorescent/LED fixtures shall be equipped with No. 12 bare copper ground wire for the full length of fixture row.
- .9 The accessories shall be as manufactured by Burndy, Erico, Amp or Caldwell.

3.1 EXECUTION

- .1 Except for those items as may be specified in Part 2 of this Section refer to Part 3 of the various sections of Specification Division 26 Electrical.
- .2 Provide complete permanent and continuous system and equipment grounding systems, including ground rods, conductors, connectors, accessories, to conform to requirements of the Authorities having jurisdiction.
- .3 Install connectors to manufacturer's instructions.

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- .4 Protect exposed grounding conductors from mechanical injury.
 - .5 Non-current carrying metal parts shall be grounded.
 - .6 The neutrals of the dry type transformer shall be connected by a separate copper ground wire to the ground bus in the switchboard.
 - .7 A separate copper ground wire to the ground bus in the switchboard shall be provided for each isolation transformer and isolated ground lighting panel.
 - .8 A separate copper wire shall be installed in all flexible conduits, in all rigid conduits, in wall or below slab conduits, EMT conduits and all non-metallic conduits.
 - .9 Connect the ground bus in the main switchboard to the main ground and incoming water main ahead of the water meter and provide a water meter shunt.
 - .10 The grounding system in the main switchboard shall be suitable for use with the ground fault system.
 - .11 Install separate grounding/bonding systems for telephone system, fire alarm system, public address system and security system, in accordance with the systems suppliers requirements.
 - .12 Install grounding system for pad mounted transformer in accordance with ESA and Local Hydro requirements.
 - .13 All grounding conductors run inside of building, except in electrical and LAN rooms, shall be run in EMT conduit.

END OF SECTION 26 04 50

1.1 GENERAL

- .1 Refer to Section 26 00 10, General Electrical Provisions.
- .2 Refer to Section 26 05 10, Lighting Fixture Schedule.

2.1 PRODUCTS

- .1 Except for those items as may be specified in Part 3 of this Section, refer to Part 2 of the various Sections of Specification, Division 26 Electrical.
- .2 L.E.D. fixtures shall be complete with integral weather-tight LED driver compartment and high performance aluminum heat sinks with bronze finish colour. Light fixtures shall be complete with the following components:
 - Driver current = 700 mA.
 - LED manufacturer = Cree.
 - Junction temperature at 25°C ambient = 60° - 70°C.
 - LM-79 luminaire photometric = by independent company.
 - Actual lumen per watt (LPW) = 73.1 LPW.
 - Driver lifetime rating = 50,000 hours (min.) with 700 mA drive current.
 - Absolute photometric data for each distribution classification, lumen maintenance data, based on laboratory tests performed in accordance with LM-80-08 standard.
 - Colour temperature shall range from 3700K to 5100K as called for in the Lighting Fixture Schedule.
- .3 The louvres for light coves in washrooms and display cases and where shown shall be 1/2" x 1/2" x 1/2" (13 x 13 x 13mm) continuous aluminum and shall be of American Louvre manufacture.
- .4 Lenses shall be acrylic (minimum of 0.175mm) with a maximum flame spread rating of 250 and smoke development classification of 600 and shall be of KSH, American Louvre or Orcons manufacture.
- .5 Light Emitting Diodes (LED) shall comply with the following:
 - .1 Light emitting diodes shall be manufactured by "Cree" or approved equal, provided that they meet the specifications.
 - .2 Junction temperature at 25°C ambient shall not exceed 60°-70°C.
 - .3 LM-79 luminaire photometric shall be performed by an independent company, and shall form an integral part of the luminaire shop drawings.
 - .4 Actual lumens per watt output (LPW) shall be not less than 73.1 LPW.
 - .5 The lifetime rating of driver, LEDs and all electrical components shall be 60,000 hours (minimum) at full load.
 - .6 Absolute photometric data for each distribution classification, lumen maintenance data, based on laboratory tests performed in accordance with LM-80-08 standard.

- .7 Colour temperature shall range from 3700K to 5100k as called for in the Lighting Fixture Schedule.
- .8 All electrical components shall have a 5-year replacement (parts and labour) warranty.

3.1 **EXECUTION**

- .1 Except for those items as may be specified in Part 2 of this Section refer to Part 3 of the various sections of Specification Division 26 Electrical.
- .2 Remove from the site all empty cartoons, crates, etc. in which the fixtures and lamps are delivered.
- .3 The chain supports required for mounting and installation of recessed lighting fixtures shall be supplied and installed by this Division. The supports shall be attached to the structure (minimum 2 supports per fixture). The ceiling system shall not be used as a supporting means. Prior to installation of lighting fixtures, Electrical Contractor shall co-ordinate with Consultant and get approval.
- .4 Surface mounted fixtures shall be independently supported from the structure above.
- .5 Fixtures connected to the circuits exceeding 150 volt to ground shall be mounted at least 8 feet above floor level.
- .6 Fixtures mounted in continuous rows shall be equipped with aligning clips.
- .7 The location of lighting fixtures in Service Areas, Electrical and Mechanical Rooms, etc. shall be determined after the equipment is installed.
- .8 Refer to the Architectural reflected ceiling drawings for the exact location of the lighting fixtures.
- .9 Co-operate with the other Divisions to establish proper clearances from sprinkler heads, diffusers, ducts, etc.
- .10 Surface mounted fixtures shall have minimum clearance of 2'-0" (600mm) from adjacent sprinkler heads.
- .11 Provide additional supports, hangers, etc, required to support fixtures mounted under ductwork and the fixture supports shall not be attached to either the ductwork or the ductwork supports.
- .12 Provide and connect all branch circuit conduit and wiring to the signs (if required).
- .13 Angles required for support of 1/2" x 1/2" x 1/2" (13 x 13 x 13mm) louvre shall be by Ceiling Division.

END OF SECTION 26 05 00

1.1 **GENERAL**

- .1 Refer to Section 26 00 10, General Electrical Provisions.

2.1 **PRODUCTS**

- .1 Except for those items as may be specified in Part 3 of this Section, refer to Part 2 of the various Sections of Specification, Division 26 Electrical.

- .2 The lighting fixtures with the inscribed letter shown, shall be of the types as described below:

Type 'A'	Shall be similar to Lithonia Lighting Cat. #2BLT4-48L-ADP-120-EZ1-LP840, 2'-0" x 4'-0" recessed LED light fixture for T-bar ceiling mounting, complete with high reflective matte white powder paint finish, curved linear prismatic lens and 120 volt integral driver and LED strips.
Type 'AA'	Shall be same as Type 'A' except with 4000 lumen light output, Cat. #2BLT4-40L-ADP-120-EZ1-LP840.
Type 'B'	Shall be similar to Lithonia Lighting Cat. #BLT4-40L-ADP-120-EZ1-LP840, 1'-0" x 4'-0" recessed LED light fixture for T-bar ceiling mounting, complete with high reflective matte white powder paint finish, curved linear prismatic lens and 120 volt integral driver and LED strips.
Type 'BA'	Shall be same as Type 'B' except suitable for drywall ceiling installation.
Type 'BB'	Shall be same as Type 'B' except fixture shall be complete with built-in occupancy sensor, Cat. #BLT4-40L-ADP-120-EZ1-LP840. Need integral occupancy sensor with dimming control to provide a 50% dim level during vacancy and 100% in occupancy. Photocell to be disabled.
Type 'BC'	Shall be same as Type 'BB' except suitable for drywall ceiling installation.
Type 'BD'	Shall be similar to Mark Architectural Lighting Cat. #S2LWD-4FT-1N40-EZB-120-WHT, 4'-0" wall mounted LED light fixture with integral LED driver. Fixture shall be complete with integral occupancy sensor with dimming control to provide 50% light output during vacancy and 100% during occupancy. (Photocell shall be disabled).
Type 'E'	Series shall be "Universal Mount" exit signs with "Running Man" pictogram, complete with left/right indicator(s) as shown on drawings, suitable for wall, ceiling and/or end to wall mounting, for 120 volt operation and provisions for 24 volt DC power supply. Overall dimensions of the fixture shall be approximately 13" L x 7.75" H x 2" deep, made of extruded aluminum. Emergi-Lite EA Series and Beghelli Quadra-RM Series shall be considered equal.
Type 'G'	Shall be similar to Lithonia Lighting Cat. #IBGN-18000LM-SEF-PFL-WD-120-0Z10-40K-80CRI-WGX-DWH, 4'-0" long lightweight aluminum surface mounted LED light fixture complete with 120 volt integral driver input voltage, semi-diffuse polycarbonate lens, wire guard, surface mounted bracket(s), and aircraft safety cables to prevent fixture, lens and wire guard from falling. Fixture shall be complete with all required components for proper surface mounting installation and operation.

Type 'H'	Shall be Current Lighting Cat. #VPW2-18L-25-3K7-4F Architectural wall surface mounted LED full cut-off light fixture complete with integrated heat sink, die-cast, low copper aluminum alloy with tempered impact resistant clear glass lens with 347 volt integral weather-tight LED driver compartments and with motion sensor. Finish colour to be confirmed by Architect at a later date. Provide minimum 5/16" drill size 1 1/4" length zinc allow/lag shield anchors with minimum 1 1/2" screws for additional support of the fixtures. Alternate Product: Eaton Lumark Cat. #GWC.
Type 'HA'	Shall be same as Type 'H' except complete with 120V input voltage.
Type 'HB'	Shall be similar to WAC Lighting, Cat. #DS-WD06-F40B-BK, tube architectural LED wall mount surface mounted light fixture complete with 347 volt integral weather-tight LED driver, with black finish colour. Fixture Up/Down light distribution shall be towards the wall.
Type 'I'	Shall be Current Lighting Cat. #LFR-6RD-M-10L2230TD9XW-DMT-LFR-6RD-T-S-CL, 6" LED vandal resistant architectural downlight complete with vandal guard. Precision die stamped galvanized steel mounting pan housing, die cast aluminum heat sink with 347V input voltage. Acceptable Manufacturers: Lithonia, Cooper.
Type 'K'	Shall be similar to Lithonia Lighting Cat. #ZL1F-L48-4500LM-MDD-120-40K-80CRI-WH, 4'-0" long channel strip LED light fixture complete with diffuse lens, baked white enamel finish and 120 volt integral driver input voltage and LED strips.
Type 'L'	Shall be similar to Lithonia Lighting Cat. #ZL1N-L48-3000LM-FST-120-40K-80CRI-WH-WGZ48, 4'-0" long channel strip LED light fixture complete with snap on/off diffuse lens, 120 volt integral driver, wire guard and LED strips.
Type 'LA'	Shall be similar to Cooper lighting, Corelite Divide Cat. #DSI-WD-60L-840-1-D-120-STD-FC-W-48-JB-12, 12'-0" long linear, direct/indirect light fixture complete with diffuse lens, 120v integral driver.
Type 'LB'	Shall be similar to Cooper lighting, Corelite Divide Cat. #DSI-WD-40L-840-1-D-120-STD-FC-W-48-JB-8, 8'-0" long linear, direct/indirect light fixture complete with diffuse lens complete with 120v integral driver.
Type 'LC'	Shall be similar to Cooper lighting, Corelite Continua Cat. #SQ4-F-0U-125D-840-1-D-UNV-STD-W-AC48-JB-12, 12'-0" long linear light fixture, 120v integral driver.
Type 'LD'	Shall be similar to Coronet lighting LS3 Direct LED, Cat. #LS3-440MED-DBW-FL, aircraft cable, 4'-0" long linear direct light fixture complete with 120v integral driver. Need integral occupancy sensor with dimming control to provide a 50% dim level during vacancy and 100% in occupancy. Photocell to be disabled.
Type 'N'	Shall be similar to Lithonia Lighting Cat. #LDN8-40/50-LO8-AR-LSS-120, 8" round LED recessed downlight, complete with 120V integral driver.
Type 'NA'	Shall be same as Type 'N' except fixture shall be 6" and suitable for drywall ceiling installation. Cat. #LDN6-40/20-LO6-AR-LSS-120.

Type 'NB'	Shall be similar to Type 'N' except fixture shall be 6" and suitable for T-bar ceiling installation. Cat. #LDN6-40/20-LO6-AR-LSS-120.
Type 'NC'	Shall be similar to Cooper Lighting Cat. #LD4-18-ERW4-830-4LW1-LI-LGSKT4IP66, 4" diameter recessed LED type down light fixture complete with wide beam specular clear reflector with white polymer trim ring, 1800 lumens (3000K) LED engine, internal 120 volt driver and weatherproof gasket kit. Suitable for drywall ceiling installation.
Type 'ND'	Shall be same as Type 'NC' except suitable for t-bar ceiling installation.
Type 'P'	Shall be RAB Design Lighting, LED under cabinet light Cat. #88863 (UC-LED1000-NW), 11W LED, 1000mm length, 4000k natural white complete with hardwire power supply Cat. #88860 (UC-40W hardwire kit) mounted in wiremold box Cat. #V5744-3 (complete with cover plate), direct connector(s) [for connection of two (2) light fixtures in continuous row]]. Fixture shall be complete with 120 volt driver to suit length and wattage. Alternate Product: Lithonia Rayzor
Type 'PA'	Shall be same as Type 'P' except 500mm long and complete with 5 watt LED.
Type 'Q'	Shall be Progress Lighting Cat. #P3649-3030K9 wall mounted LED light fixture complete with white finish and 120 volt input voltage.
Type 'QA'	Shall be Telemecanique Cat. #XB4-BVG4 pilot light for power complete with red jewel, back box and stainless steel coverplate. (Coordinate with Consultant).
Type 'QB'	Shall be similar to Edwards #G1R-V15 Series strobe light complete with plastic dome, red lamp and flasher. Activation of any fire alarm zone shall energize the flasher and the lamp in fixture shall flash until the fire alarm system is reset.
Type 'SA'	Shall be similar to Spectrum Lighting Cat.#DDS16GV-27L-40K-DO10X-TF2-PR16-PP, canopy mount LED Pendant Light. Stem length to be determined on site. Canopy finish colour to be selected by Architect at a later date.
Type 'SB'	Shall be similar to Visa Lighting Cat. #CP2026-L40K-MOVL-T-L40K-WIDE-XX 4" round – 5 feet high pendant LED light fixture complete with 120V integral driver. Finish colour to be confirmed by Architect at later date.
Type 'T'	Shall be similar to Cooper Lighting Cat. #H750T-ML5609840-693WB, 6" diameter LED recessed wide beam downlight complete with baffle trim, aluminum housing installation and heat sink with 120 volt input voltage. Shall be suitable for drywall ceiling

Type 'U'	Shall be Current Lighting LED light fixture Cat.#VP-ST-1-36L-55-3K7-3-BC complete with HSS-90B, complete with 56.8 watt, 347 volt arm mounted single head, mounted on 15 ft. pole with motion sensor. Light fixture shall be complete with integral weather-tight LED driver compartment and high performance aluminum heat sinks with finish colour. Finish colour to be confirmed by Architect at later date. Light fixture shall be complete with the following components: - Driver current = 1000 mA. - LED manufacturer = Lithonia. - Junction temperature at 25°C ambient = 60°-70°C. - LM-79 luminaire photometric = by independent company. - Actual lumen per watt (LPW) = 77 LPW. - Driver lifetime rating = 50,000 hours (min) with 1000 mA drive current. Pole shall be 5" round tapered aluminum pole complete with handhole, base plate, anchor bolts, shroud over the base and all other components required for proper installation and operation. All welds on the pole assembly shall be ground smooth and painted with primer. The complete pole assembly shall be guaranteed for wind, sleet, ice and snow loads. The poles, etc. shall have two prime coats of X-60 Rust-Oleum. The finish of the pole assembly and luminaries shall be two coats of finish paint with a dry film thickness between one and two mills per coat. The pole shall be complete with 7" wide x 12" long handhole. At the handhole, provide multi-section terminal block, neutral block bar and grounding stud, and Essma in-line or approved equal fuse holders and fuses for each fixture. All incoming and outgoing conduits shall be brought to the handholes and all wiring connections shall be made at this point. Wiring shall be brought from each driver and connected to the fuses and terminal block. All wiring inside the pole shall be TWU of minimum #12 and shall be supported from straps at the hand hole. All connections are to be provided with neoprene covers.
Type 'U1'	Shall be same as Type 'U' except complete with 2 lighting heads. Cat.#VP-ST-1-36L-85-3K7-4F.
Type 'U2'	Shall be same as Type 'U' except complete with 2 lighting heads. Cat.#VP-ST-1-36L-105-3K7-4W.
Type 'U3'	Shall be same as Type 'U' except with different distribution. Cat.#VP-ST-1-36L-85-3K7-4W-BC.
Type 'U4'	Shall be same as Type 'U' except with different distribution. Cat.#VP-ST-1-36L-85-3K7-CL-BC.
Type 'U5'	Shall be same as Type 'U' except with different distribution. Cat.#VP-ST-1-36L-85-3K7-4F.
Type 'X'	Emergency Battery Unit. Refer to Section 26 02 10.

