REGAL CONSULTING ENGINEERS INC.

CONSULTING MECHANICAL & ELECTRICAL ENGINEERS

Mechanical Specifications
DPCDSB
Catholic Education Center
BAS, VAV, Reheat Coils & Exhaust Fans Replacement Project
Issued for Tender – 21st July 2021

Catholic Education Center
BAS, VAV, Reheat Coils & Exhaust Fans
Replacement Project

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DIVISION 15: MECHANICAL

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1 General

1.1 GENERAL REQUIREMENTS

.1 Read and conform to:
- .1 The Contract CCDC 2-2008, Stipulated Price Contract as amended,
- .2 Division 1 requirements and documents refered to therein.

.2 Section 15010 applies to and governs the work of all Sections of Division 15.

.3 The technical Sections of this Division are generally divided into units of work for the purpose of ready reference. The division of the work among subcontractors is not the Consultant's responsibility and the Consultant assumes no responsibility to act as an arbiter and/or to establish subcontract limits between any Sections of the work..

.4 The specifications are integral with the drawings which accompany them. Neither is to be used alone. Any item or subject omitted from one but implied in the other is fully and properly required.

.5 Wherever differences occur in the tender documents, the most onerous condition governs. Base the bid on the most costly arrangement.

1.2 DEFINITIONS

.1 The following are definitions of words found in this specification and on associated drawings under this Division:

.1	"Concealed"	-	locations hidden from normal sight in furred spaces, shafts, ceiling spaces, walls, and partitions.
.2	"Exposed"	-	mechanical work normally visible to building occupants.
.3	"Furnish"	-	(and its derivatives) has the same meaning as the term "Supply".
.4	"Install"	-	(and its derivatives) - receive, store and handle at the site, mount and support and connect all required services. Includes adjustment and calibration, testing, commissioning, inspection by authorities having jurisdiction and documentation.
.5	"Provide"	-	(and its derivatives) - supply, install in place, connect the associated required services ready for operation, adjust and calibrate, test, commission, warrant, and document. Includes inspection by authorities having jurisdiction.
.6	"Supply"	-	(and its derivatives) purchase and deliver to the site for installation. Includes submittals, manufacturer's field inspection and warranty.
.7	"Wet"	-	locations exposed to moisture, requiring special materials and arrangement.

1.3 WORK INCLUDED

.1 Products and methods mentioned or shown in the Contract Documents complete with incidentals necessary for a complete operating installation. Provide all tools, equipment and services required to do the work.

.2 Cutting and patching of new or existing work

.3 Excavating and backfilling

.4 Identification of equipment, piping, ductwork, and valves and controllers

.5 Concrete equipment bases, housekeeping pads, sump pits and trenches.

.6 Motors required for equipment supplied under this Division.

.7 Variable frequency drives for motors and equipment supplied under this Division.

.8 Internal wiring, relays, contactors, switches, transformers, motor starters, and all controls necessary for the intended operation, furnished with terminals and external controls suitable for connection to power source at a single easily accessed location for equipment items that are supplied with motors and/or electrical or electronic components under this Division.

.9 Disconnect switches for exhaust fans located on the roof complete with;
- .1 EEMAC 1 enclosure if housed within a weatherproof cabinet,

.2 EEMAC 3 enclosure if exposed to weather

.10 Take such measures and include in Bid Price for the proper protection of the existing building and its finishes at all times during alterations and construction of the new addition. Coordinate this protective work with all trades.

.11 Refer to Mechanical/Electrical Equipment Schedule for extent of wiring and electrical characteristics.

.12 Verify the correct operation of each equipment item provided and/or altered and each system in total and obtain the Owner's approval prior to starting and/or returning to operation.

1.4 RELATED WORK

.1 Power wiring, conduit and connections for motors under this Division will be by Division 16.

.2 Power wiring, conduit and connections to variable frequency drives for motors under this Division will be by Division 16. Wiring and connections from VFD to motors under this Division will be by Division 16.

.3 Flashings for mechanical equipment and services located on or passing through roofs will be provided under Division 7. Supply counter flashings, and integral flashing collars on equipment and piping under this Division.

.4 Painting of exposed piping and ductwork other than for identification will be supplied under Division 9.

.5 Concrete equipment bases, housekeeping pads, sump pits and trenches will be provided under Division 3.

1.5 SUBMITTALS

.1 Approval Drawings: Prepare and submit drawings necessary for approval to any authority having jurisdiction, and obtain two (2) copies of approved drawings for retention by Consultant prior to commencement of work under this Division.

.2 Shop Drawings: Prepare and submit two (2) copies of shop drawings of major equipment items (including those items specifically indicated under Part 1: General of each Section), to the Consultant for review. The Consultant will return one copy, marked with comments and his review stamp as he deems appropriate. Prepare the necessary number of copies of the returned set and distribute to the Owner, the Prime Consultant, the General Contractor, the site, and to subcontractors and suppliers.

- .1 Clearly indicate manufacturer's and supplier's names, catalogue model numbers, details of construction, accurate dimensions, capacities and performance. Prior to submission check and certify as correct, shop drawings and data sheets. Do not order equipment until a copy of the shop drawings, reviewed by Consultant, has been returned to Contractor.
- .2 Clearly indicate the weight, location, method of support and anchor point forces and locations for each piece of equipment on shop drawings.
- .3 The Consultant will not review shop drawings that fail to bear the Contractor's stamp of approval or certification.
- .4 Read the following in conjunction with the wording on the shop drawing review stamp applied to each and every drawing submitted:
  "This review by the Consultant is for the sole purpose of ascertaining conformance with general design concept. This review shall not mean that the Consultant 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 errors or omissions 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 coordination of the work of all sub trades."

.3 Sleeving Drawings: Prepare and submit 4 copies of sleeving drawings to clearly and accurately indicate the exact location, elevation and size of any and all formed holes, recesses and sleeving required in the work of Division 15. Obtain Consultant's approval in writing prior to sleeving, forming or cutting any such opening. Provide a copy of approved sleeving drawings to the reinforcement detailer well in advance of planned pours.

.4 Composite Wiring Diagrams: Prepare and submit three (3) copies of complete composite wiring diagrams of each specific mechanical system. Indicate all electrical equipment and wiring, both internal and external, for review and coordination of trades.

.5 Contractor's Material and Test Certificates: Prepare and submit certificates for each system installed. Where certificates are prescribed by regulations, codes or standards ensure they conform to the requirements of those documents (eg. NFPA-standards). Include a copy of each certificate in the Operation and Maintenance manual. Certificates shall include the following:

.1 description of the system (description and type),
.2 description of the tests conducted and results observed, including re-testing, where necessary,
.3 description of any corrective measures undertaken,
.4 description of materials used (pipe and fittings),
.5 list of witnesses for each test conducted,
.6 date system left ready for service,
.7 signature of installing Contractor.

.6 Directories & Schematics

.1 Submit five (5) copies of a neat typewritten directory indicating the valve number, related service,and location of each valve under this Division.
.2 Submit five (5) copies of system control schematics for each mechanical system indicating relative locations of equipment and control devices.
.3 Enclose one (1) copy of each directory/schematic under glass in a neat polished 18" x24" (460 mm x 610 mm) metal frame, complete with mounting clips.

.7 Maintenance Data and Operating Instructions

.1 Submit three (3) copies of Operation and Maintenance Manual individually bound in hard backed three-ring binders.
.2 Ensure the binder spines have typewritten lettering as follows:
OPERATION & MAINTENANCE MANUAL
for
[Insert name of project]
[Insert date of submission]
[Insert Division Title]
.3 Provide a list of names, addresses and telephone numbers of equipment suppliers, installing contractors, general contractors, architect and Consultant. Include special telephone numbers for service departments on normal and emergency call basis.
.4 Provide descriptive literature (shop drawings) of each manufactured item. Include a bill of material with purchase order numbers and vendor's identification of equipment orders for each item.
.5 Include copies of start-up reports and checklists and all certificates issued with respect to this contract.
.6 Ensure operating instructions include the following:
.1 General description of each mechanical system.
.2 Step by step procedure to follow in putting each piece of equipment into service.
.3 Schematic control diagrams for each separate mechanical system, control thermometers, freezestats, firestats, pressure gauges, automatic valves, and refrigeration accessories. Mark correct operating settings for each control device on these diagrams.
.4 Diagram of the electrical control system indicating the wiring of all related electrical components such as PE and EP switches, firestats, freezestats, fuses, interlocks, electrical switches and relays.
.5 Drawings of each control panel including temperature control and electrical panels, completely identifying all components on the panels and their function.
.7 Ensure maintenance instructions include the following:
.1 Manufacturer's maintenance instructions for each item of mechanical equipment installed under this Division. Instructions shall include installation instructions, parts numbers and lists, name of supplier and maintenance and lubrication instructions.
.2 Summary list of each item of mechanical equipment requiring lubrication,

indicating the name of the equipment item, location of all points of lubrication, type of lubricant recommended, and frequency of lubrication.

.3 Equipment directory indicating name, model, serial number and nameplate data of each item of equipment supplied, and system with which it is associated.

.4 Balancing and testing reports.

.5 Copy of valve directory.

.8 As-Built Records: Prepare and submit complete as-built records prior to Substantial Performance of the Contract. Refer to paragraph 3.2.5 and to Division 1 for requirements.

.9 Requests for Shut-Down: Obtain permission for systems shut-down and/or service interruption from the Owner prior to disruption of any system or service in use by the Owner. Employ the Owner's standard form of request where available. Refer to Division 1 for additional requirements.

.10 Requests for Start-up: Obtain permission from the Owner to start-up or to return to service any item of equipment, system or service installed new or previously shut-down. Refer to Division 1 for additional requirements.

1.6 QUALITY ASSURANCE

.1 Conform to minimum requirements or better of provincial and local codes, where existing, and to requirements of local inspection authorities for execution of work under this Division.

.2 Ensure materials supplied under this Division conform to minimum requirements and recommendations or better of applicable standards of the following:

.1	AABC	Associated Air Balance Council
.2	AMCA	Air Moving and Conditioning Association
.3	ANSI	American National Standards Institute
.4	ASA	American Standards Association
.5	ASHRAE	American Society of Heating, Refrigerating, and Air Conditioning Engineers
.6	ASME	American Society of Mechanical Engineers
.7	ASSE	American Society of Sanitary Engineers
.8	ASPE	American Society of Plumbing Engineers
.9	ASTM	American Society of Testing and Materials
.10	AWWA	American Water Works Association
.11	CAN2	National Standard of Canada (Published by CGSB)
.12	CAN3	National Standard of Canada (Published by CSA)
.13	CGSB	Canadian General Standards Board
.14	CSA	Canadian Standards Association
.15	EEMAC	Electrical & Electronic Manufacturer's Association of Canada
.16	NBC	National Building Code of Canada
.17	NEBB	National Environmental Balancing Bureau
.18	NFPA	National Fire Protection Association
.19	NEMA	National Electrical Manufacturers Association
.20	OBC	Ontario Building Code
.21	OFC	Ontario Fire Code
.22	OFM	Ontario Fire Marshall
.23	SMACNA	Sheet Metal & Air Conditioning Contractors National Association
.24	TIAC	Thermal Insulation Asociation of Canada
.25	ULC	Underwriter's Laboratories of Canada Ltd
.26	UL	Underwriter's Laboratories (including cUL)

.3 Use latest editions and amendments in effect on date of Bid call subject to requirements of OBC.

.4 Arrange and pay for permits and inspections by authorities having jurisdiction, required in the undertaking of this Division. Make modifications required by authorities.

.5 All tradesmen employed on the project shall hold valid trade certificates/licenses and shall make a copy available for review by the Consultant and/or Owner when requested.

.6 All welding and brazing shall be executed by certified welders in accordance with registered procedures.

.7 All refrigeration work shall be executed only by mechanics with valid ODP cards.

1.7 PRODUCT DELIVERY, HANDLING AND STORAGE

.1 Immediately after letting of contract, review material and equipment requirements for this work, determine supply and delivery dates for all items, and notify Consultant of any potential delays in completion of this project in order that remedial action may be taken.
.2 Store neatly out of the way and protected from damage and theft, materials and equipment supplied under this Division that are received at the site by this Division.

1.8 JOB CONDITIONS

.1 Visit site and examine existing conditions which may affect work of this Division.
.2 Examine all Contract Documents to ensure that work of this Division may be satisfactorily completed.
.3 Notify Consultant upon discovery of conditions which adversely affect work of this Division. No allowance will be made after letting of contract for any expenses incurred through failure to do so.
.4 Submission of a bid confirms that the Contract Documents and site conditions are accepted without qualifications, unless exceptions are specifically noted in the Bid.

1.9 INTERRUPTIONS

.1 Arrange execution of work to maintain present building operations, and to minimize the effect of work under this Division on existing operations.
.2 Prior to interrupting any existing service notify the Owner and Consultant, in writing, at least 7 days in advance, and obtain written authorization. Do not interrupt any existing service without Consultant's specific authorization. Refer to Division 1 for requirements.
.3 Arrange time and duration of interruption through the Owner's Physical Plant Department. Include in Bid Price for all overtime or premium time hours necessary to minimize duration of service interruption.
.4 Test and verify the proper operation of existing equipment and systems that are shut down due to work of this project, prior to returning to service.
.5 Assume responsibility for consequential costs on failure to obtain permission to shut-down and/or start-up any item of equipment, system or service.