.3 Notes Regarding Lighting Fixtures:

- .1 For LED fixtures, unless otherwise noted, Hubbell, Cooper Lighting, Cree Lighting, Lithonia, Peerless, GE Lighting, Philips Canada, Acuity Brand shall be considered equal provided they meet the specifications, designed lighting calculations based on absolute IES files of the respective light fixtures.

- .2 For fluorescent fixtures, unless otherwise noted, Peerless, CFI, Hubbell, Lithonia, Metalux, LSI, Visioneering and Thomas Lighting shall be considered equal provided they meet the specifications.

END OF SECTION 26 05 10

1.1 GENERAL

- .1 Refer to Section 26 00 10, General Electrical Provisions.

2.1 PRODUCTS

- .1 Except for those items as may be specified in Part 3 of this Section, refer to Part 2 of the various Sections of Specifications Division 26, Electrical.

.2 General:

.1 Work Included

- a. The Theatre Lighting Contractor (TLC), as part of the work of this section, shall supply, install and test a complete lighting control system as specified herein for areas indicated on the drawings and circuit schedules.
- b. The base build Electrical Contractor shall furnish all conduit, 120v wire, connectors, hardware and other incidental items necessary for the complete and proper operation of the lighting control system.
- c. The base build Electrical Contractor shall coordinate all work described in this section with all other applicable plans and specifications, including but not limited to:
 - i. General Conditions
 - ii. Electrical Section General Provisions
 - iii. Conduit
 - iv. 120V Wire
- d. The TLC shall supply and install all necessary low voltage control cable.

.2 System Descriptions

- a. The system shall be designed for the control of theatrical LED lighting and shall consist of factory pre-wired relay and processing rack enclosures containing relays, power supplies, breakers, terminals and/or control electronics.
- b. System shall work in conjunction with specified low-voltage control stations.

.3 Submittals

- a. The Theatre Lighting Contractor shall provide 4 sets of full system submittals. Submittals shall include:
 - i. Full system riser diagram(s) illustrating interconnection of system components, wiring requirements, back box sizes and any special installation considerations.
 - ii. Full set of printed technical data sheets.
 - iii. A complete list of all deviations from specifications.

- b. **The Theatre Lighting Contractor shall provide a structural review by a Professional Engineer of the suspension system.**
- c. The Theatre Lighting Contractor shall provide any additional information, including equipment demonstration, as required by the engineer or specifier to verify compliance with specifications.

.4 Quality Assurance

- a. Manufacturer of the LED fixtures shall be one who has been continuously engaged in the manufacturer of lighting control equipment for a minimum of five (5) years. All relay and cabinet fabrication must take place in a U.S. manufacturing plant.
- b. Proposed equipment shall be UL and cUL listed, and/or CE marked (where applicable) and bear the appropriate labels.

.5 Acceptable Manufacturers

- a. The equipment herein specified shall be manufactured by Electronic Theatre Controls, Inc. (ETC) (see exceptions as noted under acceptable manufacturers). Strand is acceptable manufacturer if they meet specification.
- b. If the TLC wishes to submit an alternative manufacturer, the TLC must submit a full pre-approval package five days prior to bid date. Package shall consist of items listed in System Bill of Materials – Section 1 with complete equipment specifications.
- c. Permission to bid does not imply acceptance of the manufacturer. It is the sole responsibility of the Theatre Lighting Contractor to ensure that any price quotations received and submittals made are for controls systems which meet or exceed the specifications.

.3 Lighting Control Console:

- DMX 512 output – Minimum 1 Universe
- Controls for a minimum of 24 fixtures/devices
- Touch based controls – touchscreen
- Colour chips and colour picker
- Bump Buttons
- Multiple pages of memories
- USB Port for storage and software updates
- Fixture Library in patch
- Effects package
- Home button

Acceptable Manufacturer

- ETC – **CS20 ColourSource Console**
- Jands – **Stage CL**
- Strand - **FLX Series**

.4 Wall Mount Relay Panel:

- Minimum 8 x 20A fully rated relays for use with LED loads
- 20-amp, fully rated bi-state latching relay per outlet
- Demand response load shedding
- Plug and play
- Supports Inspire® control stations for ON/OFF control or all relays
- Constructed of 16-gauge cold-rolled steel, finished in fine-textured, black powder coat.
- Wall mount or plenum installation
- Rotary dials for selection of space and starting zone numbers
- Supports 120 and 277 VAC circuits
- UL, cUL and UL924 Listed

Acceptable Manufacturer

- ETC, Strand, Arkadium or Johnson Systems Inc.

.5 Installation Repeater/Opto Splitter:

- Minimum 1 DMX Input with 4 DMX outputs
- Terminal strip connectors
- Pass thru connectors
- No fuses, self-resetting data links
- Termination switch
- 2500V opto-isolation input to output
- 250V fault protection to all DMX ports
- Wall mount enclosure
- Black powder coat finish
- ETL listed

Acceptable Manufacturer

- Pathway - **#4905-M16-P52 c/w eDIN 1016 RDM DMX Hub**
- Doug Fleenor - **#125EE**

.6 Outlet Boxes:

Outlet boxes are designed for surface or recess mounting in theatres, for distribution of lighting circuits.

.1 Features

- a. Surface mounting available 1, 2, 3 connectors.
- b. Panel mounts connector:
 - i. Grounded Twist-Lock (20A)
- c. Over and Under hung U-bolt and C-clamp pipe mount options available.
- d. UL and cUL Listed.

.2 Physical

- a. Fabricated from 18-gauge steel with 16-gauge covers and 14-gauge end caps.
- b. Finished with fire-textured, scratch-resistant, black powder coat.
- c. 2" or 3/4" labels with white numbers on black background (sized to match product).
- d. Edison or Twist-Lock outlet spaced on 3" centers only.
- e. Outlet boxes shall support optional LED indicators to indicate the presence of power at each local circuit. The indicator shall be red in color and mounted in outlet or pigtail box.

Acceptable Manufacturer

- ETC, Arkadium or Altman

.7 Data Plug-In Stations:

.1 General

- a. Consist of the appropriate connectors required for the functional intent of the system.
- b. Available with DMX input or output.

.2 Connector Options

- a. Following standard connectors available for Plug-In Stations:
 - i. 5-Pin male XLR connectors for DMX input.
 - ii. 5-Pin female XLR connectors for DMX output.

.3 Electrical

- a. Low voltage class 2 wiring
- b. Operating Voltage: 12/24V Direct Current
- c. Barriers provided when line-voltage and Class 2 controls are ganged together in the same wallbox.
- d. Terminal block supplied for contractor terminations

.4 Physical

- a. Faceplates are .80" aluminum.
- b. Finished in fine texture, scratch-resistant black powder coat.
- c. White silk-screened graphics standard; engraving or custom legends available.
- d. Mounts in an industry standard flush mount back box (supplied by others).
- e. Surface mount back boxes (as required).
- f. Optional U-Bolt Kit for pipe mounting.

Acceptable Manufacturer

- ETC, Pathway or Altman

.8 Colour Mixing LED Profile Fixture:

- High intensity LED illuminator with DMX control of intensity and color.
- All LED Fixtures (Wash & Profile) shall be supplied by a single manufacturer per School (no mixing of manufacturers will be acceptable).
- All aluminum die cast housing.
- Multiple field angles 5°, 10°, 14°, 19°, 26°, 36°, 50°, 70° & 90°, Zoom options 15° - 30°, 25°-50°.
- Minimum 70% intensity after 20,000 hours of use.
- Minimum of 4 different LED colours shall be supplied – RGB-Lime or RGBA.
- Power and Data – Input & Thru connectors.
- 15 bit nonlinear scaling techniques for high resolution dimming.
- User control interface.

Acceptable Manufacturer

- ETC – **ColorSource Spot**
- Altman – **PHX2/PHX3.5-RGBA-LED-Zoom**

.9 Colour Mixing LED Wash Fixture:

- High intensity LED illuminator with DMX control of intensity and colour.
- All LED Fixtures (Wash & Profile) shall be supplied by a single manufacturer per School (no mixing of manufacturers will be acceptable).
- All metal die cast housing.
- Multiple secondary lens options shall be available as required.
- Minimum 70% intensity after 20,000 hours of use.
- Minimum of 4 different LED colours shall be supplied – RGB-Lime or RGBA.
- Power and Data – Input & Thru connectors.
- 15 bit nonlinear scaling techniques for high resolution dimming.
- User control interface.

Acceptable Manufacturer

- ETC – **ColorSource Par**
- Altman – **Spectra Par 100**
- Altman – **Spectra AP 150/AIP 200 LED PAR**

.10 Architectural Preset Station:

- Ten preset push buttons.
- One recessed record push button.
- One recessed fade time push button.
- Master / Slave mode selection.
- Black anodized with silver engraved nomenclature.
- Faceplate: 4.5"h X 2.75"w X 0.2"d.

Acceptable Manufacturer

- Doug Fleenor – **PRE10A**
- Philips – **STRAND VISION net**

3.1 EXECUTION

- .1 Except for those items as may be specified in Part 2 of this Section refer to Part 3 of the various Sections of Specifications, Division 26 Electrical.
- .2 **Installation:**
 - .1 The Theatre Lighting Contractor shall be responsible for field measurements and coordinating physical size of all equipment with the architectural requirements of the spaces into which they are to be installed.
 - .2 Low voltage wiring shall be supplied and installed by (TLC) and run in conduit throughout as shown and noted on the drawings. Confirm conduit routes with Electrical Contractor on site. All conduits required and shown on drawings shall be provided by the base build Electrical Contractor.
 - .3 The Theatre Lighting Contractor shall supply and install all lighting control and relay equipment in accordance with TLC's approved shop drawings.
 - .4 All branch load circuits shall be live tested before connecting the loads to the relay system load terminals.
 - .5 The base build Electrical Contractor shall be responsible for the mounting of all Junction Boxes. These will be installed according to positions outlined on the drawings. Contact the Theatre Lighting Contractor if there are any discrepancies. All other power distribution and 120 volt electrical connections are the responsibility of the base build Electrical Contractor.
 - .6 The Theatre Lighting Contractor will supply all the necessary low voltage control cable as per the drawings to ensure a complete and operational system. The installation of the low voltage control cable remains the responsibility of the TLC. The base build Electrical Contractor is responsible for all conduit and pull strings for all low voltage control cables.
 - .7 The Theatre Lighting Contractor shall be responsible for the hang and focus of all lighting fixtures, under the direction of the PDSB Media Technology Support Department.
 - .8 The Theatre Lighting Contractor shall ensure that all floors are protected from damage from the skyjack by laying down plywood or other protective materials. Any damage to the floors as a result of failure of the TLC to properly protect the flooring will be the responsibility of the TLC. When a lift (total weight, machine, operator, and load not to exceed 4,500 lbs) is used on the floor system then the floor should be protected with at least two layers of $\frac{3}{4}$ " thick clean protective sheathing with overlapping seams. Protective material should include suitable clean sheathing and floor finish protections such as red rosin paper. When operating equipment, wheels should not travel outside of the protected area whether the machine is stationary or being moved. Do not leave heavy loads on the floor overnight or for extended periods.
 - .9 A qualified Service Representative employed full time by the Theatre Lighting Contractor shall visit the job site after the installation is complete and prior to the energizing of the system to inspect, test and adjust the system. Instruction shall be provided for the Owners' representatives in the operation and maintenance of the system. These services shall not exceed one (1) day and shall be provided with a minimum of seven (7) days written notice by the contractor.

- .10 Upon completion of the formal check-out, the Theatre Lighting Contractor shall demonstrate operation and maintenance of the system to the Owners' representatives (School Staff and Designated PDSB Media Technology support Staff). Training shall not exceed four working hours. Additional training shall be available upon request at additional cost.

.3 Warranty:

- .1 Manufacturer shall warrant products under normal use and service to be free from defects in materials and workmanship for a period of two years from date of deliver.
- .2 Warranties shall cover repair or replacement of such parts determined defective upon inspection.
- .3 Warranties do not cover any product or part of a product subject to accident, negligence, alteration, abuse or misuse. Warranty does not cover any accessories or parts not supplied by the manufacturer.
- .4 Warranties shall not cover any labor expended or materials used to repair any equipment without manufacturer's prior written authorization.

.4 SYSTEM BILL OF MATERIALS

The system shall consist of the following: (As detailed in this specification)

CONTROL CONSOLE

1	LED Lighting Console – 512 Channel
1	25' DMX Control Cable

DMX DISTRIBUTION

1	DMX Opto-Splitter—4 outputs (2xFOH,2xStage LX's)
3	Plug-In Station—DMX In(Rear Gym, Front of Stage and Front of Forum)
4	Plug-In Station—DMX Out(All Lighting positions)

RELAYS & CONTROLS

1	Preset 10 Architectural Control Station
1	2 Button Station-Simple ON/OFF control for Relays
1	Minimum 8 fully rated 20A Relays for LED loads

DISTRIBUTION

3	Outlet box, Surface, 2 TLG, 9102C with U-Bolt Kit
1	Outlet box, Surface, 3 TLG, 9103C with U-Bolt Kit

LED FIXTURES

10	Colour Mixing LED Profile Fixture
10	25°-50° Zoom Lens Assembly
12	Colour Mixing LED Wash Fixture
12	C-Clamp for above
9	Medium Round Diffuser/lens
3	Wide Oval Diffuser/lens
20	Safety Chains for above
4	Single Light Cages for FOH LED Wash Fixtures
8	Single Light Cages for FOH LED Profile Fixtures

MISCELLANEOUS

4	Schedule 40 1.5" I.D. Steel Pipe-2x15ft & 2x25ft
3	External pipe clamp
1	DMX Control Cables for LED Fixtures (lengths as required)
1	Power Cables as required for LED Fixtures (lengths as required)
16	Heavy Duty Clevis Hangers for Schedule 40 Pipe above
1	Project Turn-On, Commissioning & Training
1	Submittal Drawings Package
1	Stamped Engineered Drawings for structural support pipes

ADDITIONAL EQUIPMENT FOR DOUBLE ENDED STAGE DESIGN ONLY

2 LOT	Conventional fixtures

END OF SECTION 26 06 00

1.1 GENERAL

- .1 Refer to Section 26 00 10, General Electrical Provisions.

2.1 PRODUCTS

- .1 Except for those items as may be specified in Part 3 of this Section, refer to Part 2 of the various Sections of Specification, Division 26 Electrical.
- .2 The fire alarm system shall be an addressable analog, single stage, zoned, non-coded, indicating, fully integrated system complete with F.A devices, modules, auxiliary contacts, conduits, wires etc. as specified below.
- .3 The Fire Alarm System shall be a Multi-Processor Based System designed specifically for Fire, Model EST3, and shall be ULC listed under CAN/ULC-S527 standard (equipment by Simplex and Notifier shall be considered equal if they meet the specifications). The Life Safety System shall include all required hardware and system programming to provide a complete and operational system, capable of providing the protected premises with the following functions and operations:
- Modular systems design, with a layered application design concept, including an "Operational Layer" and a "Human Interface Layer", to allow maximum flexibility of the system with a minimum physical size requirement.
 - All System operational software is to be stored in FLASH memory. Control Panel disassembly, and replacement of electronic components of any kind shall not be required in order to upgrade the operations of the installed system to conform to future application code and operating system changes.
 - Up to 128 Service Groups must be definable within the system program to allow the testing of the installed system based on the physical layout of the system, not on the wiring of the field circuits connected to the Fire Alarm Control Panel.
 - Advanced Windows-based System Definition Utility with Program Version Reporting to document any and all changes made during system start-up or system commissioning. Time and Date Stamps of all modifications made to the program must be included to allow full retention of all previous program version data.
 - System response to any alarm condition must occur within 3 seconds, regardless of the size and the complexity of the installed system.
 - System Common Control Functions shall be automatically routed to any node of the system as a function of the time of day and date.
- .4 The Life Safety System shall include the following features and shall support the following operations in each installed cabinet or node of the system:
- Up to 10 Signature Series Intelligent Device loops.
 - Up to 125 Intelligent Smoke Detectors and 125 Intelligent Modules per Signature Data Circuit.
 - Up to 144 Hardwired input/output Circuits.

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- Up to 228 Manual Control (Input) Switches.
 - Up to 456 LED Annunciation Points.
 - Up to 63 Remote Display Units.
 - Peer-to-peer network connection of up to 64 system nodes wired as Class A.
 - Ground fault detection by panel, by Signature Data Circuit and by device module.
 - Ability to download all system applications programs and "firmware" from a computer through a single point in the system.
 - True Distributed Intelligence, including microprocessor-based Detectors and Modules.
 - A.C. Power Trouble Delay adjustable from 4 Hours to 10 Hours.
 - Removable, Interlocked terminal blocks for the connection of the field wiring to the Fire Alarm Control Panel.
 - Electronic Addressing of Field Devices.
 - Advanced Power Management.
 - Dead Front Construction.
 - Activation of any alarm initiating device shall cause the following to occur: -
 - All audible signals to sound continuously for the mandatory period before they can be manually or automatically silenced.
 - The type and location of the alarm to be indicated on the control panel and the remote annunciator.
 - Transmit an alarm to the central station and Fire Department with indication on the annunciator.
 - Operation of auxiliary contacts for control of auxiliary functions.
 - Release fire doors held open by electric door hold open devices.
 - Air Handling Units/Rooftop units/fans shutdown.
 - Close all fire smoke dampers/smoke dampers.
 - Activation of any supervisory device shall cause the following to occur:
 - The common trouble alarm signal shall sound in the control panel and the annunciator.
 - The type and location for the alarm to be indicated on the control panel and the annunciator.
 - Any malfunction on the system shall sound a trouble alarm signal and illuminate a trouble indicator on the control panel and the annunciator.
 - The trouble alarm signal shall be suppressed during an alarm.
- .5 The Fire Alarm / Life Safety System shall include an Emergency Operators' Interface Panel which shall include the following system annunciation and control functions:
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- .1 System Annunciation and Control Functions:
 - Hands free Emergency Operation. The first and last highest priority event on the system shall be displayed automatically and simultaneously.
 - Control Panel Internal Audible Signal shall have four programmable signal patterns to allow for the easy differentiation between Alarm, Supervisory, Trouble and Monitor conditions within the installed system.
- .2 Five Discreet "System Status" LED's:
 - Power Status LED - Green LED shall illuminate when AC power is present.
 - Test Status LED - Yellow LED shall illuminate when any portion of the system is in the test mode. A programmable timer shall cause the system to automatically exit the test mode after a period of system inactivity.
 - Alarm operation in the rest of the building will not be affected by the test area. This Test LED shall function in a local or in a group mode.
 - CPU Fail Status LED - Yellow LED shall illuminate when the panel controller has an internal failure.
 - Ground Fault Status LED - Yellow LED shall illuminate when un-grounded wiring connected to the cabinets' power supply has continuity to ground. This feature shall function in either a local or group mode.
 - Disable Status LED - Yellow LED shall illuminate whenever any point or zone in the installed system is manually disabled.
- .3 Four Discreet Common Control Switches with associated Status LED's:
 - Reset: Depression of the Reset Switch starts the system reset operation. The associated Yellow LED shall have three flash rates during this operation to inform the user of the progress status of the reset cycle. The LED shall flash fast during the smoke detector power down sequence, then it shall flash slowly during the restart phase, and shall illuminate steadily for the restoral phase. The LED shall go out completely when the system is back to normal mode. Each phase, as well the overall reset cycle shall be programmable to perform other functions.
 - Alarm Silence: Depression of the Alarm Silence Switch shall turn off all (audible and/or visible) Notification Appliance Circuits. The associated yellow LED illuminates when the Alarm Silence function is active, whether by the Alarm Silence Switch, or by an integral software timer. Subsequent activation of the Alarm Silence Switch shall resound the signals. Activation of the Alarm Silence switch shall be programmable to perform other functions.
 - Panel Silence: Depression of the Panel Silence Switch shall turn off the systems' internal audible signal when configured as a 'local' system. The associated yellow LED illuminates when the panel silence feature is activated.
 - Drill Switch / LED: Depressing the DRILL switch activates the fire drill function. Yellow LED indicates that the fire drill function is active. The Drill Switch shall also be programmable to perform system functions other than the Drill Function.

- .4 Other Operator Control Switches:
- Previous Message Switch: Pressing the Previous Message Switch shall scroll the display to show the preceding message in the selected queue. Holding the Previous Message Switch and pressing any queue select switch moves to the top of the respective queue event list. The operator may do scrolling through event messages at any time.
 - Next Message Switch: Pressing the Next Message Switch shall scroll the display to show the following message in the selected queue. Holding the Previous Message Switch and pressing any queue select switch moves to the bottom of the respective queue event list. The operator may do scrolling through event messages at any time.
 - More Details Switch: Pressing the More Details Switch shall show the address and 42 character location message of the active device on display. If a zone is active, pressing the switch displays the address and message of active devices within the zone. When multiple devices are active, the "Previous/Next" message switch may be used to scroll through the messages.
- .6 The Liquid Crystal display shall provide the means to inform the System Operator with detailed information about the off-normal status of the installed Fire Alarm / Life Safety System. The Main Display shall automatically respond to the status of the system, and shall display that status on an 8 line by 21 character backlit alphanumeric Graphic Liquid Crystal Display.
- .7 The following status functions shall be annunciated by the Main Liquid Crystal Display when the Fire Alarm / Life Safety System is in the "Normal" Mode:
- The current Date and Time.
 - A Custom System Title (2 lines X 21 characters).
 - A summary total of the Alarm History of the system.
- .8 With the Fire Alarm Life Safety System in the Alarm Mode, the LCD shall automatically reconfigure into four logical windows:
- System Status Window:
The LCD shall show the system time, and the number of active points and disabled points in the system in this section of the LCD Display.
 - Current Event Window:
The LCD shall show the first active event of the highest priority in reverse text to highlight the condition to the Emergency Operator. The top line of the reversed text shall show the sequence number in which the displayed event was received, as well as its event type. The second and third lines of reversed text shall display an identification message related to the displayed event.
 - Last Event Window:
The LCD shall show the most recent, highest priority event received by the system.
 - Type Status Window:
The LCD shall show the total number of active events in the system, by event type. There shall be four different System Event Types, which shall be displayed, "Alarm Events", "Supervisory Events", "Active Trouble Events", and "Active Monitor Events".
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- .9 In order to simplify, and to clarify the System Status information, which is given to the Emergency Operator, the Main LCD shall include queues for each of the System Event Types. The Main LCD shall allow the Emergency operator access to the System Status information contained within those queues by pressing an associated queue select switch. Whenever there is an unacknowledged event in any of the System Event queues, the associated Status LED shall flash. Viewing each event listed in a queue shall acknowledge all events in that queue, and shall cause the associated LED to illuminate steady.
- .10 All messages contained in any of the System Event queues shall be accessible for review by the Emergency Operator using the "Previous/Next" message switch. It shall be possible to route additional event information to a printer.
- .11 The Main LCD shall also allow the System Operator to access system maintenance functions through a four level password system. The authorized System Operator shall be able to access the following functions:
- System Status:
The system shall allow the operator to determine the status of individual system components, including active points, disabled points, and active points by panel.
 - Enable:
The system shall allow the operator to restore a disabled point (device) in the system, allowing that point (device) to operate as originally intended by the application program of the system. Additionally, the system shall allow the operator to restore any group function, guard patrol function, Panel, system module, "software - defined zone", operator control, or time control function.
 - Disable:
The system shall allow the operator to disable any point (device) in the system, inhibiting that point (device) from operating as originally intended by the application program of the system. Additionally, the system shall allow the operator to disable any group function, guard patrol function, Panel, system module, "software - defined zone", operator control, or time control function within the system.
 - Activate:
The system shall allow the operator to manually turn on any system output point, or system function. Alternate Smoke Detector sensitivity, message routing within the system, guard patrol timing, and check-in group timings shall be modifiable with this simple command from the control panel.
 - Restore:
The system shall allow the operator to restore the primary (application program defined) operation to the Smoke Detector sensitivity and the message routing functions with this simple command from the control panel.
 - Control Output:
The system shall allow the operator to manually command and control relays and LED's. Relays shall be able to be commanded to "Latch", to energize as a "High Priority", or as a "Low Priority", to "Energize", or to "De-Energize". LED's shall be able to be commanded to "Latch", to energize as a "High Priority", or as a "Low Priority", to turn "On", to turn "Off", to "Slow Blink", or to "Fast Blink".
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- Reports:
The system shall provide the operator with system reports, which give detailed description of the status of certain system parameters for corrective action, or for preventative maintenance programs. The system shall provide these reports via the Main LCD, and shall be capable of being printed on any of the connected system printers.
 - The system shall provide a report, which gives a sensitivity listing of all detectors, which have less than 75% environmental compensation remaining.
 - The system shall provide a report, which provides a sensitivity listing of any particular detector.
 - The system shall provide a report, which gives a listing of the sensitivity of all of the detectors any given panel in the system, or any given SDC loop within any given panel.
 - The system shall provide a report, which gives a chronological listing of up to the last 1740 system events.
 - The system shall provide a listing of all of the firmware revision listings for all of the installed network components in the system.
- .12 The system shall allow the authorized operator to perform all of the following system functions:
- Set the System Time
 - Set the System Date
 - Set (Change) the System Passwords.
 - Restart the System.
 - Set the Dates for the System Holiday Schedule.
 - Clear the Chronological System History File.
- .13 The system shall allow the authorized operator to perform test functions within the installed system. Test functions shall be defined by the authorized operator to be performed on a per cabinet, circuit, or service group basis.
- .14 Each panel in the installed system shall include local Control and Display Annunciators. These annunciators shall have integral membrane style, tactile push-button control switches, for the control of system functions, and LED's with programmable (software-controlled) flash rates and slide-in labels for annunciation of system events. The Local Control Display Annunciators shall provide the system with individual zone and / or device annunciation.
- .15 Each remote panel in the installed system shall include remote Control and Display Annunciators. These annunciators shall have integral membrane style, tactile push-button control switches for the control of system functions, and LED's with programmable (software-controlled) flash rates and slide-in labels for annunciation of system events. The Remote Control Display Annunciators shall provide the system with individual zone and / or device annunciation. The Remote Control Display Annunciators shall provide the system with individual zone and / or device annunciation with zone.
- .16 Life Safety System Operations Interface:
- The Signature Device Card (SDC) shall be the interface between the Fire Alarm Control Panel and the Signature Series Detectors and Modules.
 - The communications format between the SDC and the Signature Series Devices shall be 100% digital. Communications to devices must incorporate BROADCAST POLLING and DIRECT ADDRESS SEARCH to ensure the fastest reporting of off-normal conditions to the system human interface layer.
 - It shall be possible to wire the SDC as Class A or Class B without twisted or shielded wire. It must be possible to wire branch circuits (T-Taps) from Class B Circuits.
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- .17 Provide where indicated on the plans supervised hard wired Notification Appliance Circuits (NAC) for the control of 24Vdc EST Integrity Series Signaling Appliances. The NAC shall be Class B, and shall control up to 3.5 amps of power to the circuit.
- .18 The Fire Alarm / Life Safety System shall allow Network Routing to be configured to any or all nodes (cabinets) in the network.
- .19 All of the system Printer ports can be configured to display any or all of the following functions:
- Alarm
 - Supervisory
 - Trouble
 - Monitor
 - Service Group
- .20 Each LCD Display on each node (cabinet) in the system shall be configurable to show the status of any or all of the following functions anywhere in the system:
- Alarm
 - Supervisory
 - Trouble
 - Monitor
- .21 Fire Alarm Components:
- .1 Intelligent Detectors - General Operation:
- The System Intelligent Detectors shall be capable of full digital communications using both broadcast and polling protocol. Each detector shall be capable of performing independent fire detection algorithms. The fire detection algorithm shall measure sensor signal dimensions, time patterns and combine different fire parameters to increase reliability and distinguish real fire conditions from unwanted deceptive nuisance alarms. Digital filters shall eliminate signal patterns that are not typical of fires. Devices not capable of combining different fire parameters or employing digital filters shall not be acceptable.
 - Each detector shall have an integral microprocessor capable of making alarm decisions based on fire parameter information stored in the detector head. Distributed intelligence shall improve response time by decreasing the data flow between detector and Analog loop controller. Detectors not capable of making independent alarm decisions shall not be acceptable. Maximum total Analog loop response time for detectors changing state shall be 0.5 seconds.
 - Each detector shall have a separate means of displaying communication and alarm status. A green LED shall flash to confirm communication with the Analog loop controller. A red LED shall flash to display alarm status. Both LED's on steady shall indicate alarm-standalone mode status. Both LED's shall be visible through a full 360 degree viewing angle.
 - The detector shall be capable of identifying up to 32 diagnostic codes. This information shall be available for system maintenance. The diagnostic code shall be stored at the detector.
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- Each smoke detector shall be capable of transmitting pre-alarm and alarm signals in addition to the normal, trouble and need cleaning information. It shall be possible to program control panel activity to each level. Each smoke detector may be individually programmed to operate at any one of five (5) sensitivity settings.
- Each detector microprocessor shall contain an environmental compensation algorithm that identifies and sets ambient "Environmental Thresholds" approximately six times an hour. The microprocessor shall continually monitor the environmental impact of temperature, humidity, and other contaminants as well as detector aging. The process shall employ digital compensation to adapt the detector to both 24 hour long term and 4 hour short term environmental changes. The microprocessor shall monitor the environmental compensation value and alert the system operator when the detector approaches 80% and 100% of the allowable environmental compensation value. Differential sensing algorithms shall maintain a constant differential between selected detector sensitivity and the "learned" base line sensitivity. The base line sensitivity information shall be updated and permanently stored at the detector approximately once every hour.
- The intelligent Analog device and the Analog loop controller shall provide increased reliability and inherent survivability through intelligent Analog standalone operation. The device shall automatically change to standalone conventional device operation in the event of a loop controller polling communications failure. In the Analog standalone detector mode, the Analog detector shall continue to operate using sensitivity and environmental compensation information stored in its microprocessor at the time of communications failure. The Analog loop controller shall monitor the loop and activate a loop alarm if any detector reaches its alarm sensitivity threshold.
- Each Signature Series device shall be capable of automatic electronic addressing and/or custom addressing without the use of DIP or rotary switches. Devices using DIP or rotary switches for addressing, either in the base or on the detector shall not be acceptable.
- The intelligent Analog detectors shall be suitable for mounting on any Signature Series detector mounting base.