1.10 WARRANTY

.1 Refer to Division 1 and to Section 15010 General Requirements.
.2 Arrange with each manufacturer/supplier to extend warranties as necessary to coincide with warranty period or those periods specified.
.3 Make submissions necessary to register product warranties to the benefit of the Owner.
.4 Submit to Consultant, prior to Substantial Performance of the Contract, manufacturer's written warranties covering periods longer than one year or offering greater benefits than required in specifications and in the Owner's name.

1.11 EXTRAS AND CREDITS

.1 Accompany all price submissions requested by Consultant for extra work, or work to be deleted, with a complete cost breakdown as follows:
- .1 Materials, quantities and unit costs including any applicable contractors trade discount clearly identified.
- .2 Labour hours and unit costs.
- .3 Total materials and labour costs.
- .4 Overhead and profit mark-ups in accordance with the General Conditions of the Contract.

2 Products

2.1 MATERIALS AND EQUIPMENT

.1 Ensure materials and equipment provided under this Division are new and free from defects and bear labels of approval as required by codes referred to in this Division and/or by inspection authorities.

.2 Ensure apparatus and equipment provided under this Division bears manufacturer's nameplate indicating name of manufacturer, model number or type, size, capacity, CRN, and other pertinent information. Ensure nameplates are easily read and clearly visible, with openings provided where equipment is insulated.

.3 Ensure manufacturers and suppliers of equipment or materials under this Division determine if their products are composed of any hazardous materials. If they are, the products are suitably labeled and supplied with Material Safety Data sheets. Obtain the Owner's approval in writing to bring hazardous materials onto the site prior to doing so.

.4 When utilizing any products that are hazardous, keep Material Safety Data sheets on file at the job site and present them to anyone requesting this information. When transferring hazardous materials from original container into other containers, provide Workplace Labels on such containers.

2.2 MOTOR STARTERS & CONTROLS

.1 Mechanical Division 15 shall provide all motor starters and associated controls required and as scheduled on drawings and noted for Division 15 equipment. Starters and controls shall be Canadian General Electric or Alternate noted. All starters, contactors, thermal overloads, etc. must be EEMAC rated. All starters shall be of one manufacturer except as specifically approved otherwise for integral pre-wired assemblies.

.2 Starter and control units shall be equipped with necessary number of auxiliary contacts and relays to provide control sequences described in Mechanical Equipment Starter Schedule on Drawings. Auxiliary contacts shall be interchangeable normally open or normally closed, by conversion in field without additional parts exterior to starter.

.3 Manual starters may only be provided for single phase equipment operated by control device such as thermostat or limit control when such control device is rated for full electrical load of equipment.

.4 Manual starters provided for single phase equipment actuated by electric timer or shall have H.O.A. feature. "Hand" position shall permit shunting of time switch. Where such units also have protective device (e.g. firestat) such device shall be wired into both "Hand" and "Auto" positions and shall not be shunted.

.5 Manual starters may only be provided for three phase equipment which is not actuated by pilot control device (pressure switch, float switch, safety limit devices, remote manual control device) unless otherwise noted in Starter Schedule.

.6 Magnetic starters for manually operated equipment shall have "On/Off" selector switch or "Start-Stop" pushbutton in cover as scheduled.

.7 Magnetic starters which are started automatically by electric time switch shall include "Hand-Off-Automatic" (H.O.A.) selector switch. "Hand" position shall permit shunting of time switch or E.M.S. Where such units also have protective pilot device (e.g. firestat) such device shall be wired into both "Hand" and "Auto" position and shall not be shunted.

.8 Magnetic starters which are started automatically by remote pilot device (or interlocked units) such as level controller, pressure switch, thermostat or flow switch shall include "Hand-off-Auto" (H.O.A.) selector switch, and, where scheduled, a "Test" pushbutton. "Hand" position shall permit shunting of remote pilot device and thereby permit operation of starter but only while depressing "Test" button.

.9 Equip starter apparatus for prime plumbing, heating, air conditioning and ventilating equipment so that these units will automatically restart on resumption of power after power outage. Starters for these units shall have "On/Off" selector switch in cover if not fitted with H.O.A. selector feature or manual starter or otherwise noted.

.10 Safety control device such as flow switches, pressure switches, high and low limited ("Fire" and "Freeze") shall not be shunted by "Hand" position of switch.

.11 Manual motor starter shall be toggle operated with following general construction features:

- Quick-Make, Quick-Break mechanism with double-break contracts.
- Overload protection heaters, one per phase and speed.
- Enclosure to suit application.
- Pilot light, neon lamp.
- Cover engraved with "On-Trip-Off".

.12 Magnetic motor starters shall comprise electrically-operated motor starters combined with disconnect switch with following general construction features:

- Quick-Make, Quick-Break mechanism with double-break contacts.
- Fuse holders to accept specified fuses, one per phase.
- Adjustable overload relays, one per phase.
- CEMA listed enclosure to suit application. Disconnect with mechanical cover interlocks, line side barriers and switch operated electrical interlocks to disconnect external control voltage unless starter includes suitable approved enclosed contacts and connections.
- "Reset" button.
- Pilot Lights of transformer type incandescent with amber safety lens cap.
- Control transformer with 120 volt fused secondary and sized to suit current rating of associated control devices.
- Scheduled cover mounted control devices with standard duty double break contact blocks.
- Minimum of two auxiliary contacts (unused "Seal-in" contact may be included).

.13 Contactors for non-motor applications shall be built similar to combination magnetic starters, except less overload relays, and with Gould Shawmut AJT time delay HRC1-J fuses, rated for load, and with enclosed continuous current rating of at least 125% of connected full load.

.14 "Double Voltage Relays" shall be CGE Model CR120 LXMC with general purpose enclosure, number of contacts required and "Mylar" shroud of enclosure of contacts, or approved equivalent.

.15 Pilot devices such as "Start-Stop" pushbuttons, "Hand-Off-Auto" selector switches and indicating lights shall be of heavy-duty construction. Indicating lamps shall be transformer type incandescent with amber safety lens caps.

.16 Each control unit shall be provided with engraved nameplates for designation of device controlled and duty. See Subsection "Equipment Markers & Nameplates" for details.

.17 Control wiring shall be 120 volt A.C. maximum. Provide control circuit transformers where these are not included in motor starters. Secondaries of control transformers shall be fused with one side grounded and controls, safety devices and interlocks shall be connected in ungrounded conductor, excepting only integral starter overload devices.

.18 Single phase motors interlocked to start or operate with other equipment shall be provided with magnetic starters or suitable relays with necessary auxiliary contacts and double voltage relays or be otherwise electrically separated.

.19 Overload relay heaters for starters shall be selected and field adjusted to trip at maximum value of 115% of actual nameplate full load amperes. Selection of heater elements shall be based on starter manufacturer's recommendations. Obtain data from Mechanical Division. Submit Motor Starter Schedule which shall list following for each motor:

- Proposed equipment nameplate data
- Actual full load amperes of motor
- Speed of motor
- Temperature Class in degrees Celsius rise and insulation class.
- Circuit breaker or fuse type and proposed rating
- Type of motor, duty and service factor.

.20 Overload relay heaters shall trip in 20 seconds or less from cold or motor-locked rotar condition.

.21 Where equipment is noted to be electrically interlocked, provide necessary interlocks, double voltage relays (Mylar shroud accepted) to provide specified operation.

.22 Provide all fuses required to protect equipment. Fuses shall be proper size blade type time delay HRC1-J current limiting. Supply three spare fuses of each size and type and obtain duplicate receipt for same. Fuse clips shall reject standard NEC fuses. Fuses shall be rated in accordance with manufacturer's published data. Fuses to be of one manufacturer throughout.

.23 Acceptable Alternate Manufacturers

1. Furnas Electric
2. Westinghouse
3. Allen Bradley
4. Square `D'
5. Cutler Hammer
6. Klockner-Moeller.
7. Commander
8. Telemecanique

2.3 EQUIVALENTS AND ALTERNATIVES

.1 Suppliers wishing approval for additional equipment items as equivalent to those specified must submit complete description, technical and performance data to Consultant at least ten (10) working days prior to Bid closing date. Such equivalent equipment, if accepted, to conform to specifications with regard to all details, accessories, modifications, features and performance. Deviations from specifications must be stated in writing at time of submission for approval.

.2 Bid Prices shall include only products specified or approved equivalents. Contractors may propose unsolicited alternatives to the products specified. Alternative proposals shall be submitted in sealed envelope at time of general contract Bid submission and shall include full description and technical data, and a statement of the related increase or decrease in Bid Price should alternatives be accepted. All additional costs associated with unsolicited alternative proposals such as larger motor starters, larger power feeders, space revisions to associated equipment, controls, etc. shall be included in alternative price. Prior approval by Consultant is not required for unsolicited alternative proposals.

.3 Where the Contractor uses equipment other than that first named, on which the design is based, he shall be responsible for all details of installation including equipment size, arrangement, fit, and maintenance of all required clearances. Contractor shall prepare and submit revised layouts to iindicate arrangement of all affected piping, ductwork, conduit, lighting, equipment, etc. Failure by Contractor to provide such drawings will be considered indication that original arrangements and space allocations are adequate. All additional costs associated with equivalent equipment such as larger motor starters, larger power feeders, space revisions to associated equipment, controls, etc. shall be included in Bid Price.

2.4 SUBSTITUTIONS DURING PROGRESS OF WORK

.1 If during the progress of work, specified products are not obtainable, equivalent or similar products by other manufacturers may be permitted by Consultant.

.2 Apply, in writing, to Consultant for substitution of any products, indicating the following:
.1 Manufacturer's name, model number, details of construction, accurate dimensions, capacities and performance of proposed products.
.2 Reason for substitution.
.3 Any revisions to the contract price made necessary by substitution.
.4 Any revisions to the contract time made necessary by substitution.
.5 Any revisions to layout, arrangement or services made necessary by substitution.
.3 No substitutions will be permitted without written authorization from the Consultant.

2.5 CONSULTANT'S REVIEW

.1 The consultants will review and evaluate unsolicited alternatives and substitutions proposed by the Contractor. Such review and evaluation work will be undertaken by the Consultant on an additional fee basis. The Contractor shall reimburse the Owner for all costs associated with such reviews and evaluations.
.2 The Contractor shall also reimburse the Owner for any and all costs incurred in updating Contract Documents to reflect such changes.

3 Execution

3.1 RELATIONSHIP WITH OTHER TRADES

3.2 INSTALLATION REQUIREMENTS

.1 The Consultant's drawings and instructions govern the location of all items. Prepare fully coordinated installation drawings prior to installation.
.2 Install equipment neatly to the satisfaction of the Consultant. Unless noted otherwise install products and services to follow building planes. Ensure installation permits free use of space and maximum headroom.
.3 Confirm the exact location of outlets, fixtures and connections. Confirm location of outlets for equipment supplied under other Divisions.
.4 Install equipment and apparatus to allow free access for maintenance, adjustment and eventual replacement.
.5 Install metering and/or sensing devices to provide proper and reliable sampling of quantities being measured. Install instruments to permit easy observation.
.6 Provide suitable shielding and physical protection for devices.
.7 Install products and services in accordance with the manufacturer's requirements and/or recommendations.
.8 Provide bases, supports, hangers and fasteners. Secure products and services so as not to impose undue stresses on the structure and systems.
.9 Do not use powder activated tools except as permitted by the Prime Consultant and the Owner's workplace health and safety policies.
.10 Ensure that the load onto structures does not exceed the maximum loading per square metre indicated on the structural drawings or as directed by the Consultant.

3.3 CONTRACT DRAWINGS

.1 The drawings of this Division are performance drawings and indicate general arrangement of the work. They are diagrammatic except where specific details are given.
.2 Obtain accurate dimensions from the architectural and structural drawings, or by measurement. Location and elevation of services are approximate. Verify them before construction is undertaken.
.3 Make changes where required to accommodate structural conditions, (beams, columns, etc.). Obtain Consultant's approval before proceeding.
.4 Adjust the location of materials and/or equipment as directed without adjustment to contract price, provided that the changes are requested before installation and do not affect material quantity. Note that outlets and/or equipment may be relocated up to 10 feet (3 m) in any direction without a change to the contract price.

.5 Note that the layout and orientation of the ceiling outlets on the architectural reflected ceiling drawings may differ from that shown on the mechanical drawings. Make the installation in accordance with the latest architectural ceiling drawings. Provide the equipment as specified and/or shown on the documents of this Division.

.6 The drawings of this Division are intended for tender pricing. The quantities and quality to be included in the bid price shall be based on the layout and specifications as shown on the mechanical documents. If there is a difference in quantity between the architectural and drawings of this Division, base the contract price on the greater quantity.

.7 Prepare installation (construction) drawing to reflect the latest architectural ceiling layout.

3.4 CONSTRUCTION DRAWINGS

.1 Prepare fully dimensioned drawings showing devices, fixtures, equipment, outlets, sleeves and openings through structure. Indicate locations and weights on load points.

.2 Prepare fully dimensioned construction drawings of products and services suitably interfaced with work of the sub-trades, in mechanical rooms, service and ceiling spaces, and other critical locations. Coordinate the work with other divisions. Base drawings on reviewed shop drawings and latest architectural drawings. Indicate details pertaining to the following: access, clearances, cleanouts, sleeves, electrical connections, drain locations and elevation of pipes, ducts, conduits.

.3 Prepare drawings of pits, curbs, sills, equipment bases, anchors, inertia slabs, etc.

.4 Submit construction drawings to other Divisions. Provide one (1) transparency and four (4) print copies of construction drawings to the Consultant for record purposes.

.5 Submit construction drawings prior to commencement of work.

3.5 RECORD DRAWINGS

.1 Maintain project "as-built" record drawings. Obtain white prints from the Consultant for this purpose and pay printing costs. Identify each set as "Project Record Copy".

.2 Record deviations from contract documents caused by site conditions or by changes ordered by the Consultant. Record deviations in red ink clearly and accurately, using industry standard drafting procedures consistent with quality and standards of Consultants documents.

.3 Record deviations as work progresses throughout the execution of this contract. Maintain record drawings on site in clean, dry, legible condition, making them available for periodic review by the Consultant.

.4 Record location of concealed services, particularly underground services. Before commencing any backfilling, obtain accurate measurements and information concerning correct location and depth of services.

.5 Transfer records from the "Project Record Copy" to a DVD in Autocad format matching the Consultant's documents. Arrange computer file in layers to exactly match the layering system of the Consultant.

.6 Submit the "Project Record Copy" on one or more DVD with white prints of each drawing to the Consultant at the time of Substantial Performance.

3.6 USE OF EQUIPMENT

.1 For the duration of this contract, do not use any piece of equipment provided under this contract for the purposes of heating, ventilation or air conditioning without the specific authorization of the Owner and Consultant. Ensure the building is "broom clean" and painting is finished before asking permission for testing to commence.

.2 Where specific written authorization is given for the use of equipment while work is still in progress, seal off ductwork, grilles, diffusers, and registers or other openings to the air distribution systems or air handling equipment that is not in use. Provide filters over openings in ductwork, over grilles, diffusers and registers and in or at any air handling equipment that is in use. Ensure that the edges are sealed so that the filters are not bypassed. Change the filters frequently, to the satisfaction of the Consultant, until the building is turned over the Owner.

3.7 SPECIAL TOOLS AND SPARE PARTS

.1 Within 30 days of award of contract, prepare a complete itemized list of special tools and spare parts and submit to Consultant for review. List will be used as a checklist and should include provision for sign off by the Owner on receipt.

.2 On completion of the project furnish spare parts to the Owner as follows:
- .1 One set of mechanical seals for each pump.
- .2 One casing joint gasket for each pump.
- .3 One head gasket for each heat exchanger.
- .4 One glass for each gauge glass installed.
- .5 One set of v-belts for each piece of machinery.
- .6 One set of new filters for each filter bank installed.

.3 Identify spare parts containers as to contents and replacement parts number.

.4 Provide one set of special tools required to service equipment as recommended by manufacturers.

.5 Furnish one grease gun and adaptors to suit different types of grease and fittings.

3.8 INSTRUCTION

.1 Instruct and familiarize Owner's operating personnel with the various mechanical systems. Arrange instruction for each system separately.

.2 Provide instruction for each system on two separate occasions, coordinated with the Owner's staff operating schedule, in order that interested personnel may arrange to attend.

.3 Ensure each instruction period includes, but is not limited to the following;
- .1 a classroom seminar with operating manuals, product and system drawings and such other audio/visual aids as may be appropriate,
- .2 instruction during the classroom seminar by the manufacturer's representative regarding the proper operating and maintenance procedures for each item of equipment,
- .3 demonstration of the proper operating procedures for each item of equipment,
- .4 explanation of the purpose and function of all safety devices provided,
- .5 demonstration of all measures required for safe and proper access for operation and maintenance.

.4 Provide a period of follow-up instruction (on two occasions) approximately one month after completing Owner's instruction to clarify and reinforce earlier instructions.

.5 Submit a letter from the Owner's management staff indicating the instruction has been given satisfactorily to the Consultant prior to substantial completion of the project.

3.9 START UP AND COMMISSIONING

.1 The Contractor shall start-up and completely commission all equipment and systems installed and/or modified under this contract. Commissioning work shall be completed to the satisfaction of the Consultant prior to acceptance of the Work or any part thereof.

.2 The Startup and Commissioning Team shall be comprised of;
- .1 The individual, company or agency undertaking the work of each Section,
- .2 Representatives of the Contractor and his sub-contractors as required,
- .3 Representatives of equipment manufacturers,
- .4 Representatives of the Consultants,
- .5 Representatives of the Owner.

.4 The Contractor and his sub-contractors shall each assign an individual representing each of the relevant trades to the startup and commissioning team and shall ensure that representatives of the equipment manufacturers are present during the relevant commissioning tasks.

.5 The Contractor shall provide all necessary labour, materials, equipment, testing apparatus and incidentals necessary to completely start-up, verify, test and commission each system provided as part of the Work.

.6 Each Section shall prepare Check Sheets in accordance with the standards listed above and shall issue them to the commissioning team for use during the commissioning process.

.7 Three (3) copies of commissioning manuals shall be provided, bound in hard cover D-ring binders with transparent cover on front and spine personalized to indicate;
  .1 name and logo of Facility,
  .2 name of the project,
  .3 the Owner's project number,
  .4 identification of the system commissioned,
  .5 the date that the system was commissioned.

.8 Commissioning manuals shall include machine printable index dividers to organize each manual by system and by commissioning stage.

End of Section

1 General

1.1 GENERAL REQUIREMENTS

.1 Comply with General Requirements of Section 15010.

1.2 WORK INCLUDED

.1 Disconnection and making safe of fire suppression systems and equipment in areas to be demolished and/or renovated will be by Division 15.
.2 Disconnection and making safe of plumbing systems and equipment in areas to be demolished and/or renovated will be by Division 15.
.3 Disposal of materials.
.4 Identification of utilities.

1.3 RELATED WORK

.1 Disconnection and making safe of power wiring and electrical equipment in areas to be demolished and/or renovated will be by Division 16.
.2 Disconnection and making safe of communication systems and equipment in areas to be demolished and/or renovated will be by Division 16.
.3 Disconnection and making safe of electronic safety and security systems and equipment in areas to be demolished and/or renovated will be by Division 16.

1.4 JOB CONDITIONS

.1 Visit site and examine existing conditions which may affect work of this Division.
.2 Examine all Contract Documents to ensure that work of this Division may be satisfactorily completed.
.3 Notify Consultant upon discovery of conditions which adversely affect work of this Division. No allowance will be made after letting of contract for any expenses incurred through failure to do so.
.4 Submission of a bid confirms that the Contract Documents and site conditions are accepted without qualifications, unless exceptions are specifically noted in the Bid.

1.5 INTERRUPTIONS

.1 Arrange execution of work to maintain present building operations, and to minimize the effect of work under this Division on existing operations.
.2 Prior to interrupting any existing service notify the Owner and Consultant, in writing, at least 7 days in advance, and obtain written authorization. Do not interrupt any existing service without Consultant's specific authorization. Refer to Division 1 for requirements.
.3 Arrange time and duration of interruption through the Owner's Physical Plant Department. Include in Bid Price for all overtime or premium time hours necessary to minimize duration of service interruption.
.4 Test and verify the proper operation of existing equipment and systems that are shut down due to work of this project, prior to returning to service.
.5 Assume responsibility for consequential costs on failure to obtain permission to shut-down and/or start-up any item of equipment, system or service.

1.6 NIL

1.7 REGULATORY REQUIREMENTS

.1 Conform to applicable codes for demolition work, dust control, products requiring electrical disconnection and re-connection.
.2 Obtain required permits from authorities.
.3 Do not close or obstruct egress width to any building or site exit.
.4 Do not disable or disrupt building fire or life safety systems without 3 days prior written notice to Owner.
.5 Conform to procedures applicable when hazardous or contaminated materials are discovered.

3 Excecution

3.1 PREPARATION

.1 Erect and maintain weatherproof closures for exterior openings.
.2 Erect and maintain temporary partitions to prevent spread of dust, odours, and noise to permit continued Owner occupancy.
.3 Protect existing materials and equipment which are not to be demolished.
.4 Notify affected utility companies before starting work and comply with their requirements.
.5 Mark location and termination of utilities.

3.2 RELATIONSHIP WITH OTHER TRADES

.1 Cooperate with other trades whose work affects or is affected by work of this Division to ensure satisfactory installation and to avoid delays.
.2 Remove and dispose of built-in items such as sleeves, anchors, and inserts.
.3 Remove and dispose of bases, supports and anchors for piping, equipment and ductwork mounted on or in walls, supported above floors and/or suspended from the structure.

3.3 PROTECTION

.1 Protect existing and new work to remain from damage due to execution of work under this Division by tarpaulins and other coverings as necessary.
.2 Repair any and all damage to the building and components resulting from failure to provide sufficient protection, to the satisfaction of the Consultant.
.3 All existing air intake and exhaust openings that may be affected by dust and/or debris from the construction work shall be fitted with appropriate filter media to protect against entry of dust and/or debris into the building and its air distribution systems. Filters shall be closely monitored and replaced when necessary. The Contractor shall replace existing filters that become contaminated with dust and/or debris from construction work with new filters.
.4 In the event that dust and debris from construction work does penetrate the building and/or its air distribution systems, the Contractor shall be responsible for cleaning the affected areas and/or systems.
.5 Temporary filters shall be removed on completion of the construction works.

3.4 DEMOLITION

.1 Notify all authorities of intent to demolish and schedule for the work.
.2 All demolition work shall conform to all codes, regulations, standards and by-laws applicable to the work.
.3 Isolate and drain systems as required to effect demolition. Disconnect, cap and make safe all mechanical services to the building including, but not limited to; sanitary sewer(s), storm sewer(s), water service, natural gas service, steam service, condensate return, water supply to standpipe and sprinkler systems, fire suppression systems hot water heating systems and condensate systems.

.4 Protect existing equipment and services to remain from debris and unwanted materials. Clean as necessary to maintain service during demolition period and on completion of the work.
.5 Coordinate all service shut downs with Owner's project coordinator. Provide notice as required by Owner and submit schedule for the work.
.6 Remove and dispose of all redundant mechanical services and equipment within the limits of the demolition site and where demolished systems extend beyond these limits.
.7 Turn over items identified for recovery by the Owner.
.8 All demolition work shall conform to Occupational Health & Safety and Environmental regulations. Ensure that all parties are familiar with requirements and experienced in the work to be undertaken.
.9 Waste disposal shall conform to the requirements of Division 1, municipal By-Laws and Ministry of the Environment regulations and standards.
.10 All existing air intake and exhaust openings that may be affected by dust and/or debris from the demolition work shall be fitted with appropriate filter media to protect against entry of dust and/or debris into the building and its air distribution systems. Filters shall be closely monitored and replaced when necessary. The Contractor shall replace existing filters that become contaminated with dust and/or debris from demolition work with new filters.
.11 In the event that dust and debris from demolition work does penetrate the building and/or its air distribution systems, this Section shall be responsible for cleaning the affected areas and/or systems.
.12 Disconnect remove, cap and identify all utilities within demolition areas.
.13 Demolish in an orderly and careful manner. Protect existing supporting structural members.
.14 Remove demolished materials from site except where specifically noted otherwise. Do not burn or bury materials on site.
.15 Remove materials as Work progresses. Upon completion of Work, leave areas in clean condition.
.16 Remove temporary Work.

3.5 RENOVATIONS

.1 Isolate and drain systems as required to effect renovations, modifications and/or repairs. On completion of renovations, modifications and/or repairs, test entire system as if new. Report repairs or replacements required of existing equipment, piping, fittings or devices that are not included in contract to Consultant and Owner for instruction. Flush, clean and refill renovated systems as specified for new.
.2 Relocate or remove existing items so designated unless specifically indicated to be relocated or removed under other Sections.
.3 Existing items to be relocated shall be cleaned and repaired or altered as required to suit new location. All damaged or ineffective parts shall be replaced and the item made "as new".
.4 Existing items to be removed remain the property of the owner and shall be delivered to a location on site designated by the owner. If the owner declares no interest in the removed items, assume ownership and remove the items from the site.
.5 Make good all surfaces and finishes in areas from which items have been removed and in which items are relocated. Cap all existing services required to be severed to effect alterations and do all other work necessary to make good such areas to satisfaction of consultant.
.6 Openings in existing floor assemblies and vertical fire separations necessitated by installation of equipment and systems or construction in general must be temporarily sealed with fire barrier materials such as mineral wool or other noncombustible insulation.
.7 If during alteration work existing asbestos material, other than known asbestos, is discovered (e.g. fireproofing, acoustic or thermal insulation, tank covering), stop work in the affected area and immediately notify consultant.
.8 Existing refrigerant indicated to be removed shall not be discharged to the atmosphere but shall be salvaged and reclaimed or disposed of following the guidelines of the authority having jurisdiction.
.9 All existing air intake and exhaust openings that may be affected by dust and/or debris from the renovation work shall be fitted with appropriate filter media to protect against entry of dust and/or debris into the building and its air distribution systems. Filters shall be closely monitored and replaced when necessary. The Contractor shall replace existing filters that become contaminated

with dust and/or debris from renovation work with new filters.