.2 Fixed Temperature Heat Detector, SIGA-HFS:

- Provide intelligent fixed temperature heat detectors, SIGA-HFS. The heat detector shall have a low mass thermistor heat sensor and operate at a fixed temperature. It shall continually monitor the temperature of the air in its surroundings to minimize thermal lag to the time required to process an alarm. The integral microprocessor shall determine if an alarm condition exists and initiate an alarm based on the analysis of the data. Systems using central intelligence for alarm decisions shall not be acceptable. The heat detector shall have a nominal alarm point rating of 135°F (57°C). The heat detector shall be rated for ceiling installation at a minimum of 70 ft (21.3m) centers and be suitable for wall mount applications.

.3 Fixed Temperature/Rate of Rise Heat Detector, SIGA-HRS:

- Provide intelligent combination fixed temperature/rate-of-rise heat detectors SIGA-HRS. The heat detector shall have a low mass thermistor heat sensor and operate at a fixed temperature and at a temperature rate-of-rise. It shall continually monitor the temperature of the air in its surroundings to minimize thermal lag to the time required to process an alarm. The integral microprocessor shall determine if an alarm condition exists and initiate an alarm based on the analysis of the data. Systems using central intelligence for alarm decisions shall not be acceptable. The intelligent heat detector shall have a nominal fixed temperature alarm point rating of 135°F (57°C) and a rate-of-rise alarm point of 15°F (9°C) per minute. The heat detector shall be rated for ceiling installation at a minimum of 70 ft (21.3m) centers and be suitable for wall mount applications.

.4 Ionization Smoke Detector, SIGA-PS:

- Provide intelligent photoelectric smoke detectors, SIGA-PS. The analog photoelectric detector shall utilize a light scattering type photoelectric smoke sensor to sense changes in air samples from its surroundings. The integral microprocessor shall dynamically examine values from the sensor and initiate an alarm based on the analysis of data. Systems using central intelligence for alarm decisions shall not be acceptable.
- The detector shall continually monitor any changes in sensitivity due to the environmental affects of dirt, smoke, temperature, aging and humidity. The information shall be stored in the integral processor and transferred to the analog loop controller for retrieval using a laptop PC or the SIGA-PRO Signature Program/Service Tool. The photo detector shall be rated for ceiling installation at a minimum of 30 ft (9.1m) centers and be suitable for wall mount applications.

The photoelectric smoke detector shall be suitable for direct insertion into air ducts up to 3 ft (0.91m) high and 3 ft (0.91m) wide with air velocities up to 5,000 ft/min. (0-25.39 m/sec) without requiring specific duct detector housings or supply tubes. The detector shall be protected by a ULC Listed protective guard in areas where subjected to mechanical damage or abuse. The guard shall be suitable for flush or surface mounted detector installation.

- The percent smoke obscuration per foot alarm set point shall be field selectable to any of five sensitivity settings ranging from 1.0% to 3.5%. The photo detector shall be suitable for operation in the following environment:
 - Temperature: 32°F to 120°F (0°C to 49°C)
 - Humidity: 0-93% RH, non-condensing
 - Elevation: no limit

.5 Standard Detector Mounting Bases, SIGA-SB:

- Provide standard detector mounting bases SIGA-SB suitable for mounting on North American 1-gang, 3 1/2" or 4" octagon box and 4" square box. The base shall, contain no electronics, support all Signature Series detector types and have the following minimum requirements:

- Removal of the respective detector shall not affect communications with other detectors.
- Terminal connections shall be made on the room side of the base. Bases, which must be removed to gain access to the terminals, shall not be acceptable.
- The base shall be capable of supporting one (1) Signature Series SIGA-LED Remote Alarm LED Indicator. Provide remote LED alarm indicators where shown on the plans.

.6 Relay Detector Mounting Bases, SIGA-RB:

- Provide relay detector mounting bases SIGA-RB suitable for mounting on North American 1 gang, 3 1/2 " or 4" octagon box and 4" square box. The relay base shall support all Signature Series detector types and have the following minimum requirements:
 - The relay shall be a bi-stable type and selectable for normally open or normally closed operation.
 - The position of the contact shall be supervised.
 - The detector processor upon power shall exercise the relay operation up.
 - The relay shall automatically de-energize when a detector is removed.
 - The operation of the relay base shall be controlled by its respective detector processor. Detectors operating standalone mode shall operate the relay upon changing to alarm state. Relay bases not controlled by the detector microprocessor shall not be acceptable.
 - Form "C" Relay contacts shall have a minimum rating of 1 amp @ 30 Vdc and be listed for "pilot duty".
 - Removal of the respective detector shall not affect communications with other detectors.
 - Terminal connections shall be made on the room side of the base. Bases, which must be removed to gain access to the terminals, shall not be acceptable.

.7 Duct Detector Housing, SIGA-DH:

- Provide smoke detector duct housing assemblies, SIGA-DH, to facilitate mounting an intelligent analog photoelectric detector, SIGA-PS, or 3D multisensor detector, SIGA-PHS, or 4D multisensor detector, SIGA-IPHS along with a standard, relay or isolator detector mounting base. Provide for variations in duct air velocity between 300 and 4000 feet per minute (300 to 1000 feet per minute for ion- photo-heat detector). Protect the measuring chamber from damage and insects. Provide an air exhaust tube and an air sampling inlet tube that extends into the duct air stream up to ten feet. Provide drilling templates and gaskets to facilitate locating and mounting the housing. Provide five one gang knockouts for mounting optional Signature Series modules. Finish the housing in baked red enamel. Provide remote alarm LED's, SIGA-LED, and Remote Test Stations, SIGA-DTS, as shown on the plans.

.8 Single Input Module, SIGA-CT1:

- Provide intelligent single input modules, SIGA-CT1. The Single Input Module shall provide one (1) supervised Class B input circuit capable of a minimum of 4 personalities, each with a distinct operation. The module shall be suitable for mounting on North American 2 1/2" (64mm) deep 1-gang boxes and 1 1/2" (38mm) deep 4" square boxes with 1-gang covers. The single input module shall support the following circuit types:
 - Normally-Open Alarm Latching (Manual Stations, Heat Detectors, etc.).
 - Normally-Open Alarm Delayed Latching (Waterflow Switches).
 - Normally-Open Active Non-Latching (Monitor, Fans, Dampers, Doors, etc.).
 - Normally-Open Active Latching (Supervisory, Tamper Switches).

.9 Dual Input Module, SIGA-CT2:

- Provide intelligent dual input modules, SIGA-CT2 where shown on the plans. The Dual Input Module shall provide two (2) supervised Class B (Style 4) input circuits, each capable of a minimum of 4 personalities, each with a distinct operation. The module shall be suitable for mounting on North American 2 1/2" (64mm) deep 1-gang boxes and 1 1/2" (38mm) deep 4" square boxes with 1-gang covers or may be panel mounted. The dual input module shall support the following circuit types:
 - Normally-Open Alarm Latching (Manual Stations, Heat Detectors, etc.).
 - Normally-Open Alarm Delayed Latching (Waterflow Switches).
 - Normally-Open Active Non-Latching (Monitor, Fans, Dampers, Doors, etc.).
 - Normally-Open Active Latching (Supervisory, Tamper Switches).

.10 Single Input Signal Module, SIGA-CC1:

- Provide intelligent single input signal modules, SIGA-CC1 where shown on the plans. The Single Input (Single Riser Select) Signal Module shall provide one (1) supervised Class B output circuit capable of a minimum of 2 personalities, each with a distinct operation. When selected as a telephone power selector, the module shall be capable of generating its own "ring tone". The module shall be suitable for mounting on North American 2 1/2" (64mm) deep 2-gang boxes and 1 1/2" (38mm) deep 4" square boxes with 2-gang covers, 100mm European square boxes or may be panel mounted. The single input signal module shall support the following operations:
 - Audible/Visible Signal Power Selector (Polarized 24 Vdc @ 2A, 25 Vrms at 50W or 70 Vrms @ 35 Watts of Audio).

.11 Control Relay Module, SIGA-CR:

- Provide intelligent control relay modules, SIGA-CR or intelligent polarity reversing control relay modules, SIGA-CRR where shown on the plans. The Control Relay Module shall provide one form "C" dry relay contact rated at 2 amps @ 24 Vdc to control external appliances or equipment shutdown. The control relay shall be rated for pilot duty and releasing systems. The position of the relay contact shall be confirmed by the system firmware. The Polarity Reversing Relay Module will be used to power an activate groups of detectors sounder bases installed on the system. The control relay and polarity reversing modules shall be suitable for mounting on North American 2 1/2" (64mm) deep 1-gang boxes and 1 1/2" (38mm) deep 4" square boxes with 1-gang covers or may be panel mounted.

.12 Isolator Module, SIGA-IM:

- Provide intelligent class A Isolator modules ,SIGA-IM. The Class A Isolator Module shall be suitable for mounting on North American 2 1/2" (64mm) deep 2-gang boxes and 1 1/2" (38mm) deep 4" square boxes with 2-gang covers, or European 100mm square boxes. Following a short circuit condition, each isolator module shall be capable of performing an internal self-test procedure to re-establish normal operation. Isolator modules not capable of performing independent self tests shall not be acceptable. The isolator base shall have the following minimum requirements:
 - The isolator shall operate within a minimum of 23 msec. of a short circuit condition on the communication line.
 - When connected in Class A configuration the Signature Loop Controller shall identify an isolated circuit condition and provide communications to all non isolated analog devices.
 - **Locations of fault isolators shall be marked on the nearest ceiling grid with an adhesive label or other measure approved by the PDSB. Fault isolators locations shall also be noted on the as-built drawings.**

.13 Intelligent Manual Pull Stations - General Operation:

- It shall be possible to address each Signature Series fire alarm pull station without the use of DIP or rotary switches. Devices using DIP switches for addressing shall not be acceptable. The manual stations shall have a minimum of 2 diagnostic LED's mounted on their integral, factory assembled single or two stage input module. A green LED shall flash to confirm communication with the loop controller. A red LED shall flash to display alarm status. The station shall be capable of storing up to 24 diagnostic codes that can be retrieved for troubleshooting assistance. Input circuit wiring shall be supervised for open and ground faults. The fire alarm pull station shall be suitable for operation in the following environment:
 - Temperature: 32°F to 120°F (0°C to 49°C)
 - Humidity: 0-93% RH, non-condensing

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- .14 Manual Pull Station, SIGA-270, SIGC-270F, SIGC-270B:
- Provide intelligent single action, single stage fire alarm stations. The fire alarm station shall be of metal construction with an internal push button switch. Provide a locked test feature. Finish the station in red with silver "PULL IN CASE OF FIRE" lettering. The manual station shall be suitable for mounting on North American 2 1/2" (64mm) deep 1-gang boxes and 1 1/2" (38mm) deep 4" square boxes with 1-gang covers. Unit shall be complete with lexan cover and integrally powered horn.
- .15 Self-Synchronized Strobes (Type 'QB'):
- Provide strobes manufactured by EST as shown on Drawing. In-Out screw terminals shall be provided for wiring. The strobes shall have a red plastic faceplate. They shall provide 15 cd synchronized flash outputs. Strobes shall mount in a North American 1-gang box. The strobe shall have lens markings oriented for wall or ceiling mounting, as shown on drawings. It shall be possible to replace the lens markings with LKW series or LKC series lens marking kits. Ceiling mounted strobes shall have lens markings with correctly oriented lettering. Removal of an installed strobe to change the lens markings shall not be acceptable.
- .16 F. A. Cone Speakers:
- Provide F.A. cone speakers manufactured by EST Cat. No. 757. In-Out screw terminals shall be provided for wiring. The F.A. cone speakers shall have a red plastic housing. A steady tone sound output level of 103 dBA peak shall be provided. F.A. cone speakers shall mount to a North American 4" electrical box with extension ring using the 2 screws provided with ring. F.A. cone speakers and strobe lights shall be square flush mounted type (not round). It shall not be necessary to completely remove the screws to facilitate mounting. Also provide amplifiers to suit quantities of F.A. cone speakers plus 20% for future expansion (minimum 120 watts).
- .17 F.A. Cone Speaker/Strobes:
- Provide electronic F.A. cone speaker/strobes manufactured by EST. In-Out screw terminals shall be provided for wiring. The F.A. cone speaker shall have a red plastic housing. A steady tone sound output level of 100 dBA peak shall be provided. The strobe shall provide 15/75 cd synchronized flash outputs (field selectable). The strobe shall have lens markings oriented for wall or ceiling mounting, as per drawings. It shall be possible to replace the lens markings with LKW series or LKC series lens marking kits. Ceiling mounted strobes shall have lens markings with correctly oriented lettering. Removal of an installed F.A. Cone Speaker/Strobe to change the lens markings shall not be acceptable. F.A. Cone Speakers/Strobes shall mount in a 4" electrical box with extension ring using the 2 screws provided with ring. It must not be necessary to completely remove the screws to facilitate mounting.
- .18 Supervisory switches shall be alarm devices, which shall have normally open contacts that close on alarm. These devices will be supplied by another Division of this Specification, but shall be installed and connected by this Division.
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- .19 The loss of power devices shall be provided by this Division.
- .20 End of line resistors shall be provided by this Division for the complete system.
- .21 A multi-colour passive graphic display board shall be provided consisting of electronically stored outline of school building, with floor and zone outline, printed on dimensionally stabilized clear film under UV protective clear acrylic shield. Different colours as approved by the School Board shall depict floor outline, zone areas and egress corridors. Every fire alarm device shall be shown including initiating devices, indicating devices, exit doors, fire hose cabinets, siamese connections, elevators, smoke control fans, fire pump, sprinkler pump, gas shut off valves, etc. Symbol legend and "YOU ARE HERE" notation shall be included. All room numbers identified shall be the final room numbers as created by the Architect and School Board. The drawing room numbers **must not** be used.
- .22 Provide amplifiers to suit quantities of F.A. cone speakers as shown on drawings plus 20% spares for future use.
- .23 The main fire alarm panel shall contain three (3) spare prewired circuits for future connections. Clearly identify the location of junction boxes locations for future connection on drawings. The spare circuits shall be as follows:
 - .1 one (1) speaker, speaker. Strobe circuit;
 - .2 two (2) zone circuits.
- .24 All speaker, speaker/strobe devices shall red in colour with white 'FIRE' lettering and wall mounted. Other colours and ceiling mounted devices are not acceptable.

3.1 **EXECUTION**

- .1 Except for those items as may be specified in Part 2 of this Section, refer to Part 3 of the various Sections of Specification, Division 26 Electrical.
- .2 The equipment shall be installed strictly in accordance with the manufacturer's requirements and recommendations and the requirements of the Authorities having jurisdiction:
 - Canadian Electrical Code.
 - Canadian, Provincial and Local Building codes.
 - Local Authorities Having Jurisdiction.
 - ULC, BSA
 - Underwriters Laboratories Canada Inc.
- .3 Install wiring to conform with the requirements of the Canadian Electrical Code. Size wiring in accordance with Class 2 requirements, except for A.C. Signal Circuits where the wiring shall be sized in accordance with Class 1 requirements, but be protected from mechanical injury or other injurious conditions such as moisture, excessive heat or corrosive action in conduit. Connect wiring to the screw terminals in the devices.
- .4 Install fire alarm systems in accordance with following Standards:

- CAN/ULC-S527 1987	Control Units for Fire Protective Signaling Systems.
- CAN/ULC-S529-M87	Smoke Detectors for Fire Protective Signaling Systems.
- CAN/ULC-S529-M87	Smoke Detectors for Duct Applications.
- CAN/ULC-S530-M91	Heat Detectors for Fire Protective Signaling Systems.
- CAN/ULC-S525-M78	Audible Signaling Appliances.