.10 In the event that dust and debris from renovation work does penetrate the building and/or its air distribution systems, the Contractor shall be responsible for cleaning the affected areas and/or systems.

.11 Temporary filters shall be removed on completion of the renovation work.

3.6 REFRIGERANT RECOVERY / RECYCLING

.1 Removal, relocation and/or refilling of refrigeration piping and/or equipment that contains ozone depleting substances and other halocarbons including;

.1 solvents and sterilants

.2 fire extinguishing equipment

.3 refrigerants

shall conform to regulations under the Environmental Protection Act, including O. Reg. 463/10.

.2 Ozone depleting substances (ODS) and other halocarbons shall be recovered using equipment and processes that are designed and approved specifically for the task.

.3 Disposal of ODS and other halocarbons and associated equipment and containers shall comply with requirements under the Environmental Protection Act, including O. Reg. 463/10.

.4 Persons servicing, testing and/or performing tasks associated with the removal, relocation and/or refilling of refrigeration piping and/or equipment that contains ozone depleting substances and other halocarbons shall be certified under Section 34 of O. Reg. 463/10.

.5 Prepare and submit all records and notices required by authorities having jurisdiction.

End of Section

1 General

1.1 GENERAL REQUIREMENTS

.1 Comply with General Requirements of Section 15010.

1.2 COMMON WORK RESULTS

.1 Section 15100 applies to and governs all work of Division 15.

1.3 REFERENCE STANDARDS

.1 Provide all work in accordance with requirements of Regulatory Agencies and conform to:
- .2 Local and district by-laws, regulations and published engineering standards.
- .3 The Ontario Building Code as amended,
- .4 The Ontario Gas Utilization Code as amended
- .5 Regulations for Construction Projects under the Occupational Health and Safety Act.
- .6 Fire Code made under the Fire Marshal's Act.

.2 Conform to following CSA Standards:
- .1 CAN1-B149.1 Natural gas and propane installation code.
- .2 CSA B64.1 Manual for the Selection and Installation of Backflow Prevention Devices
- .3 CSA B64.1 Manual for the Maintenance and Field Testing of Backflow Prevention Devices.
- .4 CSA W48 series Electrodes.
- .5 CAN/CSA-W117.2, Safety in Welding, Cutting and Allied Processes

.3 Conform to following National Research Council Canada publications:
- .1 National Building Code of Canada and Supplements to National Building Code of Canada
- .2 National Fire Code of Canada.
- .3 Canadian Plumbing Code.
- .4 Model National Energy Code for Buildings

.5 Conform to following Underwriters Laboratories (UL) Standards:
- .1 UL 393 - Indicating Pressure Gauges for Fire-Protection Services.
- .2 UL 404 - Gauges, Indicating Pressure, for Compressed Gas Service.
- .3 AFBMA 9 - Load Ratings and Fatigue Life for Ball Bearings.

.6 Conform to AFBMA 11 - Load Ratings and Fatigue Life for Roller Bearings.

.7 Conform to IEEE 112 - Test Procedure for Polyphase Induction Motors and Generators.

.8 Conform to NEMA MG 1 - Motors and Generators.

.9 Provide work where indicated in conformance with guide Specification of the Victaulic System for Building Services, G-100.

.10 The above documents or portions thereof are referenced within the work of Division 15 and shall be considered part of the requirements of this document as though fully repeated herein.

1.4 FIELD QUALITY CONTROL

.1 All work, materials, and equipment shall comply with the rules and regulations of applicable local, provincial and federal codes and standards.

.2 Contractor shall continually monitor the field installation for code compliance and quality of workmanship.

1.5 QUALIFICATIONS

.1 Motor manufacturer: Company specializing in manufacture of electric motors for HVAC use, and their accessories, with minimum three years documented product development, testing, and manufacturing experience.

.2 Firestop Sealant Manufacturer: Company specializing in manufacture of sealants with minimum three years documented product development, testing, and manufacturing experience.

.3 Firestop components and assemblies shall be ULC listed and tested in accordance with ULC S115 Standard Method of Fire Test for Firestop Systems.

1.6 SUBMITTALS

.1 Submit shop drawings in accordance with Section 15010.1.5.2, for the following items:
1. piping specialties
2. gauges and thermometers
3. access doors

.2 Submit list of wording, symbols, letter size, and colour coding for mechanical identification.

.3 Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.

.4 Submit manufacturers catalogue literature for each product. Provide wiring diagrams with electrical characteristics and connection requirements. Provide performance data, certification agency file numbers and environmental requirements.

.5 Submit manufacturer's installation instructions indicating settings, mechanical connections, lubrication, wiring instructions, special procedures and installation details.

.6 Provide a complete installation schedule which indicates use, operating range, total range and locations for gauges and thermometers.

.7 Submit test reports verifying nominal efficiency and power factor for three phase motors larger than 5 HP (3.7 kW).

.8 Submit project record documents showing actual locations of components and devices.

.9 Submit operation and maintenance data as follows;
- .1 Operation Data: Include instructions for safe operating procedures.
- .2 Maintenance Data: Include assembly drawings, bearing data including replacement sizes, and lubrication instructions.

.10 Prepare and submit a schedule of service penetration systems to be employed indicating the ULC listing designation, services involved, location of opening through fire separation and the components of the fire separation and/or assembly.

.11 Submit specific details of all PVC and/or DWV pipe penetrations in fire separations for review prior to construction.

1.7 DELIVERY, STORAGE, AND HANDLING

.1 Transport, handle, store, and protect products. refer to Division 1 requirements as well.

.2 Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weather-proof covering. For extended outdoor storage, remove motors from equipment and store separately.

1.8 WASTE MANAGEMENT & DISPOSAL

.1 Separate and recycle waste materials in accordance with Division 1 Waste Management and Disposal, and with the Contractor's Waste Reduction Workplan.

.2 Place materials defined as hazardous or toxic waste in designated containers.

.3 Ensure emptied containers are sealed and stored safely for disposal away from children.

1.9 REGULATORY REQUIREMENTS

.1 Products Requiring Electrical Connection: Listed and classified by CSA, ULC, cUL or Special Inspection as suitable for the purpose specified and indicated.

2 Products

2.1 PIPING SPECIALTIES

.1 Cast brass, pressure, copper to copper unions shall be used with seamless copper tubing smaller than 3" (75 mm).

.2 Cast brass flanges shall be used with seamless copper tubing, type L for tubing 3" (75 mm) and larger.

.3 Dart type, 125 lb. (860 kPa) black malleable iron unions shall be used with all steel pipe for piping 2-1/2" (65 mm) and smaller.

.4 Slip-on, 150 lb. (1000 kPa) carbon steel flanges with 1/16" (4 mm) raised face shall be used with all steel pipe for piping larger than 2-1/2" (65 mm).

.5 Gaskets for joining flanged steel pipe shall be 1/16" (4 mm) Cranite ring type gaskets.

.6 Piping specialties including backflow preventers, strainers, valves etc. shall be line size unless indicated otherwise on drawings.

.7 Strainers

.1 Manufacturers:

.1 Sarco SB

.2 S. A. Armstrong

.3 Crane

.4 Conbraco

.5 Colton

.2 In copper tubing: Class 250, wye type, bronze, screwed connection, with blind caps, and 1/32" (0.8 mm) perforated stainless steel screen.

.2 In Steel Piping: 2" (50mm) and smaller

.1 Body and cover: screwed, line size Y type strainer, semi-steel conforming to ASTM A278-85, Class 30, complete with screwed blind cap. Primary service rating of 125 psi @ 350 F (860 kPa @ 178 C). Body shall have side drain connection.

.2 Screen: perforated type 304 stainless steel service:

Water 1/32" (0.8 mm)

Water @ Pump Suction 1/8" (3.2 mm)

3. In Steel Piping: 2-1/2" (65mm) and larger

.1 Body and cover: flanged, line size Y type strainer, cast steel, class 150, complete with flanged blow down cover. Primary service rating of 150 psi @ 500 F (1 MPa @ 260 C).

.2 Screen: performated type 304 stainless steel service:

Water 1/16" (1.6 mm)

Water @ Pump Suction 1/4" (6.4 mm)

4. In grooved piping:

.1 Victaulic Style 730 grooved end tee-type strainer for piping 2 1/2" (65 mm) and larger or approved equivalent.

2. Victaulic Style 731 suction diffuser, or approved equivalent

2.2 ADHESIVES, SEALANTS, PAINTS AND COATINGS

.1 Adhesives, Sealants, Paints and Coatings: Use only low VOC emitting materials meeting following criteria;

.1 Paint for Mechanical Identification: maximum VOC emission of 250g/L

.2 Touch-Up Paint: maximum VOC emission of 250g/L

.3 Zinc-Rich Primer: maximum VOC emission of 250g/L

.4 Adhesives for Mechanical Identification: maximum VOC emission of 70g/L

.5 Sealants for service penetrations: maximum VOC emission of 650g/L clear and 350 g/L pigmented

.6 Sealants for Firestopping: max. VOC emission of 650g/L clear and 350 g/L pigmented

.7 Acrylic Sealant for supports and anchors: maximum VOC emission of 250g/L

.8 Insulation Vapour Barrier Lap Adhesive: maximum VOC emission of 80g/L

.9 Insulation Joint Sealer: maximum VOC emission of 250g/L

.10 Insulation Vapour Barrier Mastic: maximum VOC emission of 400g/L

.11 Flame Retardent Adhesive: maximum VOC emission of 650g/L clear and 350 g/L pigmented

2.3 NAMEPLATES

.1 Provide laminated plastic plates with black face and white centre of minimum size 3-1/2" x 1-1/2" x 3/32" (90 x 40 x 2 mm) nominal thickness, engraved with 1/4" (6 mm) high lettering. Use 1" (25 mm) lettering for major equipment.

.2 Fasten nameplates securely in conspicuous place. Where nameplates cannot be mounted on cool surface, provide standoffs.

.3 Identify equipment type and number and service of areas or zone of building served.

.4 For each item of equipment which may be started automatically or remotely, add a red lamacoid

plate, 2-1/2" x 9" (65 x 230 mm), reading: "WARNING. THIS EQUIPMENT IS AUTOMATICALLY CONTROLLED AND MAY START AT ANY TIME."

2.4 TAGS

.1 Plastic Tags: Laminated three-layer plastic with engraved black letters on light contrasting background colour. Tag size minimum 1-1/2" (40 mm) diameter. **OR**

.2 Metal Tags: Brass, aluminum or stainless steel with stamped letters; tag size minimum 1-1/2" (40 mm) diameter with smooth edges.

.3 Chart: Typewritten letter size list in anodized aluminum frame.

2.5 STENCILS

.1 Stencils: With clean cut symbols and letters of following size:

- .1 3/4"-1-1/4" (20-30 mm) Outside Diameter of Insulation or Pipe: 8" (200 mm) long colour field, 1/2" (15 mm) high letters.
- .2 1-1/2"-2" (40-50 mm) Outside Diameter of Insulation or Pipe: 8" (200 mm) long colour field, 3/4" (20 mm) high letters.
- .3 2-1/2"-6" (65-150 mm) Outside Diameter of Insulation or Pipe: 12" (300 mm) long colour field, 1-1/4" (30 mm) high letters.
- .4 8" - 10" (200-250 mm) Outside Diameter of Insulation or Pipe: 24" (600 mm) long colour field, 2-1/2" (65 mm) high letters.
- .5 Over 10" (250 mm) Outside Diameter of Insulation or Pipe: 32" (800 mm) long colour field, 3-1/2" (90 mm) high letters.
- .6 Ductwork and Equipment: 2-1/2" (65 mm) high letters.

2.6 PRESSURE GAUGES

.1 Manufacturer: Trerrice Model 600C.

.2 Other acceptable manufacturers offering equivalent products.

- .1 Weiss
- .2 Winter
- .3 Morrisson
- .4 Taylor

.3 Gauge: 4-1/2" (115mm) diameter black cast aluminum, phosphor bronze bourdon tube, rotary brass movement, brass socket, with front recalibration adjustment, black scale on white background, mid-scale accuracy: 1%, scale: psi and kPa.

.4 Gauge Cock: Tee or lever handle, brass for maximum 150 psi (1034 kPa0.

.5 Needle Valve: Brass, 1/4" (6 mm) NPT for minimum 150 psi (1034 kPa).

.6 Pulsation Damper: Pressure snubber, brass with 1/4" (6 mm) connections.

.7 Syphon: Steel, Schedule 40, 1/4" (6 mm) angle or straight pattern.

2.7 TEST PLUGS

.1 Manufacturer: Peterson Equipment Co. Inc. Model Pete's Plug II.

.2 Other acceptable manufacturers offering equivalent products.

- .1 Watts series TP.