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- CAN/ULC-S526-M87	Visual Signaling Appliances.
- CAN/ULC-S528-M91	Manually Activated Signaling Boxes.
- CAN/ULC-S548 1990	Water flow Indicators for Fire Protective Signaling Systems.
- CAN/ULC-S524-M97	Installation of F.A devices.
- CAN/ULC-S537-M86	Verification of Fire Alarm System.
- .5 Install end-of-line resistors in a separate outlet box with grille.
- .6 Provide a complete system of relays for the auxiliary functions.
- .7 Mechanical connectors are not acceptable. Solder and insulate all joints, if wire cannot be continuous.
- .8 Wire with colour coded conductors.
- .9 Supervise all wiring.
- .10 All wiring shall have copper conductors.
- .11 Prior to energizing or commissioning the system, the F.A. system shall be fully inspected, tested, checked and adjusted to include, but not limited to, the following:
- That the type of equipment installed is that designated by the specifications.
 - That the wiring connections to all equipment components show that the installer has complied with ULC and CSA requirements.
 - That the equipment has been installed in accordance with the manufacturer's recommendations and that all devices have been operated and tested to verify their operation and that the system operates in accordance with the requirements of the Specification.
 - That the supervisory wiring of those items of equipment connected to a supervisory circuit is operated as specified.
 - That Governmental regulations will be met to the satisfaction of inspection office.
- .12 The inspection and testing reports, and certification of fire alarm system prepared by the fire alarm vendor shall be submitted for review by the Consultant. This work shall be complete 3 weeks prior to occupancy date.
- .13 The "dBA" readings shall be provided by the fire alarm system vendor in each room in the building. The testing report shall be prepared and submitted for review by the Consultant. This work shall be complete 3 weeks prior to occupancy.
- .14 System installation and operations shall be verified by the manufacturer's representative and a verification certificate presented upon completion. The manufacturer's representative shall be responsible for an on-site demonstration of the system operation and initial staff training as required by the Owner and/or Consulting Engineer.
- .15 System changes shall be verified by the manufacturer's representative and a verification certificate presented upon completion.
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- .16 When the fire alarm system has been commissioned and verified it shall be fully demonstrated by this Division to the authorities having jurisdiction.
- .17 The supplier shall have sufficient stock on hand and have a fully equipped service organization capable of guaranteeing response time within 8 hours of service calls, 24 hours a day, 7 days a week.
- .18 Warranty all materials, installation and workmanship for one (1) year from date of acceptance, unless otherwise specified.

END OF SECTION 26 07 20

1.1 GENERAL

- .1 Refer to Section 26 00 10, General Electrical Provisions.
- .2 Arrange for the fire alarm zones verified in accordance with the National Standard of Canada "Standard for the Verification of Fire Alarm Systems", CAN/ULC-S537.
- .3 Electrical Contractor shall include in tender price to employ and pay for the services of an independent company as listed below (or approved equivalent) to test, inspect and verify the operation of the fire alarm system in accordance with CAN/ULC-S1001-11 for "Integrated Systems Testing of Fire Protection and Life Safety Systems" three weeks prior to substantial completion of the contract.
 - .1 **Brosz Technical Services Inc.**
64 Bullock Dr. Markham,
Ontario, L3P 3P2
(Tel): 905- 472-6660 or Toll Free: 1-877-472-7670
 - .2 **BACx Incorporated**
23 Lesmill Road, Unit 410
Toronto, Ontario, M3B 3P6
Contact: Mr. John Bell
(Cell): 437-288-6714
(Email): jbell@bacx.ca
 - .3 **Lonergan Engineering Inc.**
4 Industrial Parkway South
Aurora, Ontario L4G 3W1
Contact: Mr. Michael Lonergan
(Tel): 416-684-2305
(Email): m.lonergan@lonerganeng.com
- .4 Contractor shall verify that fire protection and life safety and their components (i.e. fire alarm systems, sprinklers, standpipes, smoke control, ventilation, pressurization, door hold open devices, elevator recalls, smoke and fire shutters and dampers, emergency power, emergency lighting, fire pumps, generators, etc.) including their interconnections with other building systems, are functioning according to the intent of their design. CAN/ULC-S1001, "Integrated Systems Testing of Fire Protection and Life Safety Systems" provides the methodology for verifying and documenting, as applicable.
- .5 Electrical Contractor shall complete the installation and checking of the fire alarm system as specified in Section 26 07 20, and perform "Integrated systems testing of fire protection and life systems" in accordance with CAN/ULC-S1001-11 with independent company as noted above and advise the Consultant and authority having jurisdiction in writing accordingly by providing all supporting documentation as required for CAN/ULC-S1001-11 inspection, testing and verification process.
- .6 Electrical contractor must provide all information, drawings, documents and assistance to the independent company who will be performing inspection, testing and verification of integrated system testing of fire protection and life system in accordance with CAN/ULC-S1001-11.

- .7 Electrical Contractor and the fire alarm manufacturer's representatives/fire alarm testing/verification company shall provide whatever assistance necessary in order that the inspection, testing and verification in accordance with CAN/ULC-S1001-11 (Integrated Systems Testing of Fire Protection and Life Systems) specified herein can be successfully completed.

2.1 PRODUCTS

- .1 Except for those items as may be specified in Part 3 of this Section, refer to Part 2 of the various Sections of Specification, Division 26, Electrical.
- .2 Provide all necessary materials and equipment for the work.

3.1 EXECUTION

- .1 Except for those items as may be specified in Part 2 of this Section refer to Part 3 of the various Sections of Specification Division 26, Electrical.
- .2 Provide inspection, testing and verification of fire alarm system and auxiliary equipment in accordance with CAN/ULC-S537 and CAN/ULC-S1001-11 (Integrated Systems Testing of Fire Protection and Life Systems).
- .3 Complete and sign all necessary forms and documents.
- .4 Provide letter addressed to the Consultant and authority having jurisdiction confirming that the verification has been satisfactorily completed. The letter shall be signed by a registered Professional Engineer.

END OF SECTION 26 07 21

1.1 GENERAL

- .1 Refer to Section 26 00 10, General Electrical Provisions.

2.1 PRODUCTS

- .1 Except for those items as may be specified in Part 3 of this Section, refer to Part 2 of the various Sections of Specification, Division 26 Electrical.
- .2 The telephone wiring and equipment shall be provided by others.
- .3 The plywood backboards shall be supplied by this Division.

3.1 EXECUTION

- .1 Except for those items as may be specified in Part 2 of this Section, refer to Part 3 of the various Sections of Specification Division 26 Electrical.
- .2 Provide all conduits, outlets, blank cover plates and other materials as required and/or shown on the drawings for a complete system ready for installation of cables and equipment by others.
- .3 The installation shall be in accordance with the requirements of the Board.
- .4 A fish wire shall be installed in each telephone conduit.
- .5 All distribution conduits shall be complete with slip sleeves to permit the installation of the distribution cables.
- .6 Install all telephone plywood backboards.
- .7 Co-ordinate with the Board the supply and installation of their equipment and cabling.

END OF SECTION 26 07 40

1.1 **GENERAL**

.1 Refer to Section 26 00 10, General Electrical Provisions.

.2 **Scope of Work**

- .1 To provide a fully operational alarm system protecting all areas of the building, installed to Board standards and CAN/ULC S-561-03 standards for monitoring fire alarm signals. Work to include the alarm devices as outlined in the drawings and specifications provided. Motion detectors shall be provided in ground floor classrooms/offices with windows, and in stairway entrances. Door contacts shall be placed on all ground floor doors and roof top doors/hatches. Second and third floor rooms with a roof access door must also have protection. General alarm protection to be placed in hallways. The DSC GS4010 cellular module and Bell phone lines will be the two forms of communications used to monitor the DSC 4020.
- .2 Please ensure the installer/project manager receives the installation guide/bid sheet, any change orders and site drawings as specific site instructions, and equipment requirements are noted. This will avoid unnecessary deficiencies and follow up visits.

.3 **Bidder's Requirements**

- .1 All bidders shall be qualified to work on DSC 4020 panels. DSC 4020 and DSC GS4010 cellular module to be installed to CAN/ULC S561-03 for monitoring fire signals. The Peel District School Board requests proof of qualifications from bidders, plus names of references where the bidder(s) have installed or are currently providing ongoing service to DSC panels.
- .2 Further, all bidders to have an account with TRI-ED and be a customer in good standing.
- .3 In the space below, provide 3 (three) DSC panel references for institutional or commercial installations where the DSC 4020 was installed to meet CAN/ULC S561-03 standards.

Installation of the DSC 4020 must pass the Board's monitoring company inspection as per CAN/ULC S-561-03 Appendix C Test and Inspection Report.

IF ANY ISSUES ARE NOTED DURING THE INSPECTION, CORRECTIONS MUST BE COMPLETED IMMEDIATELY IN ORDER TO OBTAIN OCCUPANCY OF THE SCHOOL. IF BOARD'S MONITORING COMPANY REQUIRES ADDITIONAL FOLLOW-UP VISITS TO ADDRESS DEFICIENCIES, INSTALLER MAY BE CHARGED BACK THE INSPECTION/TEST VISIT OF \$300.

Note: The Board reserves the right to contact any or all of the firms listed below and to request details as to the performance of your firms work including, but not limited to, confirmation of the information provided.

1. Organization/Location: _____
 Description of equipment: _____
 Contract Duration (Start Date/Completion Date): _____
 Approximate Value: \$ _____
 Contact: _____ Telephone #: _____

2. Organization/Location: _____
 Description of equipment: _____
 Contract Duration (Start Date/Completion Date): _____
 Approximate Value: \$ _____
 Contact: _____ Telephone #: _____

3. Organization/Location: _____
 Description of equipment: _____
 Contract Duration (Start Date/Completion Date): _____
 Approximate Value: \$ _____
 Contact: _____ Telephone #: _____

.4 Alarm System Functions

- .1 Detection of an alarm, from either security field devices, alarm operation of the fire alarm system or detection of low temperature thermostats, shall be zone annunciated in the control panel's LCD keypad. Also initiate a programmed signal transmitted via the communicator, over the Bell Canada telephone system and the GS4010 cellular module to the School Board's central monitoring agency. Supply wiring in the fire alarm system to trip the 24 hour fire zone. Trouble and Supervisory indication on the fire alarm panel shall activate a supervised trouble condition at the LCD keypad. Board Monitoring contractor to check to ensure that the connection between the security panel and the Fire panel is consistent with CAN/ULC S-561-03 and Board standards.

- .2 The control unit shall be able to receive up to 128 unique signals (zones) and initiates the programmed action or actions to be performed. The control panel shall be capable of logging and storing in memory 600 events. The memory shall be protected by and supervised by a low battery condition. It shall be possible for users to generate a report of logged information upon request, both at the panel and by means of a remote computer. The wall mounted control/communicator panel with tamper-protected lockable door shall be a DSC PC4020 complete with dual line dialer module (DSCPC4701), cellular module (DSCGS4010), DSC T-Link 250-Network alarm communicator (TL250), an LCD 4501 message keypad and an LCD 4501R red message keypad.
- .3 The system shall log all functions initiated through the system. It shall provide a local signal if any of the perimeter door contacts are opened and shall automatically transmit a signal to a remote ULC listed central monitoring station.

2.1 PRODUCTS

- .1 Except for those items as may be specified in Part 3 of this Section, refer to Part 2 of the various Sections of Specification, Division 26 Electrical.

.2 Alarm Devices

- .1 Approved alarm devices are as follows:
 - Zone Expanders: PC4116 adds 16 hardwire zones with initial system zone.
 - T-Link-Network Alarm Communicator TL 250 Unit and the GSM Alarm Communicator (GS4010 cellular module). IP address and network drop to be provided at time of installation. DSC T-Link to be installed, programmed and working with the Security Department at HJA Brown Education Centre.
 - LCD Touch pad Model 4501: Large, backlit, 2 lines 32 -character display, plain language display of zone status, system status, trouble conditions, event buffer, system instructions, date and time. Location of keypad is to be next to the control panel in the Custodian's office.
LCD Touch pad Model 4501R: Large, backlit, 2 lines 32 -character display, red keypad, plain language display of zone status, system status, trouble conditions, event buffer, system instructions, date and time. Location of keypad is to be next to the control panel in the custodian's office to annunciate Fire zones. Fire Alarm Area on partition one of DSC 4020.
 - Alarm Sirens: (used only for burglary alarm annunciation) sirens shall be DSC, 15 watt, surface Model # DSCSD15W DC. Power supply for the alarm sirens shall be provided from a power supply and shall operate horn for a minimum of 15 minutes. Sirens to be mounted above ceiling space in hallways. All relays for sirens must be placed on expander and not in main panel.

- Key Switches: Board to provide. Generally one key switch is at the front door and the second is placed next to the control panel in the Custodian's Office. From the control panel to each key switch, a three pair cable is required. The indicators of the key switch shall be:
 - Green Light - system armed
 - Red Light - zone open (NOT to be noted as READY light)
- Sensors for classroom corners or wall mount: C & K DT-7450 Series, Dual TEC Motion Sensor (loop series in with tamper loop).
- Door Contacts: The door contacts shall be concealed magnetic switches Sentrol Model #1078 Series where specified, and shall be installed on all exterior doors. Where surface contacts are required they will be Sentrol Model #1085T Series.
- 360 degree Sensors: Sentrol 6255FM Series (flush single-gang outlet box required). Used in small offices and stairwells.
- Long Range Motion Sensors: 200' Long Range PIR Motion Detector SENAP633, or Interlogix VE735.
- Overhead Door Contacts: ODC 59A (For roof hatch and roll up doors only).

.3 System Features/Required Installation Programming

- .1 Each device is to be placed on a separate and dedicated zone. The placement of more than one device on a zone will not be accepted. Zone descriptions to be provided in writing to Board Security Department, monitoring station and school by successful bidder.
- .2 Door contacts are to be flush mounted and concealed in exterior doorframe. Any deviation from flush mounted door contacts requires the approval of the Security Administrator.
- .3 Overhead doors to have contacts placed on top of doors. (ODC 59A)
- .4 Motion detectors are NOT to be placed on the corner that is considered the front of the classroom (at the blackboard). Motion detectors must not be a distraction for staff and students. To be mounted where possible, in the corner of classroom (corner mount) along window facing into the classroom and 7 to 8 feet from floor. Sensitivity of motion detector not to be set at 100% but left at 65 to 75% depending on coverage.
 - Reserved Zones: Zone 1 School key switch, Zone 2 Portable key switch, Zone 3 Daycare or other key switch, Zone 12 GSM Trouble/Comm. Fault, Zone 13 GSM/Cabinet tamper, Zone 14 Fire Trouble, Zone 15 Fire Supervisory, Zone 16 Fire Alarm and Zone 18 Low Temperature.
 - Zone placement shall start at main doors and go in an orderly fashion around the school.
- .5 Each device MUST be directly wired to the control panel or expander found in the Custodian's Office. All termination wires at the DSC 4020 panel shall be marked and identified by a zone. No remote zone expanders or power supplies without the Board's prior approval.

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- .6 The system is to operate as indicated and in accordance with the manufacturer. Adequate power supplies are required to power all devices. On battery power for a minimum 24 hour period. Two 12V DC 7 AMP hour batteries required. All batteries to be labeled with date of installation.
 - .7 Provide sufficient power supplies to power motion detectors within system (approximately 25 to 30 motion detectors per 4204CX). No motion detectors to be powered from DSC 4020. Power supplies to be DSCPC4204CX with battery back-up.
 - .8 Plug in transformers must NOT be used. Primary power transfer must be directly connected to panel. Primary to be in metal box, secondary is to be wired straight into DSC4020 and the first DSC PC4204CX (will be used to power the GS4010) using FTB3716-NAA-100 transformer. A/C (DSC Model ULC-LA) light to be installed on main panel. Breaker panel powering DSC4020 must be labeled.
 - .9 Provide an additional tamper-protected lockable cabinet DSC 4001C to house expansion modules (PC4116) for an initial system zone capacity of 64 zones. DSC544 locks to be included (part #: TRI-CL1). If system requires more than 64 zones, provide required expanders and power supplies, plus an additional 12 spare zones. All systems to have an additional 12 spare zones. Cabinet tampers to be connected to one zone per cabinet location (i.e. Custodian's Office Head End and Expander to zone 13). GSM tamper is to be in series with cabinet tamper and labeled "Cab/GSM Tamper".
 - .10 DSC panel to be programmed to report any bypassed zones to the central monitoring station. Program Communication Toggles REF: (00 04 01) toggle "PC ID" and "PC ID Restores" to (Y). This will allow the panel to communicate zones, which have been bypassed.
 - .11 System devices to have tamper switch and double end-of-resistors at device for supervision.
 - .12 A (DSCPC4701) Dual Line Dialer module is required. The 3 CA38A jacks are to be installed at the Bell demarcation at telephone system. The two extra CA38A jacks are to be used as back-up in the event of line failure. FT6 cables must be run between the telephone system and the security panel in new ½ EMT conduit. Each line must be programmed to send a 24-hour test signal each day. Alarm sirens must NOT be programmed to activate on Low temperature alarm, alarm tamper, Fire Trouble, and Fire Alarm.
 - .13 For Low Temperature zone, add a summer/winter toggle switch to expander cabinet, label correctly and test with monitoring station to ensure working. Low temperature to be programmed as (21) 24 hour Freeze zone, inaudible, and non-by-passable. Only way to bypass zone is to place summer/winter switch in summer mode.
 - .14 GSM (GS4010 cellular module) is powered from a separate power supply, PC4204CX (ULC labelled) and connected to the main panel using a hardwired transformer (ATC-FTB 3716) with 2 batteries for 24 hour supervision.