.3 Test Plug: 1/4" or 1/2" (6 mm or 15 mm) brass fitting and cap to receive 1/8" (3 mm) outside diameter pressure or temperature probe with two valve cores of [Neoprene for maximum 93°C (200°F)] [Nordel for maximum 135°C (275°F)] at 72.6 kPa (500 psi) fitted with a colour coded cap strap with gasket and shall be rated for 145 kPa (1000 psi) at 60°C (140°F).

.4 Test Kit: Carrying case, internally padded and fitted containing one 0-100 psi pressure gauge, one 25 - 125°F and one 0-220°F 1"(25 mm) dial thermometers with 1/8" (3 mm) probes and two gauge adapters.

2.8 ACCESS DOORS

.1 Standard:
- .1 Minimum 12ga. [16ga.]
- .2 [steel, prime coat painted], [steel, epoxy coated], [304 stainles steel, no. 7 satin finish]
- .3 heavy duty fully concealed hinges
- .4 screwdriver operated, cam latch

.2 Concealed (Recessed):
- .1 Minimum 12ga. [16ga.]
- .2 [steel, prime coat painted], [steel, epoxy coated], [304 stainles steel, no. 7 satin finish]
- .3 heavy duty fully concealed hinges
- .4 screwdriver operated, cam latch

.3 Fire Rated:
1. Access doors in fire separations or fire rated assemblies: ULC labelled.
2. Refer to architectural drawings for ratings of fire separations and assemblies.
3. Minimum 12ga. [16ga.]
4. [steel, prime coat painted], [steel, epoxy coated], [304 stainles steel, no. 7 satin finish]
5. heavy duty fully concealed [frame and] hinges
6. screwdriver operated, cam latch

2.9 MOTOR CONSTRUCTION AND GENERAL REQUIREMENTS

.1 Motors less than 0.33 HP (250 W), for intermittent service may be equipment manufacturer's standard and need not conform to these specifications.

.2 Electrical Service:
- .1 Motors 0.35 HP (0.38 kW) and Smaller: 115 volts, single phase, 60 Hz.
- .2 Motors Larger than 0.35 HP (0.38 kW): 575 volts, three phase, 60 Hz.

.3 Type:
- .1 Open drip-proof except where noted otherwise.
- .2 Design for continuous operation in 104°F (40°C) environment.
- .3 Design for temperature rise to NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.
- .4 Motors with frame sizes 254T and larger: NEMA premium efficiency.

.4 Motors smaller than 0.5 HP (372 W): Provide continuously rated squirrel cage induction type with capacitor start, EEMAC `N' starting characteristics and a minimum of Class `A' insulation.

.5 Motors 0.5 HP (372 W) and over: Provide continuously rated squirrel cage induction type with EMAC `B' starting characteristics and a minimum of Class `B' insulation.

.6 Provide drip-proof type motors with a 1.15 service factor, unless specified or required otherwise by the motor location.

.7 Provide fan cooled totally enclosed motors having a 1.0 service factor.

.8 Visible Nameplate: Indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, service factor, power factor, efficiency.

.9 Wiring Terminations:
- .1 Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to code, threaded for conduit.
- .2 For fractional horsepower motors where connection is made directly, provide conduit connection in end frame.

.10 Provide motors within the 1-500 horsepower range of the "high efficiency" or "premium efficiency" as required under provincial regulations. Ensure this is indicated on the motor nameplate. Provide "T" frame (NEMA Specifications) motors approved under the Ontario Electrical Safety Code. If delivery of specified motor will delay delivery of any equipment, install an acceptable motor for temporary use. Final acceptance of equipment will not occur until the specified motor is installed.

.12 Coordinate with Division 16 the sizing of electrical protective devices supplying new and relocated echanical equipment that contain integral motor starters and contactors.

.13 Motor ratings rated in watts refer to output watts.

.14 Provide constant speed motors 7.5 HP and larger at 208 volt, 3-phase and 20 HP and larger at 575 volt, 3-phase with reduced voltage starters. Not required where variable frequency drive (VFD)

provided.

.15 Motors for use with variable frequency drives shall be rated for invertor duty.

.16 Motors for pumps and fans shall be rated for inverter duty whether or not VFD are included at this time.

.17 Whenever variable frequency PWM drives are installed to control AC motors, a maintenance free, circumferential, conductive micro fiber shaft grounding ring such as AEGIS™SGR Bearing Protection Ring shall be installed on the AC motor in accordance with the manufacturer's installation instructions to discharge shaft currents to ground.

.18 Design BHP shall not exceed 80% of nominal motor HP.

2.10 SINGLE PHASE POWER - SPLIT PHASE MOTORS

.1 Starting Torque: Less than 150 percent of full load torque.

.2 Starting Current: Up to seven times full load current.

.3 Breakdown Torque: Approximately 200 percent of full load torque.

.4 Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, prelubricated sleeve or ball bearings.

.5 Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, prelubricated ball bearings.

2.11 SINGLE PHASE POWER - PERMANENT-SPLIT CAPACITOR MOTORS

.1 Starting Torque: Exceeding one fourth of full load torque.

.2 Starting Current: Up to six times full load current.

.3 Multiple Speed: Through tapped windings.

.4 Open Drip-proof or Enclosed Air Over Enclosure: Class A (50 degrees C temperature rise) insulation, minimum 1.0 Service Factor, prelubricated sleeve or ball bearings, automatic reset overload protector.

2.12 SINGLE PHASE POWER - CAPACITOR START MOTORS

.1 Starting Torque: Three times full load torque.

.2 Starting Current: Less than five times full load current.

.3 Pull-up Torque: Up to 350 percent of full load torque.

.4 Breakdown Torque: Approximately 250 percent of full load torque.

.5 Motors: Capacitor in series with starting winding; provide capacitor-start/capacitor-run motors with two capacitors in parallel with run capacitor remaining in circuit at operating speeds.

.6 Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, prelubricated sleeve bearings.

.7 Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, pre-lubricated ball bearings.

2.13 THREE PHASE POWER - SQUIRREL CAGE MOTORS

.1 Starting Torque: Between 1 and 1-1/2 times full load torque.

.2 Starting Current: Six times full load current.

.3 Power Output, Locked Rotor Torque, Breakdown or Pull Out Torque: NEMA Design B characteristics.

.4 Design, Construction, Testing, and Performance: Conform to NEMA MG 1 for Design B motors.

.5 Insulation System: NEMA Class B or better.

.6 Testing Procedure: To IEEE 112. Load test motors to determine free from electrical or mechanical defects in compliance with performance data.

.7 Motor Frames: NEMA Standard T-Frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts.

.8 Thermistor System (Motor Frame Sizes 254T and Larger): Three PTC thermistors imbedded in motor windings and epoxy encapsulated solid state control relay for wiring into motor starter; refer to Section 26 29 23 - Variable Frequency Controllers.

.9 Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for relubrication, rated for minimum AFBMA 9, L-10 life of 20,000 hours. Calculate bearing load with NEMA minimum V-belt pulley with belt centre line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.

.10 Sound Power Levels: To NEMA MG 1.

.11 Part Winding Start Where Indicated: Use part of winding to reduce locked rotor starting current to

approximately 60 percent of full winding locked rotor current while providing approximately 50 percent of full winding locked rotor torque.

.12 Weatherproof Epoxy Sealed Motors: Epoxy seal windings using vacuum and pressure with rotor and starter surfaces protected with epoxy enamel; bearings double shielded with waterproof non-washing grease.

.13 Nominal Efficiency: As scheduled at full load and rated voltage when tested to IEEE 112.

.14 Nominal Power Factor: As scheduled at full load and rated voltage when tested to IEEE 112.

2.14 ADHESIVES, SEALANTS, PAINTS & COATINGS

.1 Adhesives, Sealants, Paints and Coatings: Use only low VOC emitting materials meeting following criteria;

- .1 Sealants for Service Penetrations: maximum VOC emission of 650g/L clear and 350 g/L pigmented
- .2 Sealants for Firestopping: max. VOC emission of 650g/L clear and 350 g/L pigmented

2.15 FIRESTOPPING COMPOUNDS

.1 Manufacturer: 3M products indicated.

.2 Other acceptable manufacturers offering equivalent products.

- .1 Dow Corning
- .2 John Manville
- .3 Hilti Firestop Systems

.3 Fire Rated Sealants: intumescent material, synthetic elasomers, capable of expanding up to 8 to 10 times when exposed to temperatures of 250°F (121°C) or higher. ULC listed and labelled.

2.16 SLEEVES

.1 Materials: minimum schedule 20 galvanized steel or cast iron.

2.17 ESCUTCHEONS

.1 Finish: Polished chrome

2.18 FLASHINGS AND COUNTERFLASHINGS

.1 Thaler or equivalent mechanical/electrical flashings as recommended for specific purpose.

.2 Stainless steel flashing sleeve, integral deck flange and EPDM seal.

2.19 PENETRATION SEALS

.1 Manufacturer: Link-Seal or Watts

.2 Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe and wall opening. Links shall be loosely assembled with bolts to form a continuous rubber belt around the pipe with a pressure plate under each bolt head and nut.

3 Excecution

3.1 INSPECTION

.1 Inspect installed work of other trades and verify that such work is complete to point where work under this Division may properly commence.

.2 Verify that work of this Division may be executed in accordance with pertinent codes and regulations, specifications, drawings, and referenced standards.

.3 Review drawings and verify dimensions at the site. Report discrepancies immediately to Consultant before proceeding with any construction work or shop drawings.

3.2 PREPARATION

.1 Existing services and equipment shall be relocated or removed to suit new construction and renovation work.

.2 Services that are no longer required shall be removed or cut back and capped to the satisfaction of Consultant.

.3 Obtain written authorization from Consultant for renovation work that is not specifically indicated.

.4 Where modifications or connections to existing systems require shutdown of the system the Contractor shall submit a request for system shutdown describing the system or part to be shutdown, the duration of the shutdown, the work planned and steps to be taken to reinstate the system to full operation. The request shall be submitted in the format stipulated by the Owner.

.5 All work required to prepare systems for shutdown and/or re-instatement, such as draining, chemical treatments, and re-filling shall be included in this Bid Price.

3.3 PIPING INSTALLATION - ABOVE GROUND

.1 Cooperate with other trades whose work affects or is affected by work of this Section, to ensure satisfactory installation and to avoid delays. Provide all materials to be built-in such as sleeves, anchors, etc., together with accurate dimensions or templates, promptly.

.2 Layout all work accurately, installing piping parallel to lines of building.

.3 Install piping, wherever possible, in partitions and above ceiling. Do not install piping in outside walls unless so shown on drawings. Wrap uninsulated piping in masonry walls with building paper.

.4 Install concealed piping close to building structure to minimize furring dimensions.

.5 Provide adequate space around piping to facilitate application of insulation.

.6 Use dielectric couplings where piping of dissimilar metals connect.

.7 Where piping passes through concrete floors, or walls, sleeves shall be sized to permit the pipe to expand freely without binding or crushing pipe insulation.

.8 Where branch pipes are welded into main without the use of "T" connections, torch cut openings must be cut true, bevelled and filed smooth. Branch pipes must not be allowed to project inside of main pipe. Openings must not be cut large enough to permit entry of welding metal and slag within the pipe.

.9 Arrange all take-offs from mains to allow for expansion and contraction of pipes. Hot water branches serving downfeed risers must be taken from lower sides or bottom of mains and grade down slightly to risers. Branches which serve units above the mains shall be taken from the top or sides of mains.

.10 When using PVC-DWV pipe, provide for expansion and contraction of risers by using ProSet E-Z Flex Coupling in accordance with good engineering practices.

3.4 PIPING JOINTS

.1 Make joints in piping installed under this Division using persons familiar with the particular materials being used and in accordance with Canadian Plumbing Code, manufacturer's instructions, and as specified herein.

.2 Use only welder and/or brazer operators, with a valid identification card, as issued under The Boiler and Pressure Vessels Act, to make joints in Registered Piping Systems, as indicated under Section 15010, paragraph 1.11.

.3 Use 95/5 Sb.Sn (tin-antimony) solder for joining copper drainage tubing smaller than 4" (100 mm), and for joining copper water tubing installed above grade, and smaller than 4" (100 mm).

.4 Use silver solder or Silfos for joining copper water tubing installed below grade, and all copper tubing 4 " (100 mm) and larger in size.

.5 Carefully ream joints in threaded pipe and paint with approved graphite type joint sealer on male connections only. Make connections with proper wrench to suit pipe size. Where leaks occur, the joint shall be disassembled and corrected if possible, or replaced. Over-tightening, caulking or peening will not be acceptable.

.6 Make joints in cast iron pipe with standard M-J joints in accordance with manufacturer's recommendations and CSA B70.

.7 When using Victaulic Grooved Piping Method:

.1 Make joints in grooved piping with couplings and gaskets in accordance with Victaulic Company of Canada Ltd, General Catalogue G-100, latest edition. Cut or roll grooves using tools specifically designed for that purpose.

.2 Use Zero-flex or rigidlok couplings in locations where rigidity is required, in particular in

mechanical rooms on coils, headers and pumps.

.3 Vic-Boltless couplings may be used.

.8 Install unions or welding flanges at connections to valves, etc. to facilitate removal.