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- .15 GSM (GS4010 cellular module) Installation/Programming requirements:
- Line 2 on security for GSM, Line 1 to Bell Demarcation
 - Relays for GSM are to be DSC RM1C ULC listed relays (ULC labeled)
 - Relays are installed in main panel only.
 - Output 4 on GSM is connected to a separate zone on the main panel and labeled "GSM Trouble/Communication Fault" (zone 12 on panel).
 - A programmable output from main panel is connected through RM1C ULC relay to Input 1 on GSM (Fire Alarm).
 - All GSM zones on main panel must be clearly labeled and enrolled in fire partition (Area 1 of System).
 - Cables from GSM to main panel must be mechanically protected.
- .16 Three (3) FT6 4/22 cables must be run in new ½ EMT conduit between the fire panel and the security panel. Connection to fire alarm panel for fire alarm, fire supervisory and fire trouble monitoring. Board's monitoring company will verify and inspect. All fire zone cables must be clearly labeled.
- .17 Provision and installation of 120 volt supply in conduit terminated at location of control/communication unit for connection to control cabinet by Division 26.
- .18 All wiring shall be FT6 plenum rated to conform to requirements of the Canadian Electrical Code and Provincial Codes. Only FT6 rated #22 AWG cable will be acceptable. All system wiring/cables to be installed as per all applicable codes and regulations.
- .19 System cabling must NOT be placed on ceiling tiles. All cables must be supported a minimum of every 1.67 metres. Cable to be supported with approved cable support devices, i.e. J hooks, tie wraps. If tie wraps are used they must not be too tight. System cabling may be placed in cable trays located in hallways, if available. No cable shall be installed between the supporting structure, i.e. steel joists or masonry walls and the floor or roof deck. All cables shall be a minimum 12" below the roof deck. All cables passing through fire separations shall be installed in dedicated, approved sleeves.
- .20 Equipment, conduit and cables must be installed in a workmanlike manner. The installation is to be neat and tidy in appearance. Exposed wiring must be placed in metal mould with metal clips secured to the surface or pipe. System wiring leading into the control panel must be neat and in raceway/conduit.
- .21 Wherever services (conduit, cables etc.) cross building expansion joints, install the services in such a manner to permit free movement without imposing additional stress or load upon the support system, and to prevent excessive movement at joints and connections.
- .22 Board is to conduct a review of installation ensuring that all noted items in tender were installed accordingly. All work to be performed and completed in accordance with applicable standards, building codes, manufacturer's recommendations and current construction trades practices. Work that is unsatisfactory to the Peel District School Board will be replaced at no extra cost.
- .23 Bypassing group feature only to be used by installer during installation process and not allowed to be left on, once system is fully operational.
- .24 Main panel to be labeled with School Name, Location #, and Breaker Panel #.
-

.4 Warranty

- .1 The installation shall include a one-year warranty for all materials and labour effective from the date of commissioning and acceptance.

.5 Programming

- .1 When motions are mounted in hallways or large open areas, use a room next to the device to best describe the location. (i.e. MDL outside RM101 instead of MD L/R PIR in S/W Corr. facing S.). Panel to be programmed with zone number and description, not just description. Simple descriptions programmed into the panel will allow custodian's and trade staff to better investigate possible problem devices.

.6 Testing

- .1 Confirm that all devices/zone points are reporting to the monitoring centre and that zone descriptions/designations are correct. Board Security to be advised when testing with monitoring centre is complete. Board Security to print off testing report and confirm that all zones/devices reported to the monitoring centre.
- .2 A zone listing is to be faxed or e-mailed to the Board Security department prior to panel changeover. This zone list will be forwarded to the monitoring company for programming. It must be noted on the zone list which zone belongs to which zone expander at schools with approved zone expander locations.
- .3 As built drawings with zoning identification, cabling routes, wire list, and power supply locations are to be submitted to the Board's Security Administrator. One copy of the wire list is to be left locked in the control panel.
- .4 A set of school drawings with zone numbers plotted on the drawings is to be delivered to the Board Security department. Zone numbers are to be written on the drawings with location of device (i.e. classroom 101, zone 32 will appear in classroom 101 and MD or DC will be noted where the device is located within the classroom).
- .5 The successful intrusion alarm system contractor shall perform a complete test of the system. A letter is to be provided on your firm's letterhead confirming that such tests have been completed and that the operating instructions to the owner have been performed and additionally indicate that:
 - The system complies with Manufacturer's installation recommendations.
 - The system has been tested, verified, and certified in writing by the Board's monitoring station.
 - The installation is acceptable for warranty.

Further, a complete acceptance test in the presence of and to the satisfaction of the Board. Note: No payments will be forwarded until tests, to the satisfaction of the Board, have been completed.

- .6 After testing is complete; the installer is to review panel operation with day and afternoon custodial staff. Custodian's should be able to reset the system after a fire test, check the panel for open zones (for all partitions), know how to bypass problem zones (for all partitions), and know what the trouble conditions are on the keypad, etc. Training may be required more than once during the first three to four months of installation.
- .7 Manuals, Programming and Printouts
 - .1 Installation and program manuals to be provided to Security/Risk personnel.
 - .2 A printout of the complete system program to be provided to Security/Risk personnel, as well as software required for uploading/downloading and manuals.
 - .3 All access codes at all levels are to be left at factory settings. System is to be ready for uploading/downloading by Security/Risk personnel.
- .8 Alarm Panel Access Codes
 - .1 The installer shall hand over to the Board all access and programmable codes once the alarm system is activated.
 - .2 The Board, upon recognizing that the alarm system and all its functions are operating in a satisfactory manner, may change the codes.
 - .3 Changing the codes from the ones issued by the installer until changed by the Board shall not void the warranty or programming.
- .9 Security System Installers
 - .1 Approved DSC Security System installers for Peel District School Board:

Barrie Communications Equipment Ltd
1114 Westport Crescent
Mississauga, ON L5T 1G1
Phone: 905-564-7026
Fax: 905-564-0806
Alfred Spedale

Underwriters Security Controls Incorporated
172 Bullock Dr., Suite 27
Markham, ON L3P 7M9
Phone: 905-201-0241
Fax: 905-201-0625
Alex Dumitrescu / Dan (cell: 416-567-0516)

Altel Integration Systems
2425 Matheson Blvd. E., Suite 721
Mississauga, ON L4W 5K4
Phone: 905-361-2551
Fax: 905-361-2615
Shawn Hurd

Detson Integrated Security Systems
588 Edward Avenue, Unit 57
Richmond Hill, ON L4C 9Y6
Phone: 905-770-7075
Fax: 905-770-8185
Joe Cuprik

Gems Security Systems Inc.
4000 Steeles Ave., W. Unit 29
Vaughan, ON L4L 4V9
Phone: 905-850-8511
Fax: 905-850-8513
Rose Catalano

.10 Subcontracting

- .1 During this project, the successful Alarm contractor shall not sub-contract any of the contractual obligations without written authorization of the Board.

.11 Completion Schedule

- .1 The Intrusion Alarm System must be completed 1 week before owner takes occupancy of the school.

.12 Deficiencies

- .1 Upon completion, a deficiency audit will be conducted by the Peel District School Board, or assigned designate. Performance Surety will not be released until 100% substantial completion of all noted deficiencies.

.13 Quantities

- .1 Alarm device quantities indicated on drawings are estimates only. Successful bidder(s) is responsible to ensure correct quantities are supplied and installed to adequately protect the school. No additional costs will be accepted after the award of this contract, if quantities within your bid submission are not correct.

.14 Telephone Connection

- .1 The surveillance control panel will communicate with the central monitoring station. Part of this contract is to provide empty conduit between telephone terminal and surveillance control panel.

- .15 Turn over three (3) copies of the operating and maintenance manual to the Board representative.

.16 Manual to contain, but not limited to the following:

- 'As-built' drawings
- Zone chart
- Wiring schematic
- Manufacturer's Technical Data
- Manufacturer's Operating & maintenance Instructions
- Programming sheet
- Name of manufacturer's authorized service representative, with contact name, address and twenty-four (24) hour telephone number.

3.1 **EXECUTION**

- .1 Except for those items as may be specified in Part 2 of this Section, refer to Part 3 of the various Sections of Specification, Division 26 Electrical.
- .2 Provide all conduits, outlets and other materials as required and/or shown on the drawings for a complete system ready for installation of cables and equipment.
- .3 Locate the control panel where shown on the drawings.
- .4 Install the complete security system as indicated and in accordance with the manufacturer's instruction.
- .5 Flush wall mount the control unit, wall mount double remote arming station and zone status indicators as detailed on the drawings. Connect with power wiring.
- .6 Surface mount motion detectors where shown. Secure the baseplate of each detector to a flush outlet box and connect with wiring. When decorating work is complete, adjust detector sensitivity as required and snap detectors into place. Mount detectors at 300mm below ceiling and 2500mm above floor in areas without ceiling.
- .7 Surface mount wall mount alarm sirens (horn speakers) in ceiling spaces where shown. Ensure that each speaker is accessible and that exact locations are marked in the As-Built drawings.
- .8 Submit a riser diagram showing major components and wiring as a shop drawing.
- .9 All zoning designation shall be subject to the approval of the Consultant and Owner.
- .10 Provide all required end-of-line resistors to supervise wiring. Refer to system riser diagram on drawings.
- .11 Confirm exact locations of all components prior to roughing-in.
- .12 Alarm contractor to provide EMT conduit with 22 AWG wire from the control panel to telephone equipment backboard for system monitoring via Schedule 3A data channel using dual phone lines to a ULC listed monitoring system.

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- .13 Be responsible for co-ordinating all aspects of the system which are to be supplied.
- .14 Provide the door supplier with all pertinent information regarding hole sizes and location of holes to be drilled in the doors and frame to accommodate door contacts.
- .15 Surface mount or recess motion or break glass detectors where shown. Secure the base plate of each detector to a flush outlet box and connect with wiring. When decorating work is complete, adjust detector sensitivity as required and snap detectors into place.
- .16 Alarm contractor to provide EMT conduit with 22 AWG wire from the fire alarm panel to the security control panel for connection of the fire alarm and trouble outputs.
- .17 System Testing and Verification
- .1 When the security system is complete, make a complete inspection of all installed equipment including each and every component such as motion detectors, door contacts, control equipment, etc. with a competent and qualified member of the system manufacturer's personnel to ensure the following:
- That the system is complete in accordance with the contract documents.
 - That the system is installed in accordance with manufacturer's recommendations and all other governing requirements.
 - That the regulations concerning the supervision of components have been adhered to and are properly wired and supervised.
- .2 Perform any changes necessary as a result of sub-paragraphs 1 and 2 above in accordance with the system manufacturer's directions.
- Refer to attached ULC Installation Checklist.
 - Refer to attached Appendix 'C1' and 'C2' information.
- .3 Provide a copy of the inspecting technician's report showing location of each device and certifying the test results of each device, and forward to the Engineer and Owner.
- .4 All costs for testing, verification, connection to Bell and the designated ULC central monitoring station, attendance of the designated alarm monitoring company technician and demonstration of the system will be included in the tender price.
- .5 The installation shall include a one (1) year warranty for all material and labour effective from the date of commissioning and acceptance.
- .6 A certificate or letter of verification shall be provided on completion of the installation, commissioning and acceptance and shall be posted at the control equipment or left with the Head Caretaker to display prominently.

.7 Requirements:

- When testing, verification and certification procedures specified above are completed and upon receipt of the inspection report, arrange for the system manufacturer to visit the site and demonstrate proper operation and maintenance of the security system to designated members of the Owner's staff and the designated alarm monitoring company technician.
- Confirm the exact location of all system components with the Architect prior to roughing-in.
- Quantities for components shall be as per the floor plans.
- Be responsible for ensuring that the nomenclature of annunciator's identification nameplates are verified with the Owners and authorities and that the necessary approvals have been obtained prior to ordering.

.8 Quantities:

- Alarm device quantities indicated on drawings are estimates only. Successful bidder(s) is responsible for ensuring that correct quantities are supplied and installed to adequately protect the school. No additional costs will be accepted, after the award of this contract, if quantities within your bid submission are not correct.

.9 Test and Inspection Forms/Checklist:

- Fill out attached Test and Inspection Forms.
- Fill out attached Checklist.

END OF SECTION 26 07 42

1.1 GENERAL

- .1 Refer to Section 26 00 10, General Electrical Provisions.

2.1 PRODUCTS

- .1 Except for those items as may be specified in Part 3 of this Section, refer to Part 2 of the various Sections of Specifications Division 26, Electrical.
- .2 The computer devices complete with wiring and equipment will be provided by others as part of Cash Allowance. Part of this contract will be to provide outlet boxes, blank cover plates and empty conduits as shown on the drawings.

3.1 EXECUTION

- .1 Except for those items as may be specified in Part 2 of this Section refer to Part 3 of the various Sections of Specifications, Division 26 Electrical.
- .2 Provide conduits, outlet boxes, blank cover plates and other materials as required and/or shown on the drawings for installation of computer devices and equipment by others.
- .3 The installation shall be done in accordance with the Board's and manufacturer's requirements.
- .4 A fish wire shall be installed in each empty conduit.
- .5 All distribution conduits shall be complete with slip sleeves to permit the installation of the distribution cables.

END OF SECTION 26 07 44

1.1 GENERAL

- .1 Refer to Section 26 00 10, General Electrical Provisions.

2.1 PRODUCTS

- .1 Except for those items as may be specified in Part 3 of this Section, refer to Part 2 of the various Sections of Specification, Division 26 Electrical.
- .2 Electric supplementary heaters and controls shall, unless otherwise noted, be supplied by Division 23.

3.1 EXECUTION

- .1 Except for those items as may be specified in Part 2 of this Section, refer to Part 3 of the various Sections of Specification, Division 26 Electrical.
- .2 Install all electric heaters and remote electric thermostats supplied by Division 23.
- .3 Electric duct heater shall be installed by another Division of Specification.
- .4 Provide all conduit, wiring, etc. and connect to the electric heaters, electric duct heaters and remote electric thermostats to provide a complete Electric Heating System.
- .5 Install filler pieces where shown on the drawings between baseboard heaters to form a continuous length.
- .6 All L.V. control wiring shall be by Division 23.

END OF SECTION 26 08 50

1.1 GENERAL

- .1 Refer to Section 26 00 10, General Electrical Provisions.

2.1 PRODUCTS

- .1 Except for those items as may be specified in Part 3 of this Section, refer to Part 2 of the various Sections of Specification, Division 26 Electrical.
- .2 The pipe tracing cables and controls shall, unless otherwise noted, be provided by Division 23.

3.1 EXECUTION

- .1 Except for those items as may be specified in Part 2 of this Section, refer to Part 3 of the various Sections of the Specification, Division 26 Electrical.
- .2 Provide all conduit, wiring, etc., and connect to the pipe tracing cables and controls to provide a complete pipe tracing system.