.9 Use butt welding and/or schedule 40 carbon steel welding fittings to join sections of steel piping with welding ends.

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3.5 FLUSHING AND CLEANING

.1 Flush and sterilize domestic water mains in accordance with procedures established by AWWA Specification C601.

.2 Flush new domestic water piping in accordance with Local and Provincial Codes.

.3 Thoroughly flush all other piping installed by this Division.

.4 Remove, clean and replace all strainers in systems after flushing.

.5 Thoroughly clean all equipment and fixtures, lubricate mechanical equipment, and leave all items in perfect order ready for operation.

3.6 PIPING SYSTEMS TESTING AND INSPECTION

.1 Prior to tests, isolate all equipment or other parts which are not designed to withstand test pressures.

.2 Test all piping at the completion of roughing-in, before connecting to existing systems, and prior to concealment, insulation or covering of piping.

.3 Make tests, that are required by any authority having jurisdiction, in the presence of the authority's authorized inspector and shall be certified by him.

.4 Conduct tests in the presence of:

.1 Authorized inspector(s) for authorities having jurisdiction.

.2 The Owner's Representative

.3 The Consultant

.5 Notification must be given at least 48 hours in advance of tests being conducted, to all persons required to be present.

.6 Repair all leaks exposed during testing and retest. If defects in pipe or fittings are discovered in the system, they shall be removed and replaced.

.7 Certify tests: not required by authorities having jurisdiction.

3.7 EQUIPMENT TESTING AND INSPECTION

.1 Test operation of equipment installed under this Division according to instructions in appropriate articles of this Division. Make any required adjustments or replacements to ensure equipment is operating as intended. Retest equipment requiring adjustment or replacement.

.2 Pay all fuel consumption charges for equipment under testing and during commissioning.

.3 Conduct tests before application of external insulation and before concealment of piping or ductwork.

.4 Arrange and pay for inspections by authorities as required by code and complete any changes or alterations required by such inspections.

.5 Conduct tests in the presence of:

.1 Authorized inspector(s) for authorities having jurisdiction.

.2 The Systems Verification Agency.

.3 The Consultant.

.4 The Owner's Representative.

.6 Notification must be given at least 48 hours in advance of tests being conducted, to all persons required to be present.

3.8 TESTING AND BALANCING

.1 Allow sufficient time for testing and verification prior to substantial completion. Notify Testing and Balancing Agency on completion of adjusting and balancing of systems.

.2 Adjust systems and components (drives, sheaves, belts, etc.) as required by Testing and Balancing Agency.

.3 Maintain systems in full operation during testing and verification.

.4 Make adjustments to control systems as required to facilitate verification. Maintain all safety controls in operation.

.5 Check and correct alignment of V-belts, drive shaft coupling drives, etc. as required by Testing and Balancing Agency.

.6 Provide pitot tube test fittings at all main branches of sheet metal work and at intake and discharge locations of air handling systems as required by Testing and Balancing Agency.

3.9 ELECTRICAL COMPONENTS AND WIRING

.1 Conform to requirements of Division 16 for all wiring included in Division 15. Includes pre-wired equipment provided by Sections under Division 15.

.2 Ensure that all pre-wired electrical equipment is CSA approved. Arrange and pay for special approval where this is not possible.

.3 Coordinate all wiring requirements with other Divisions. Line voltage wiring from power distribution panels to starters and from starters to motors will be provided under Division 16. All ther field wiring for equipment shall be included under Division 15.

3.10 PROTECTION

.1 Protect finished and unfinished work by tarpaulins, or other covering, from damage due to execution of work under this Division.

.2 Repair to satisfaction of Consultant, damage to building resulting from failure to provide such protection.

.3 All existing air intake and exhaust openings that may be affected by dust and/or debris from the construction work shall be fitted with appropriate filter media to protect against entry of dust and/or debris into the building and its air distribution systems. Filters shall be closely monitored and replaced when necessary. The Contractor shall replace existing filters that become contaminated with dust and/or debris from construction work with new filters.

.4 In the event that dust and debris from construction work does penetrate the building and/or its air distribution systems, the Contractor shall be responsible for cleaning the affected areas and/or systems.

.5 Temporary filters shall be removed on completion of the construction works.

3.11 CUTTING AND PATCHING

.1 Include cutting and patching as required in execution of work under respective Sections of this Division.

.2 Holes through the structure will not be permitted without written approval of the Consultant. Any and all openings required through the completed structure must be clearly and accurately shown on a copy of the relevant structural drawing(s). Exact locations, elevations and size of the proposed opening must be identified well in advance of the need for the work.

.3 All sleeved or formed openings through the structure must be shown on sleeving drawings and must be approved by the Structural Consultant prior to construction.

.4 The Contractor shall conduct exploratory work including x-ray of the existing structure, shall mark the location of embedded reinforcements, anchors, conduits and piping on exposed surfaces of adjacent floors and/or walls and shall pay all associated costs.

.5 Reinforcing shall not be cut or modified without prior approval of the Structural Consultant. Should reenforcement be cut without such prior approval, the cost of any additional reenforcement deemed necessary by the Structural Consultant shall be the responsibility of this Contractor.

.6 Alternative imaging techniques are subject to the approval of the Structural Consultant.

.7 Ensure that cutting and patching of roofs and reinforced concrete structures is executed by specialists familiar with the materials affected, and is performed in a manner to neither damage nor endanger the work. Coordinate and supervise such cutting and patching.
.8 Maintain the integrity of fire rated assemblies where they are pierced by ducts and pipes.
.9 Make good surfaces affected by this work and repair finish to satisfaction of Consultant. Finish painting, where required, will be provided under Division 9.
.10 Stop work immediately upon discovery of any hazardous material and report discovery to the Owner and Consultant. Obtain instruction prior to proceeding with the work.

3.12 NOT USED

3.13 SEALANTS & CAULKING

.1 Fill voids around pipes:
  .1 Seal between sleeve and pipe in foundation walls and below grade floors with penetration seals (link-seal)). Install as per manufacturer's installation instructions.
  .2 Where sleeves pass through non-fire rated walls or floors, caulk space between pipe and sleeve with fibreglass. Seal space at each end with waterproof, fire retardant, non-hardening mastic.
  .3 Ensure no contact between copper tube or pipe and ferrous sleeve.
  .4 Fill future-use sleeves with easily removable filler.
  .5 Coat exposed exterior surfaces or ferrous sleeves with heavy application of zinc rich paint (VOC content not to exceed 250 g/L).
.2 Temporarily plug all openings during construction.

3.14 FIRESTOPPING

.1 All openings in fire separations and fire rated assemblies for service penetrations shall be protected with ULC listed service penetration firestop systems (SP).
.2 The service penetration firestop system shall have F and FT ratings equal to or greater than ratings specified by the Architect for the fire separation (F) and firewall (FT) joint firestop systems (JF).
.3 All components employed in the service penetration firestop system shall conform to the ULC listing.
.4 Contractor shall prepare and submit a schedule of service penetration firestop systems to be employed indicating the ULC listing designation, services involved, location of opening through fire separation and the components of the fire separation assembly.
.5 Refer to architectural drawings for ratings of fire separations and assemblies.

3.15 SLEEVES AND CURBS

.1 Provide pipe sleeves at points where pipes pass through masonry or concrete.
.2 Provide sleeves of minimum schedule 20 galvanized steel or cast iron.
.3 Use cast iron or steel pipe sleeves with annular fin continuously welded at midpoint:
  .1 through foundation walls, with penetration seals.
  .2 through floors of mechanical rooms and equipment rooms.
.4 Provide 1/4" (6 mm) clearance all around, between sleeve and pipes or between sleeve and insulation.
.5 Where piping passes below footings, provide minimum clearance of 2" (50 mm) between sleeve and pipe. Backfill up to underside of footing with concrete of same strength as footing with concrete of same strength as footing.
.6 Terminate sleeves flush with surface of concrete and masonry and 2" (50 mm) above floors. Not applicable to concrete floors on grade.
.7 Provide watertight concrete curb 4" (100 mm) high around mechanical services (pipes, ducts, conduits) which rise through mechanical (service) room floors. Provide minimum 4" (100 mm) clearance between openings for services within curbs.
.8 For pipes passing through roofs, use cast iron sleeves with caulking recess and flashing clamp device. Anchor sleeves in roof construction, caulk between sleeve recess and pipe, fasten roof flashing to clamp device, make water-tight durable joint. Co-ordinate with roofing Section.

3.16 FLASHINGS

.1 Provide all flashing at each point where piping passes through the roof.
.2 Coordinate this work with the roofing Trades to ensure a satisfactory installation and to avoid delays.

3.17 ESCUTCHEONS AND PLATES

.1 Provide on pipes passing through finished walls, partitions, floors and ceilings.
.2 Use chrome plated or nickel plated brass, solid type with set screws for ceiling or wall mounting.
.3 Inside diameter shall fit around finished pipe. Outside diameter shall cover opening or sleeve.
.4 Where sleeve extends above finished floor, escutcheon or plates shall clear sleeve extension.
.5 Secure to pipe or finished surface, but not insulation.

3.18 SUPPORT AND ATTACHEMENT

.1 Support and attach piping, ductwork fixtures and equipment from load bearing structures such as beams, joists, reinforced concrete slabs and concrete block walls, and do not support from or attach to steel roof deck and/or wall or ceiling finishes.

3.19 PAINTING

.1 Repair minor damage to finish of equipment with standard factory applied baked enamel finish under the appropriate Sections of this division. Replace entirely, items suffering major damage to finish if too extensive to be repaired in the opinion of the Consultant.
.2 Apply at least one coat of corrosion resistant primer paint to supports, and equipment fabricated from ferrous metals.

3.20 DISSIMILAR METALS

.1 Separate dissimilar metals in order to prevent galvanic corrosion.
.2 Provide gaskets or shims of approved materials to avoid electrolytic action.
.3 Use dielectric unions and/or flanges where piping of dissimilar metals are connected.

3.21 EQUIPMENT BASES AND CURBS

.1 Supply and erect structural work required for installation of mechanical equipment.
.2 Build concrete bases 6" (150 mm) high, providing all necessary inserts, anchor bolts and other fasteners required, for floor mounted tanks, heaters, pumps, air handlers, boilers, etc. Make concrete bases 2" (50 mm) larger all around than the base of the supported equipment and trowel finish to a neat smooth finish. Anchor equipment to pads using 8" (200 mm) cast-in-place anchor bolts. Ensure concrete supplied under this Division is 2500 psi (17 MPa) compressive strength after 28 days.
.3 Build 4" (100 mm) high concrete curbs around all openings through floors. Ensure joint between curb and floor is watertight and maintains integrity of floor membrane where applicable.

3.22 SERVICE CONNECTIONS

.1 Include in Bid Price all amounts required by municipality and/or utilities for service connections and /or modifications to service connections for water services. Ensure amounts include fees, assessments, charges, etc., required in relation to service connection. Do not include acreage or frontage charges.

3.23 BELT DRIVES AND SHEAVES

.1 Provide belt driven equipment with V-belt drive, designed for at least 130 percent of motor nameplate horsepower rating and in accordance with manufacturer's recommendations for type of service intended. Ensure belt drives are at least 95 percent efficient. Balance and properly align drives. Provide matched sets of belts for multiple belt assemblies. Select belts to suit starting torque of driver. Do not use single belt drives only for motors larger than two horsepower.
.2 Provide motor sheaves for one and two belt drives of variable pitch type, with Dodge key adjustments. Supply two sets of fixed drive sheaves for drives with three or more belts. Install first set of fixed motor sheaves to obtain the originally specified rpm. After initial test and preliminary adjustment, supply and install the second set of fixed sheaves if necessary, to provide the design

flow quantities as established on the job. Obtain correct total flow rate for fans through speed changes and not by throttling.

.3 Provide adjustable sheaves on motor sizes up to 2 HP (1492 w) and fixed sheaves on larger motors.

3.24 GUARDS

.1 Provide OSHA compliant guards for exposed drives as follows;
- .1 expanded metal screen (both sides) welded to 1" (25 mm) steel angle frame.
- .2 18 ga. 1" (25 mm) thick galvanized sheet metal tops and bottoms.
- .3 removable sides for servicing.
- .4 1-1/2" (40 mm) dia. holes on both shaft centres for insertion of tachometer.

.2 Provide means to permit lubrication and use of test instruments with guards in place.

.3 Install belt guards to permit movement of motors for adjusting belt tension.

.4 For flexible couplings, provide removable, "U" shaped, 12 ga. 1/10" (2.7 mm) thick galvanized frame and 18 ga. 1/25" (1.2 mm) thick expanded mesh face.

.5 Provide 3/4" (20 mm) galvanized mesh wire screen on inlet or outlet of exposed fan blades such that net free area to openings is not less than 1.25 of original openings.

3.25 FIELD QUALITY CONTROL

.1 Temporary and Trial Usage
- .1 Allow the Owner the privilege of temporary and trial usage of installed equipment, as soon as work is complete, for a period of time required to conduct a thorough test.
- .2 Do not construe such usage as evidence of acceptance of work by Owner.
- .3 Repair damage to work tested, resulting from such trial usage, by this Contractor at no cost to Owner.