END OF SECTION 26 08 70

1.1 GENERAL

- .1 Refer to Section 26 00 100, General Electrical Provisions.

2.1 PRODUCTS

- .1 Except for those items as may be specified in Part 3 of this Section, refer to Part 2 of the various Sections of Specification, Division 26 Electrical.
- .2 Division 23 will supply and install a Computerized Building Automation System complete with the distribution boxes, control sequencing and all interfacing.
- .3 Division 26 shall provide individual lighting relays and/or contactors for each individual circuit and associated relay boxes and connect to load side of relays, as shown on the drawings (all control wiring by Division 23).
- .4 Contactors used in conjunction with building automation system shall be electrically operated, electrically held type (refer to Section 26 01 72).
- .5 Coordinate work with Division 23.

END OF SECTION 26 08 90

1.1 GENERAL

- .1 Refer to Section 26 00 10, General Electrical Provisions.

2.1 PRODUCTS

- .1 Except for those items as may be specified in Part 3 of this Section, refer to Part 2 of the various Sections of Specification, Division 26 Electrical.
- .2 The P.A. and telephone devices (i.e. speakers, handsets, master units, etc.) complete with wiring and equipment will be provided by Division 28 as part of Cash Allowance. Part of this contract will be to provide outlet boxes, blank cover plates, back boxes and empty conduits as shown on the drawings.

3.1 EXECUTION

- .1 Except for those items as may be specified in Part 2 of this Section, refer to Part 3 of the various Sections of Specification, Division 26 Electrical.
- .2 Provide conduits, outlet boxes, blank cover plates and other materials as required and/or shown on the drawings for installation of telephone/P.A. system devices and equipment by others.
- .3 Conduits for telephone/P.A. devices shall be terminated as shown on the drawings (co-ordinate all work with the system supplier).
- .4 The installation shall be in accordance with the Board's requirements.
- .5 A fish wire shall be installed in each empty conduit.
- .6 All distribution conduits shall be complete with slip sleeves to permit the installation of the distribution cables.

END OF SECTION 26 09 10

1.1 GENERAL

- .1 Refer to Section 26 00 10, General Electrical Provisions.
- .2 Provide complete and operational sound system as specified herein and as indicated on the drawings. It is the responsibility of the contractor to provide all miscellaneous equipment and materials such as clips and hangers, etc. required to provide a fully operational system even though such miscellaneous equipment and material may not be specifically itemized and specified.
- .3 The complete system must carry C.S.A. and Ontario Hydro Approvals on all power amplifiers, and other electrical components. These components shall be fully licensed and factory built by a recognized manufacturer.
- .4 Provide one year warranty on all entire sound systems, to commence upon completion of installation.
- .5 All equipment supplied shall be new and of current manufacture. Used or reconditioned equipment will not be accepted.
- .6 Division 26 to supply and install all necessary conduit, back boxes, coverplates and wire with one meter tails at each termination point.
- .7 All switches, connectors, outlets, control panels, etc. shall be clearly and permanently marked with engraved or other indelible means.
- .8 All cable and wires shall be as specified, in its own conduit and be of continuous run between termination points.
- .9 System Operation and Requirements
 - .1 The system shall provide even audio distribution throughout the audience area of program material originating from microphones, tape sources, and any auxiliary input source.
 - .2 The sound level uniformity shall be +/- 2dB in the 4 kHz. octave band throughout the coverage area.
 - .3 The Central Equipment Cabinets shall be portable and be capable of being operated from two locations as shown on the drawings. Appropriate cabling and connection points shall be provided for this requirement.
- .10 System supplier will be required to co-ordinate all work with the General Contractor and Electrical Contractor on site.

2.1 PRODUCTS

- .1 Except for those items as may be specified in Part 3 of this Section, refer to Part 2 of the various Sections of Specifications Division 26, Electrical.

.2 School Gymnasium System

a. Central Equipment Cabinet: (Refer to **Figure 1** for detailed layout)

- The equipment cabinet shall be a floor standing unit, Middle Atlantic PTRK-21 series (or approved equal), complete with locking front and rear doors and shall be equipped with casters for portability.
- The cabinet shall be complete with all necessary flexible interconnect cables (Digiflex brand), and mounting rails.
- The cabinet shall include a 3-unit sliding mount drawer.
- The cabinet shall include one (1) sliding shelf with position lock for audio mixer.
- Include two (2) surge protected power bars complete with 6 receptacles with the ability to accommodate two (2) transformer plugs. One power bar to be mounted front-facing with a 15-foot power cable and one power bar mounted rear facing with a 3-foot cable.
- The cabinet components will consist of but are not limited to the following:
 - Audio mixing console
 - Amplifier
 - Equalizers
 - Audio CD player with iPod dock
 - Wireless Receiver

b. Audio Mixing Console:

- The mixing console shall be a Allen and Heath ZED (or approved equal) and must meet the following minimum requirements:
 - Audiophile-quality and ultra-low noise
 - 12 Mic/Line inputs
 - +48V phantom power
 - 2 stereo channels with 4-band EQ
 - 3-band EQ with swept mid-range plus low cut on each mono channel
 - 2 AUX sends, one with Pre/Post switch
 - XLR connector on main L/R output
 - Red LED for each muted channel
 - Gain control for each channel
 - Peak indicator for each channel
 - Rack Mount Kit

c. Amplifier/Equalizer:

- The amplifier shall be GXD4/QSC with built-in graphic equalizer (or approved equal) to drive main speakers. Front speakers to be connected to Channel A (left). Rear speakers to be connected to Channel B (right).
- The Amplifier must meet the following minimum requirements:
 - Dual Channel Model
 - The front panel controls shall include power switches and individual stepped gain controls
 - Front panel indicators shall include On/Off indicator illuminated clipping indicators and illuminated standby indicators
 - Minimum 300 watts per channel
 - Provide all necessary cables.

- The Equalizer shall be DBX 215 Brand (or approved equal) and must meet the following minimum requirements:
 - Dual 15 bands.
 - 2 gain controls.
 - 12 db – 6 db switch.
 - 2 by-pass switch/indicators.
 - 2 peak and LED level indicators.
- d. **CD Player with iPod Dock:**
 - The audio CD player shall be Denon 300AB (or approved equal), and must meet the following minimum requirements:
 - Black in colour.
 - Front of the player must have a full functional display and must contain full function control buttons for the following: Power, Play, Pause, Stop, Skip Forward and Skip Back.
 - Provide all necessary cables.
- e. **Speakers:**
 - Provide four (6) EVSX 100+E speakers, fly mounted on either side of double Gym walls as shown in **Figure 3**.
 - Provide four (6) fly mounting hardware to fly mount speakers.
 - Speakers to be installed 15' – 25' high and tilted down 60-80 degrees.
 - All speaker installations must be reinforced with aircraft type cables.
- f. **Floor/Stage Monitor Speaker:**
 - The Floor/Stage Monitor Speaker shall be a Yorkville NX 55P brand (or approved equal).
 - One (1) duplex power outlet and one (1) audio jack must be installed on the front middle of the stage front wall to accommodate floor/stage monitor speaker.
- g. **Microphones:**
 - Supply a wireless microphone system to be a SENNHEISER XSW dual wireless system with two PG2/PG58 handheld microphones.
 - Supply two (2) wired microphones, to be a SHURE SM58 (or approved equal).
 - Two (2) MC-100C microphone stands shall be supplied.
 - One (1) Digiflex Mono DI Box.
 - Two (2) 6 ft. Digiflex patch cables, 3.5mm stereo mini to 2 1/4".
- h. **Speaker Jack Panel:** (Refer to **Figure 4**)
 - Install two (2) remote interconnect boxes (GS1). Shall be housed in a flush "D" type box, with one located at the front wall of the gymnasium next to the stage, and the other at the centre back wall of the gym, approx. 2 ft. off the floor. Refer to Figures 1 and 2.
 - Box shall be complete with locking door accessible only through a key lock.
 - Box shall contain:
 - 1 duplex power outlet
 - 1 internet jack
 - 1 8-wire speakon jack
 - 2 stage monitor jacks
 - 1 lighting jack
 - 6 XLR microphone jacks

i. **Muting Control Unit:** (Refer to **Figure 5**)

- The Muting Control Unit must provide a voice activated relay which will connect to the Office PA Systems PCM2000 to allow muting of the sound system in the gym during paging announcements and/or lockdown.
 - One (1) Bogen VAR-1 (or approved equal) voice activated relay to be supplied and installed.
 - One (1) Bogen PRS40C power supply unit to be supplied and installed (or approved equal).

.3 **Wiring and Cable**

a. **Wiring:**

- Wiring and connections shall be in accordance with manufacturer's specifications and wiring diagrams.
- Wiring shall be supplied and installed by System Supplier/Installer and run in conduit throughout as shown and noted on the drawings. Confirm conduit routes with Electrical Contractor on site. All conduits required and shown on drawings are provided by Electrical Contractor.

b. **Cable:**

- All speaker cable shall be 1 pair twisted, stranded, AWG 14, FT6 with dual overall PVC jacket.
- All microphone cables shall be 1 pair twisted; 100% shielded AWG 22, FT6 stranded conductors with an overall PVC jacket.
- All microphone cables shall be Digiflex with Neutrix microphone XLR connectors.
- Cabling in conduit shall be rated FT4, cabling outside of conduit shall be rated FT6.
- Wiring shall be installed in three separate conduit systems: one for hydro, one for speakers, and one for all other low-signal cables for each of the items listed above.

3.1 **EXECUTION**

- .1 Except for those items as may be specified in Part 2 of this Section refer to Part 3 of the various Sections of Specifications, Division 26 Electrical.
- .2 All wiring shall be run in conduit.
- .3 All equipment installation and wiring shall be done in accordance with manufacturer's wiring diagram for the complete system.
- .4 Provide systems demonstration and instructions.
- .5 Use submitted operation and maintenance manual as reference during demonstration and training.
- .6 Provide the Owner with a training program designed to make all users familiar with the operation of the sound systems.
- .7 Provide guarantee/warranty for the installed system, against defects in material and workmanship.
- .8 Final inspection and approval of the sound system installation by the Peel District School Board Medial Support Staff is required before system will be signed off on.

- .9 The Sound System Contractor shall ensure that all floors are protected from damage from the skyjack by laying down plywood or other protective materials. Any damage to the floors as a result of failure of the TLC to properly protect the flooring will be the responsibility of the TLC.
- .10 When a lift (total weight, machine, operator, and load not to exceed 4,500 lbs) is used on the floor system that the floor should be protected with at least two layers of ¾" thick clean protective sheathing with overlapping seams. Protective material should include suitable clean sheathing and floor finish protections such as red rosin paper. When operating equipment, wheels should not travel outside of the protected area whether the machine is stationary or being moved. Do not leave heavy loads on the floor overnight or for extended periods.
- .11 A qualified Service Representative employed full time by the Sound System Contractor shall visit the job site after the installation is complete and prior to the energizing of the system to inspect, test and adjust the system. Instruction shall be provided for the Owners' Representatives in the operation and maintenance of the system. These services shall not exceed one (1) day and shall be provided with a minimum of seven (7) days written notice by the contractor.
- .12 Upon completion of the formal check-out, the Sound System Contractor shall demonstrate operation and maintenance of the system to the Owners' Representatives (School Staff and Designated PDSB Media Technology Support Staff). Training shall not exceed four working hours. Additional training shall be available upon request at additional costs.

Figure 1: Cabinet Layout

Tascam CD player with iPod dock	
Audio Mixing Console Pullout Drawer for Mixer with lock	
2 Unit Spacer	
Equalizer	Muting Control Unit
Wireless Mic Shelf	
Drawer 3 unit	
Jack Panel for speakon only	
1 Unit Space	
Amplifier	
1 Unit Space	
2 Power Bars. 1 forward facing with 15' cable. 1 back facing with 3' cable.	

Quantity	Model Number	Equipment
6	EVSX 100+E Or equivalent	EV speakers 12" 2way 200w black
6	Rigging systems for flying speakers from the ceiling of the gym	
1	12 channel Mixer	Allen and Heath ZED or equivalent
2	GXD4 amplifier with built in graphic equalizer	QSC or equivalent
1	Denon 300AB or equivalent	USB, BLUETOOTH, mp3 player
1	MAPTRK 21	Middle atlantic 21u audio rack with locking doors and casters
1	MAVT1	Middle atlantic vented back panel
1	MAVT2	Middle Atlantic vented back panel
1	MAVT3	Middle Atlantic vented back panel
1	MAT	Slide out mixer tray with lock
1		Locking pull out drawer
1		Rack mounts for wireless microphone receivers
2		Mounted power bars with lights One in the back And one on the front
2	Sennheiser XSW Wireless Microphones	2 Hand held units
1	Rack for wireless receivers	To be mounted in the cart
1	Rack mount for MP3 player unit	
1	Yorkville NX	Floor/Stage monitor speaker
2	XLR cables	Digiflex 25 feet
1	Digiflex stereo passive direct box or equivalent	

1	Bogen voice mute device	Voice activated relay sound system there is a PA speaker located on the stage
1	Bogen power supply	
1	Speakon cable	25 foot NL8 signal microphone cable Speakon input to be installed back stage
	Speaker cable	14/2 FT 4 rated
1	Hardware and cables	All required
1		Rental, delivery and pick up of scissor lift or scaffolding.
1	Labour	Installation of speakers, fly hardware, mounting of speakers, route/fish speaker cable Setup of rack equipment Testing training