.2 Systems Verification:
- .1 Verify the correct installation and proper operation of equipment and systems installed. Adjust and balance each system as necessary to achieve optimum operation of each system.
- .2 Co-operate with the TAB agency as follows:
  - .1 provide assistance when and as requested,
  - .2 co-ordinate completion of work systematically to permit orderly verification and adherence to schedules,
  - .3 provide additional necessary flow balancing devices as directed by agency,
  - .4 notify TAB Agency of tests being conducted.

3.26 ADJUST AND CLEAN

.1 Clean equipment and fixtures, lubricate mechanical equipment installed under this Division and leave items in perfect order ready for operation.

.2 Test and adjust control devices, instrumentation, relief valves, dampers, etc., installed in this Division after cleaning of systems and leave in perfect order ready for operation.

.3 Remove from the premises upon completion of work of this division, debris, surplus, and waste materials resulting from operations.

3.27 MECHANICAL IDENTIFICATION INSTALLATION

.1 Degrease and clean surfaces to receive adhesive for identification materials.

.2 Prepare surfaces for stencil painting.

.3 Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer (VOC content not to exceed 680 g/L).

.4 Install tags with corrosion resistant chain.

.5 Comply with standard detail drawing plate, "Detail of Piping Identification".

.6 Apply stencil markings on all covered piping.

.7 Install plastic tape pipe markers complete around bare pipe to manufacturer's instructions.

.8 Identify medical gas piping in accordance with CSA Z305.1 and CSA Z7396-1

.9 Identify anaesthetic gas scavenging piping in accordance with CSA Z7396-1.

.10 Label piping that is heat traced or equipped with heating cable "HEAT TRACED" in addition to other identification. Locate such labels adjacent to other identifications.

.11 Clearly identify abandoned services left in place as "ABANDONED".

.12 Mark drain from hot lab sink with radiation warning symbols at 10 ft. (3 m) intervals.

.13 Install underground plastic pipe markers 6"-8" (150-200 mm) below finished grade, directly above buried pipe.

.14 Identify pumps, water heating equipment, tanks, and water treatment devices with plastic nameplates. Small devices, such as in-line pumps, may be identified with tags.

.15 Identify control panels and major control components outside panels with plastic nameplates.

.16 Identify valves in main and branch piping with tags. Consecutively number valves in each system.

.17 Identify piping, concealed or exposed, with stencilled painting and plastic tape pipe markers . Identify service, flow direction, and pressure. Install in clear view and align with axis of piping. Locate identification not to exceed 6 m on straight runs including risers and drops, adjacent to each valve and Tee, at each side of penetration of structure or enclosure, and at each obstruction.

.18 For each item of equipment which may be started automatically or remotely, add a red lamacoid plate, 2-3/8" x 9" (60 x 230 mm), reading:

"WARNING. THIS EQUIPMENT IS AUTOMATICALLY CONTROLLED. IT MAY START AT ANY TIME."

.19 Provide colour coded self-adhesive dots to locate valves or dampers above T-bar type panel ceilings. Locate in corner of panel closest to equipment.

3.28 MECHANICAL IDENTIFICATION SCHEDULES

.1 Consult the Owner and identify piping, ductwork and equipment as directed;

.1 conforming to the Owner's existing identification practices, or

.2 conforming to the following Pipe and Valve Identification Table:

Pipe Marker Legend	Valve Tag Legend	Primary Colour	Secondary Colour
Cold Water	CW	Green	None
Dom. Hot Water Supply	DHWS	Green	None
Dom. Hot Water Recirc.	DHWR	Green	None
Sanitary Sewer	SAN	Green	None
Storm Sewer		Green	None
Vent		Green	None

.2 Where coloured PVC jacketing is specified, conform to the following schedule;

Service	Legend	Colour
Cold Water	CW	Dark Green
Dom. Hot Water Supply	DHWS	Yellow
Dom. Hot Water Recirc.	DHWR	Yellow
Sanitary Sewer	SAN	Dark Grey
Storm Sewer	STRM	Light Grey

3.29 MANUFACTURER'S NAMEPLATES

.1 Provide metal nameplates on each piece of equipment, mechanically fastened with raised or recessed letters.

.2 Include registration plates, Underwriters' Laboratories and CSA approval, as required by respective agency and as specified. Indicate size, equipment model, manufacturer's name, serial number, voltage, cycle, phase and power of motors, all factory supplied.

.3 Locate nameplates so that they are easily read. Do not insulate or paint over plates.

3.30 INSTALLATION OF GAUGES

.1 Install to manufacturer's instructions.

.2 Install positive displacement meters with isolating valves on inlet and outlet to AWWA M6. Provide full line size valved bypass with globe valve for liquid service meters.

.3 Provide one pressure gauge per pump, installing taps before strainers and on suction and discharge of pump. Pipe to gauge.

.4 Install pressure gauges with pulsation dampers. Provide gauge cock to isolate each gauge. Provide syphon on gauges in steam systems. Extend nipples and syphons to allow clearance from insulation.

.5 Install gauges in locations where they are easily read from normal operating level.

.7 Adjust gauges clean windows and lenses, and calibrate to zero.

3.31 INSTALLATION OF ACCESS DOORS

.1 Supply access doors for access to equipment requiring service, lubrication or adjustment and all concealed valves, cleanouts, trap primers, control and volume dampers, and other such equipment.

.2 Turn over access doors to the appropriate general trade for installation under other Sections.

.3 Refer to architectural drawings for ratings of fire separations and assemblies. install fire rated access doors in fire rated partitions, walls, and ceilings.

.4 Access doors in ceilings shall be minimum 24" x 24" (600mm x 600mm), unless otherwise approved by the Consultant.

.5 Provide concealed access doors in GWB ceilings and coordinate in-fill with general trades.

3.32 MOTOR APPLICATIONS

.1 Single phase motors for shaft mounted fans: Split phase type.

.2 Single phase motors for shaft mounted fans or blowers: Permanent split capacitor type.

.3 Single phase motors for fans: Capacitor start type.

.4 Single phase motors for fans: Capacitor start, capacitor run type.

.5 Motors located in exterior locations: Totally enclosed type.

.6 Motors located in outdoors: Totally enclosed weatherproof epoxy-treated type.

.7 Motors located in outdoors: Totally enclosed weatherproof epoxy-sealed type.

.8 Motors located in flammable and combustible liquid storage and handling areas: Totally enclosed fan cooled

3.33 INSTALLATION OF MOTORS

.1 Install motors to manufacturer's instructions.

.2 Install securely on firm foundation. Mount ball bearing motors with shaft in any position.

.3 Check line voltage and phase and ensure agreement with nameplate.

End of Section

1 General

1.1 GENERAL REQUIREMENTS

.1 Comply with General Requirements of Section 15010.

1.2 SECTION INCLUDES

.1 Pipe and equipment hangers and supports.
.2 Equipment bases and supports.
.3 Sleeves and seals.
.4 Flashing and sealing equipment and pipe stacks.

1.3 REFERENCES

.1 ASME B31.1 - Power Piping.
.2 ASME B31.2 - Fuel Gas Piping.
.3 ASME B31.5 - Refrigeration Piping and Heat Transfer Components.
.4 ASTM F708 - Design and Installation of Rigid Pipe Hangers.
.5 MSS SP58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
.6 MSS SP69 - Pipe Hangers and Supports - Selection and Application.
.7 MSS SP89 - Pipe Hangers and Supports - Fabrication and Installation Practices.
.8 NFPA 13 - Installation of Sprinkler Systems.
.9 NFPA 14 - Installation of Standpipe, Private Hydrants, and Hose Systems.
.10 UL 203 - Pipe Hanger Equipment for Fire protection Service.

1.4 SUBMITTALS

.1 Section 15010: Procedures for submittals.
.2 Shop Drawings: Indicate system layout with location and detail of trapeze hangers.
.3 Product Data: Provide manufacturers catalogue data including load capacity.
.4 Design Data: Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers.
.5 Manufacturer's Installation Instructions: Indicate special procedures and assembly of components.

1.5 REGULATORY REQUIREMENTS

.1 Conform to CSA B-51 for support of piping.

2 Products

2.1 PIPE HANGERS AND SUPPORTS

.1 Manufacturers:
  .1 Anvil
  .2 Myat
  .3 Hunt
.2 Plumbing Piping:
  .1 Conform to CSA B-51 and ASME B31.1
  .2 Hangers for Pipe Sizes 1/2" to 1-1/2" (13 to 38 mm): Carbon steel, adjustable swivel, split ring.
  .3 Hangers for Cold Pipe Sizes 2" (50 mm) and Over: Carbon steel, adjustable, clevis.
  .4 Hangers for Hot Pipe Sizes 2" to 4" (50 to 100 mm): Carbon steel, adjustable, clevis.
  .5 Hangers for Hot Pipe Sizes 6" (150 mm) and Over: Adjustable steel yoke, cast iron roll, double hanger.
  .6 Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
  .7 Multiple or Trapeze Hangers for Hot Pipe Sizes 6" (150 mm) and Over: Steel channels with welded spacers and hanger rods, cast iron roll.

.8 Wall Support for Pipe Sizes to 3" (76 mm): Cast iron hook.
.9 Wall Support for Pipe Sizes 4" (100 mm) and Over: Welded steel bracket and wrought steel clamp.
.10 Wall Support for Hot Pipe Sizes 6" (150 mm) and Over: Welded steel bracket and wrought steel clamp with adjustable steel yoke and cast iron roll.
.11 Vertical Support: Steel riser clamp.
.12 Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
.13 Floor Support for Hot Pipe Sizes to 4" (100 mm): Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
.14 Floor Support for Hot Pipe Sizes 6" (150 mm) and Over: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.
.15 Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

.3 Refrigerant Piping:
.1 Conform to ASME B31.5.
.2 Hangers for Pipe Sizes 1/2" to 1-1/2" (13 to 38 mm): Carbon steel, adjustable swivel, split ring.
.3 Hangers for Pipe Sizes 2" (50 mm) and Over: Carbon steel, adjustable, clevis.
.4 Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
.5 Wall Support for Pipe Sizes to 3" (75 mm): Cast iron hook.
.6 Wall Support for Pipe Sizes 4" (100 mm) and Over: Welded steel bracket and wrought steel clamp.
.7 Vertical Support: Steel riser clamp.
.8 Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
.9 Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

2.2 ACCESSORIES

.1 Hanger Rods: galvanized, carbon steel continuous threaded.
.2 Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

2.3 EQUIPMENT ROOF CURBS

.1 Fabrication: Welded 0.05" (1.2 mm) galvanized steel shell and base, mitred 3" (75 mm) cant, variable step to match roof insulation, factory installed wood nailer.

2.4 ROOFTOP PIPE/DUCT SUPPORTS

.1 Acceptable manufacturers;
.1 Portable Pipe Hangers, Inc.
.2 Unistrut

.2 Pre-enginnered pipe/duct support system including;
1. Bases: weather resistant and UV radiation resistant with seismic attachments
2. Framing: 1-5/8" (41.3mm) strut or 1-7/8" (47.6mm) strut, fabricated of steel to ASTM A570, Grade 33., roll formed of 12-gauge (2.7mm thick) steel into 3-sided or tubular shape.
3. Pipe Supports and Hangers: Conform to MSS SP-58 and MSS SP-69, fabricated of carbon steel. Single roller supports for piping subject to expansion and contraction.
4. Finishes:
.1 Plastics as moulded with UV radiation protection.
.2 Metal surfaces hot dip galvanized free of roughness, whiskers, unsightly spangles, icicles, runs, barbs, sags, droplets and other surface blemishes. Galvanizing shall conform to ASTM A123 for tubing and to ASTM A153 for hardware and accessories.

.5 Shop Drawings: Manufacturer to provide detailed shop drawings to indicate layout and supporting capacities of system components with installation and assembly instructions for each application. Shop drawings shall bear the signature and seal of a professional

engineer licenced in Ontario.

3 Execution

3.1 INSTALLATION

.1 Install to manufacturer's instructions and best trade practises.

3.2 INSERTS

.1 Provide inserts for placement in concrete formwork.
.2 Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
.3 Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4" (100 mm).
.4 Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
.5 Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.

3.3 PIPE HANGERS AND SUPPORTS

.1 Support horizontal piping in accordance to code requirements. Where there are no code requirements support as scheduled below.
.2 Install hangers to provide minimum 1/2" (13 mm) space between finished covering and adjacent work.
.3 Place hangers within 12" (300 mm) of each horizontal elbow.
.4 Use hangers with 1-1/2" (38 mm) minimum vertical adjustment.
.5 Support horizontal cast iron pipe adjacent to each hub, with 5 feet (1.5 m) maximum spacing between hangers.
.6 Support vertical piping at every other floor. Support vertical cast iron pipe at each floor at hub.
.7 Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
.8 Support riser piping independently of connected horizontal piping.
.9 Provide copper plated hangers and supports for copper piping.
.10 Design hangers for pipe movement without disengagement of supported pipe.
.11 Prime coat exposed steel hangers and supports. Refer to Section 09 91 10. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

3.4 EQUIPMENT BASES AND SUPPORTS

.1 Provide housekeeping pads of concrete, minimum 4" (100 mm) thick and extending 6" (150 mm) beyond supported equipment. **Refer to Section 03 30 00**.
.2 Provide templates, anchor bolts, and accessories for mounting and anchoring equipment.
.3 Construct supports of steel members. Steel pipe and fittings. Brace and fasten with flanges bolted to structure.
.4 Provide rigid anchors for pipes after vibration isolation components are installed.