Figure 3: Middle School Gymnasium Layout

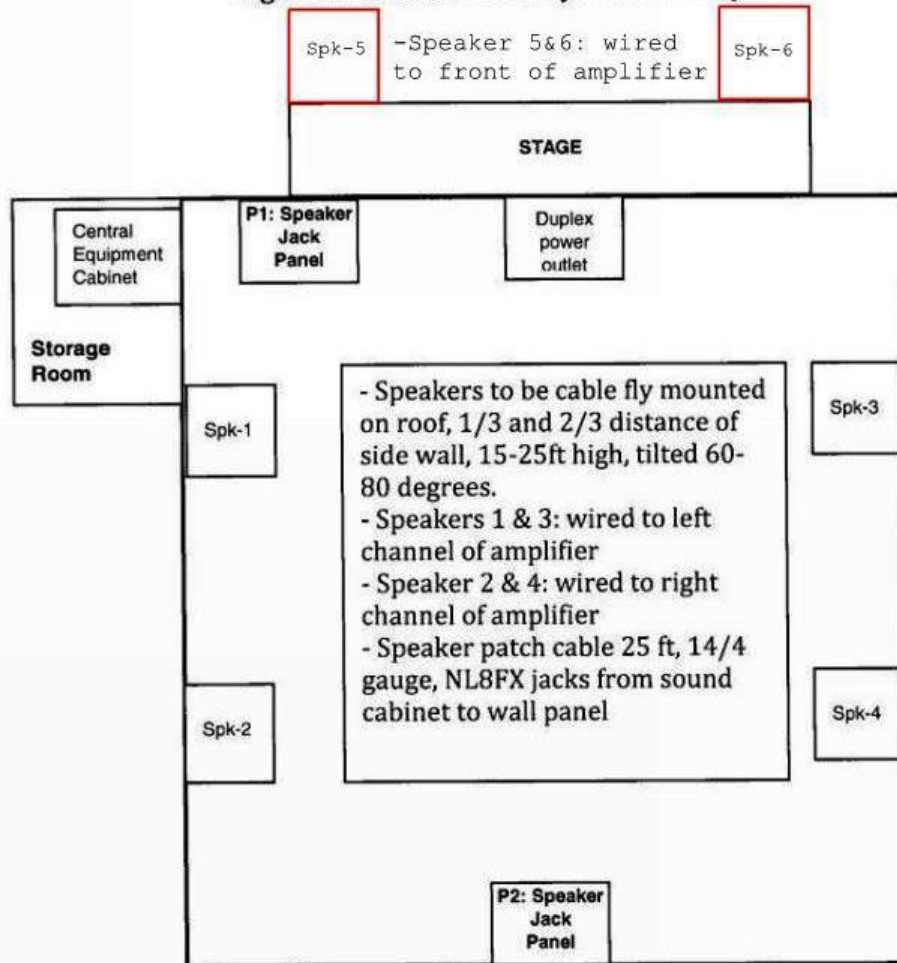


Figure 4: Speaker Jack Panel

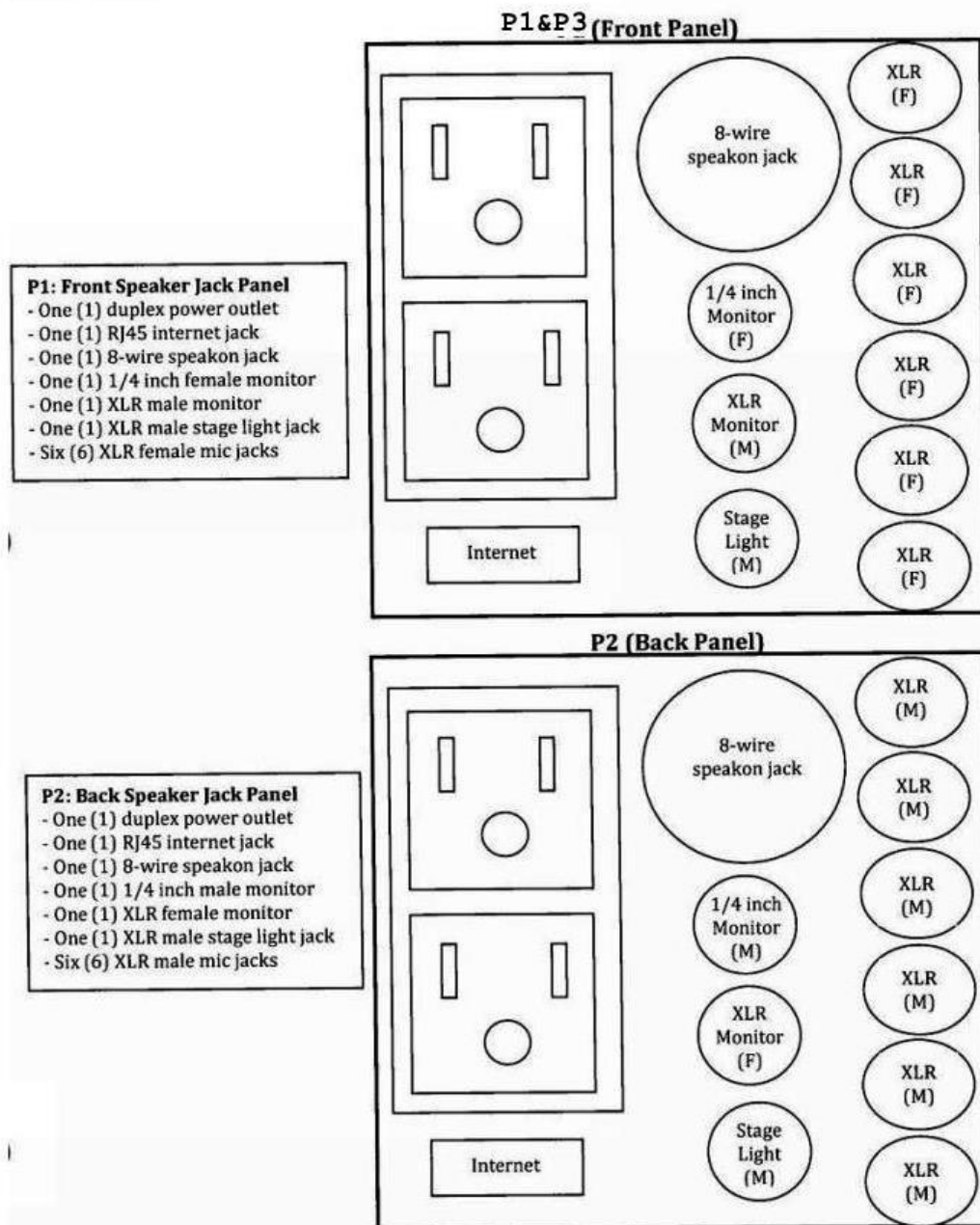
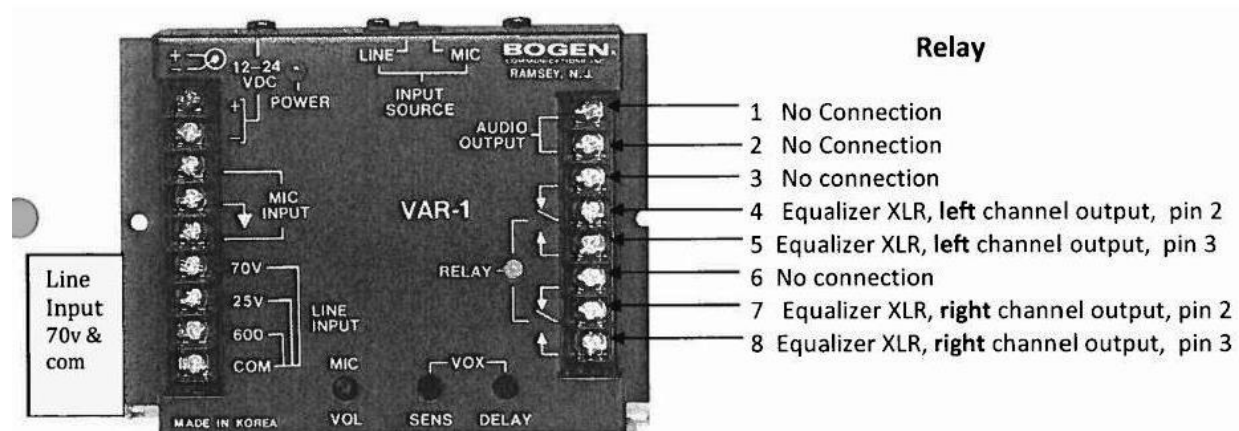


**Figure 5: Muting Control Unit
Cart Installation and Wiring Diagram**

Parts list:

- One (1) Bogen VAR-1 unit
- One (1) DC power supply 18v. 1000ma.
- Two (2) XLR 'y' splitters (XLR female – 2 male) 6ft long.
- Two (2) 3/16" x 1" lock nuts and screws.



- Using one of the 'Y' splitters - connect the female end to the Equalizer Lift Output, one of the male end to the Amplifier XLR Left input, and the second male end to be terminated to the VAR-1 .
- Using the second XLR 'y' splitter, duplicate the above except it is designated to the Right Equalizer out , power amp in and VAR-1
- Connect a pair of wires from one of the PA speakers in the gym via the new 8 pin speakon speaker connector to VAR-1 Line Input, 70v and com.
- Install Power Supply
- On the input source switch, select Line.
- May need to adjust Sensitivity and increase Delay.

END OF SECTION 26 09 11

1.1 GENERAL

- .1 Refer to Section 26 00 10, General Electrical Provisions.

2.1 PRODUCTS

- .1 Except for those items as may be specified in Part 3 of this Section, refer to Part 2 of the various Sections of Specification, Division 26 Electrical.
- .2 Clocks (surface mounted) complete with all associated wireguard and hanger shall be supplied by others as part of Cash Allowance. Division 26 shall install as per locations on drawings.
- .3 Clocks in general purpose room shall be 15" diameter and shall be complete with wire guard.
(2 units)

3.1 EXECUTION

- .1 Except for those items as may be specified in Part 2 of this Section, refer to Part 3 of the various Sections of Specification, Division 26 Electrical.

END OF SECTION 26 09 15

1.1 GENERAL

- .1 Refer to Section 26 00 10, General Electrical Provisions.

2.1 PRODUCTS

- .1 Except for those items as may be specified in Part 3 of this Section, refer to Part 2 of the various Sections of Specification, Division 26 Electrical.
- .2 The hand dryers shall be electronic type, World Dryer Cat. #K-974 (surface type in washrooms), vandal resistant type, fixed nozzle and site title grille with a capacity of 1200 watts at 120 volt. Colour to be selected by the Architect.

3.1 EXECUTION

- .1 Except for those items as may be specified in Part 2 of this Section, refer to Part 3 of the various Sections of Specification, Division 26 Electrical.
- .2 Provide backboxes for dryers and connect to circuits as shown on the drawings (co-ordinate with Architectural drawings).
- .3 Install the hand dryers at the following mounting heights:
- | | |
|------------------|---------------|
| - Boys Washroom | 1118mm A.F.F. |
| - Girls Washroom | 1067mm A.F.F. |
- (Co-ordinate with Architect).
- .4 Install dryers in accordance with manufacturer's recommendations.

END OF SECTION 26 09 30

1.1 GENERAL

- .1 Refer to Section 26 00 10, General Electrical Provisions.
- .2 Supply and install complete Assistive Listening Systems to Stage/Gym Area as described herein.

2.1 PRODUCTS

- .1 Stage/Gym Area.

- .1 Modulator:

Modulator shall be a Williams Sound Corp. Model MOD1 as follows:

Dimensions Weight:	8.45" (21.5cm)W x 8.18 (20.8cm)D x 1.72" (4.4cm)H, 3 lbs. (1.5 kg).
Colour:	Black epoxy paint with white legends.
Rack Mount:	One IEC rack space high, one or two units can be mounted in a single rack space with optional RPK 005 (single) or RPK 006 (double) rack mount kits.
Power:	External power supply, 24 VAC, 50 or 60Hz. 2.4Va, 82mA max. current drain.
Modulation:	95Hz. FM, $\pm$ 15Hz. deviation, 75 Ohm source impedance, 75 micro-second pre-emphasis.
AGC:	Variable slope compressor/limiter.
Operating Req.:	0-50°C ambient temperature, non-condensing, non-corrosive atmosphere.
Front Panel:	
Power Switch:	Two-position rocker, ON/OFF.
Power Indicator:	Green LED.
Audio Indicators:	Amber LED 'OK' for nominal input signal level. Red LED 'HI' for excessive input signal level.
Audio Level Control:	Rotary pot, screwdriver adjust, used with audio indicator lights.
Tape Output:	RCA jack, 600mV, 1200 Ohm source impedance, 10K Ohm nominal load impedance.
Infrared Test LED:	IR LED for receiver testing, monitoring and audio signal testing.
Rear Panel:	
Audio Inputs:	All three inputs are actively mixed into a single signal, allowing use of mono, stereo or 3 channel audio sources.
Balanced Audio In:	3-pin female CLR, accepts microphone, line, 25V. or 70V. audio input.
MIC Input:	10-Z, 100 microV min. to 50mV max. 1mV nominal, 3K Ohm impedance supplies simplex power 20V (DIN 45296) for condenser mics.
Line Input:	21mV min. to 10V max., 212mV nominal, 100K Ohm input impedance.
70 Volt Input:	216mV min. to 100V max., 2.16V nominal, 100K Ohm input impedance.

Unbalanced Audio Ins:	(2) RCA, 21mV min. to 10V max., 212mV nominal, 50K Ohm input impedance.
Input Selection:	3-position slide-type switch, selects: mic/line/70V on balanced audio input.
High-Pass Filter:	3-position slide-type switch, 20hZ., 175 Hz, 6dB/octave roll-off.
Modulation Outputs:	(2) F-type connectors, 75 Ohm. 95kHz FM and 15kZz deviation, 0.5V P-P signal uses RG-59 cable, 1000 ft. (304m) max. CATV splitters cannot be used.
Power Connection:	2-conductor, screw terminals, extra terminals are not used (for future applications).
Transmitter Type:	For use with Williams Sound WIR TX1, WIR TX2, WIR TX3 transmitter/emitter panels. Each MOD 1 modulator can drive two transmitter panels directly for multi-transmitter system, each TX3 repeats the modulation signal to drive the next transmitter in the chain.

.2 Transmitter:

Transmitter shall be a Williams Sound Corp. Model #TX3 as follows:

Dimensions, Weight:	11.125" (28.3cm)W x 8.125" (20.6cm)H x 3.23" (8.3cm)D, 3.25 lbs. (1.6 kg).
Colour:	Black epoxy paint with white legends, red acrylic window.
Wall Mount:	Omni-directional mount included for wall and ceiling mounting.
Tripod Mount:	Optional SS-2 tripod stand kit available.
Power:	External power supply, 24 VAC, 50 or 60 Hz. 30VA, 0.9A nom. Current drain transmitter shuts off when modulation signal is not present.
Operating Req.:	0-50°C ambient temperature, non-condensing, non-corrosive atmosphere.
Coverage Area:	5000 sq. ft. (465 sq.m) 50 cone pattern, see coverage diagram.
TX3 Front Panel: Power Indicator:	Red LED, visible in centre of window, also indicates modulation signal present.
TX3 Rear Panel: Mounting Holes:	Two sets of threaded holes for use with omni-directional mount (included), two threaded holes on sides of the cabinet for tripod stand kit.
Modulation Input:	F-type connector, 75 Ohm, 95k Hz. FM, 0.5V P-P signal from MOD 1 modulator.
Modulation Input:	F-type connector, 75 Ohm, 95k Hz. FM, 0.5V P-P signal output to additional TX3.
Power Connection:	2-conductor, screw-terminals.
Fuse:	Internal, 1.25A, 250VAC. 3AG.
Modulation Cable:	RG-59 Co-ax, F-connectors.
Power Cable:	NEC Class 2 wiring, 2-conductor, 18 Ga. Min. 200 foot (61 max. length (for 18 ga. wire). Each TX3 transmitter requires its own 24 VAC power supply.

.3 Headsets:

Provide eight (8) headsets of William Sound Corp. Model #WIRRX4 as follows:

Weight:	154g (5.4 oz.) with batteries.
Earpad Size:	6.5cm (2.5") diameter, foam cushions, adjustable headband.
Material and Colour:	ABS plastic, textured grey.
Battery Type:	2 - AAA alkaline.
Battery Life:	40 hours.
Modulation Frequency:	95kHz. FM, 50micro-seconds de-emphasis.
Signal to Noise Ratio:	45dB at 4 meters.
Controls:	On/Off slide switch, volume control wheel.
Frequency Response:	-1dB at 66Hz., -8dB at 8488 Hz., electrical response.
Distortion, Electrical:	3.2% THD Max at 1kHz.
Acoustic Output:	118dB max SSPL 90, 109dB HF AVG SSPL90 with 6cc coupler.
HF Full-On Gain:	28dB at 60dB in.
Distortion, Acoustic:	at 70dB in: 5.0% at 500 Hz., 2% at 800 Hz., 1.5% at 1600 Hz.

3.1 EXECUTION

- .1 Systems shall be supplied and installed by an authorized dealer of the supplier.
- .2 Test system for performance and submit a certificate that the system performance meets all Code requirements as set out by the Ontario Department of Education, Radio Education Branch.
- .3 Equivalent system supplied by Phonic Ear and Telex will be acceptable.

END OF SECTION 26 09 60

1.1 GENERAL

- .1 Refer to Section 26 00 10, General Electrical Provisions.

2.1 PRODUCTS

- .1 Except for those items as may be specified in Part 3 of this Section, refer to Part 2 of the various Sections of Specification, Division 26 Electrical.
- .2 Cable tray system shall be spline type, 305mm (1'-0") wide, 100mm (4") deep and complete with centre rod suspension system and all necessary fittings for a complete and operating system. (Configuration shall be as shown on the drawing).
- .3 Cable tray system shall be rod hung and shall be supported at 10'-0" centres. Also trays shall be braced to block walls to suit seismic requirements (minimum of every 20'-0").
- .4 The cable tray system and associated supports shall provide a complete engineered system, and the complete installation shall conform to all C.S.A. Standards and all Authorities having jurisdiction, Codes and requirements.

3.1 EXECUTION

- .1 Except for those items as may be specified in Part 2 of this Section, refer to Part 3 of the various Sections of Specification, Division 26 Electrical.
- .2 All equipment installations shall be in accordance with the manufacturer's recommendations.

END OF SECTION 26 09 70