3.5 ROOFTOP PIPE/DUCT SUPPORT

.1 Coordinate installation of supports and bases with roofing work. Ensure that roofing surfaces are smooth and flat and are ready to receive work.
.2 Use care in installation of support systems not to damage roofing, flashing, equipment or related materials.
.3 Install and secure support systems in strict accordance with manufacturer's written instruction.
.4 Consult manufacturers of roofing system to determine if walk pads are required. Provide and fully adhere walk pads to roof system where required.
.5 Bases and support framing shall be located as indicated on shop drawings provided by support system manufacturer and as specified herein. The support of all piping shall be complete and adequate, whether or not all required devices are shown.
.6 The use of wood or wire for supporting piping will not be permitted.

.7 Deflection of pipes shall not exceed 1/240th of the span.

.8 Accurately locate and align bases. Where applicable, replace gravel around bases. Set framing posts into bases and assemble framing structure as indicated.

.9 Use galvanized fasteners for galvanized framing, and use stainless steel fasteners for stainless steel framing.

3.6 FLASHING

.1 Provide flexible flashing and metal counterflashing where piping and ductwork penetrate weather or waterproofed walls, floors, and roofs.

.2 Flash vent and soil pipes projecting 3" (75 mm) minimum above finished roof surface with lead worked 1" (25 mm) minimum into hub, 8" (200 mm) minimum clear on sides with 24" x 24" (600 x 600 mm) sheet size. For pipes through outside walls, turn flanges back into wall and caulk, metal counterflash, and seal.

.3 Flash floor drains in floors with topping over finished areas with lead, 10" (250 mm) clear on sides with minimum 36" x 36" (910 x 910 mm) sheet size. Fasten flashing to drain clamp device.

.4 Seal roof, floor, shower and mop sink drains watertight to adjacent materials.

.5 Provide acoustical lead flashing around ducts and pipes penetrating equipment rooms, installed to manufacturer's instructions for sound control.

.6 Provide curbs for mechanical roof installations 14" (350 mm) minimum high above roofing surface. Flash and counterflash with sheet metal; seal watertight. Attach counterflashing mechanical equipment and lap base flashing on roof curbs. Flatten and solder joints.

.7 Adjust storm collars tight to pipe with bolts; caulk around top edge. Use storm collars above roof jacks. Screw vertical flange section to face of curb.

3.7 SLEEVES

.1 Set sleeves in position in formwork. Provide reinforcing around sleeves.

.2 Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.

.3 Extend sleeves through floors 1" (25 mm) above finished floor level. Caulk sleeves.

.4 Where piping or ductwork penetrates floor, ceiling, or wall, close off space between pipe or duct and adjacent work with stuffing insulation and caulk. air tight. Provide close fitting metal collar or escutcheon covers at both sides of penetration.

.5 Install chrome plated steel escutcheons at finished surfaces.

3.8 SCHEDULES

.1 Imperial Measure (IP)

Pipe Size(in)	Rod Diameter (in)	Support Spacing (Ft)	
		Steel Pipe	Copper Tube
1/2	3/8	7	6
3/4	3/8	7	6
1	3/8	7	6
1-1/4	3/8	7	6
1-1/2	3/8	9	8
2	3/8	10	9
2-1/2	3/8	12	10
3	3/8	12	10
4	5/8	14	12
6	7/8	17	
8	7/8	19	
10	7/8	21	
12	7/8	23	
14	1	25	
16	1	27	
18	1	28	

.2 Metric Measure (SI)

Pipe Size(mm)	Rod Diameter (mm)	Support Spacing (m)	
		Steel Pipe	Copper Tube
13	10	2.1	1.8
20	10	2.1	1.8
25	10	2.1	1.8
32	10	2.1	1.8
38	10	2.7	2.4
50	10	3	2.7
65	10	3.6	3
75	10	3.6	3
100	16	4.2	3.6
150	22	17	
200	22	5.7	
250	22	6.4	
300	22	7	

End of Section

1 General

1.1 GENERAL REQUIREMENTS

.1 Comply with General Requirements of Section 15010.

1.2 SECTION INCLUDES

.1 The mechanical contractor will be responsible for the work of Testing, Adjusting and Balancing of HVAC systems as follows;
  .1 Testing, adjustment, and balancing of plumbing systems.

.2 This Section shall verify correct operation of;
  .1 piping systems,
  .2 Equipment

1.3 REFERENCES

.1 Ontario Building Code.
.2 Ontario Fire Code.
.3 AABC - National Standards for Total System Balance.
.4 ACG - AABC Commissioning Guideline.
.5 ADC - Test Code for Grilles, Registers, and Diffusers.
.6 ASHRAE 111 - Practices for Measurement, Testing, Adjusting, and Balancing of Building Heating, Ventilation, Air-conditioning, and Refrigeration Systems.
.7 ASHRAE Guideline 0 The Commissioning Process,
.8 ASHRAE Guideline 1 The HVAC Commissioning Process,
.9 ASHRAE Guideline 1.1 HVAC&R Technical Requirements for the Commissioning Process,
.10 ASTM E779 Determining Air Leakage Rate by Fan Pressurization.
.11 NEBB - Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems.
.12 SMACNA - HVAC Systems Testing, Adjusting, and Balancing.
.13 SMACNA HVAC Systems Commissioning Manual,

1.4 SUBMITTALS

.1 Submit name of adjusting and balancing agency for approval within 30 days after award of Contract.
.2 Field Reports: Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.
.3 Prior to commencing work, submit report forms or outlines indicating adjusting, balancing, and equipment data required.
.4 Submit draft copies of report for review prior to final acceptance of Project. Provide final copies for Consultant and for inclusion in operating and maintenance manuals.
.5 Provide reports in soft cover, letter size, 3-ring binder manuals, complete with index page and indexing tabs, with cover identification at front and side.
.6 Include detailed procedures, agenda, sample report forms and copy of AABC National Project Performance Guaranty prior to commencing system balance.

.7 Test Reports: Indicate data on AABC National Standards for Total System Balance forms. Submit data in S.I. Metric units.

.7 All reports shall be prepared in electronic (computer) format using MS Word software and all tabulations shall be prepared in electronic (computer) format using MS Excel spreadsheet software. Submittals shall include three (3) copies each of hard copy printout and two (2) copies with text in ".pdf" and tabulations in ".xls" or ".xlsx" formats on CD, DVD, or USB flash drive.

1.5 PROJECT RECORD DOCUMENTS

.1 Include set of reduced drawings with air outlets and equipment identified to correspond with data sheets, and indicating thermostat locations.

.2 Record actual locations of flow measuring stations.

1.6 QUALITY ASSURANCE

.1 Perform total system balance to AABC National Standards for Field Measurement and Instrumentation, Total System Balance.

.2 Maintain one copy of each document on site.

1.7 INDEPENDENT AGENCY

.1 All work of Mechanical Testing, Adjusting and Balancing shall be undertaken by a single agency, employed under Division 15.

.2 The work of the agency consists of the furnishing of all labour, materials, equipment and accessories necessary in the testing, verification and documentation of the operational performance of all equipment and systems installed under the Sections of Division 15: Mechanical.

1.8 QUALIFICATIONS

.1 Agency: Company specializing in the testing, adjusting, and balancing of systems under this Section with minimum five years documented experience certified by AABC and prequalified as listed below.

.2 Work shall be performed under the supervision of an AABC certified Test and Balance Engineer, an NEBB Certified Testing, Adjusting and Balancing Supervisor or a registered Professional Engineer experienced in the performance of this work and licensed at the place where the Project is located.

.3 Prequalified agencies include;

.1 National Air Balancing Only.

.2 All Air Balancing work will be done thru Cash Allowance and the Air balancing contractor will Work under the directions of the owner/consultant.

1.9 PRE-BALANCING CONFERENCE

.1 Convene one week prior to commencing work of this Section.

1.10 SEQUENCING

.1 Sequence work to commence after completion of systems and schedule completion of work before Substantial Completion of Project.

1.11 SCHEDULING

.1 Schedule and provide assistance in final adjustment and test of life safety system with Fire Authority.

1.12 CO-OPERATION

.1 Co-operate with installing Contractor(s) in advising them of specific scheduling requirements for systems verification.
.2 Provide advice to installing Contractors regarding the location and installation of devices required to permit system balancing and measurements, prior to start of the installation work.
.3 Coordinate verification of smoke control and automatic sprinkler systems with verification of fire alarm system under Division 16.

2 Products

2.1 REFERENCE STANDARDS

.1 All equipment required for the verification of equipment and systems shall be furnished by the agency employed to conduct the Mechanical Systems Verification.
.2 Testing and measuring equipment used in the verification of the mechanical systems shall be calibrated to give true readings within the accuracy specifications of the equipment used. A certificate of calibration from an independent testing laboratory may be required by the Consultant if there is any reason to suspect that the equipment used is giving erroneous readings. In such an event the verification agency shall reconduct its verifications.
.3 All equipment used by the agency in its verification of mechanical systems remains the property/responsibility of the agency and is not included in the supply to the project.

3 Execution

3.1 EXAMINATION

.1 Verify that systems are complete and operable before commencing work. Ensure the following conditions:
  .1 Systems are started and operating in a safe and normal condition.
  .2 Temperature control systems are installed complete and operable.
  .3 Proper thermal overload protection is in place for electrical equipment.
  .4 Final filters are clean and in place. If required, install temporary media in addition to final filters.
  .5 Duct systems are clean of debris.
  .6 Fans are rotating correctly.
  .7 Fire and volume dampers are in place and open.
  .8 Air coil fins are cleaned and combed.
  .9 Access doors are closed and duct end caps are in place.
  .10 Air outlets are installed and connected.
  .11 Duct system leakage is minimized.

.2 Submit field reports. Report defects and deficiencies noted during performance of services which prevent system balance.
.3 Beginning of work represents acceptance of existing conditions in the areas served.

3.2 PREPARATION

.1 Provide instruments required for testing, adjusting, and balancing operations. Make instruments available to Consultant to facilitate spot checks during testing.
.2 Provide additional balancing devices as required.

3.3 INSTALLATION TOLERANCES

.1 Roof Top Unit: Adjust to within plus or minus 5 percent of design for supply systems and plus or minus 5 percent of design for return and exhaust systems.
.2 Air Outlets and Inlets: Adjust total to within plus 5 percent and minus 5 percent of design to space. Adjust outlets and inlets in space to within plus or minus 5 percent of design.

3.4 ADJUSTING

.1 Ensure recorded data represents actual measured or observed conditions.
.2 Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.
.3 After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.
.4 Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.
.5 At final inspection, recheck random selections of data recorded in report. Recheck points or areas as selected and witnessed by the Owner.
.6 Check and adjust systems approximately six months after final acceptance and submit report.

3.5 NIL.

3.6 WATER SYSTEM PROCEDURE

.1 Adjust water systems to provide required or design quantities.
.2 Use calibrated Venturi tubes, orifices, or other metered fittings and pressure gauges to determine flow rates for system balance. Where flow metering devices are not installed, base flow balance on temperature difference across various heat transfer elements in the system.
.3 Adjust systems to provide specified pressure drops and flows through heat transfer elements prior to thermal testing. Perform balancing by measurement of temperature differential in conjunction with air balancing.
.4 Effect system balance with automatic control valves fully open to heat transfer elements.
.5 Effect adjustment of water distribution systems by means of balancing cocks, valves, and fittings. Do not use service or shut-off valves for balancing unless indexed for balance point.
.6 Where available pump capacity is less than total flow requirements or individual system parts, full flow in one part may be simulated by temporary restriction of flow to other parts.

3.7 VERIFICATION CHECKLIST

.1 Prepare a series of checklists to record the verification of each item of equipment and each system. Submit a draft of each checklist to the Consultant and the Owner for review and approval. Discuss comments offered the Consultant and Owner and include improvements as directed.
.2 Checklists shall include the following as a minimum;
  .1 date(s) of observations and/or tests,
  .2 a record of the nameplate data for each equipment item and each associated motor,
  .3 a list of observations appropriate to the equipment item or system with space adjacent to indicate whether the item was satisfactory or unsatisfactory,
  .4 appropriate space for recording comments and/or instructions given during observations.

3.8 EQUIPMENT VERIFICATION

.1 Test the operation of all equipment installed under Division 15 according to instructions in appropriate articles of this Division. Advise installing contractor of any required adjustments or replacements to ensure that equipment is operating as intended. Retest equipment after adjustment or replacement.
.2 Ensure that the Contractor has given proper advance notification to all persons required to be present as tests are conducted. Refer to 15100.
.3 Instrumentation: verify installation of air filter gauges, pitot traverse stations, and flow-measuring devices ensuring that:
  .1 Location of points for readings is appropriate to measure what it is intended to measure;
  .2 The scale range is appropriate to place the normal reading near mid-range of the scale;
  .3 Proper positioning of instrumentation to allow reading from a convenient location, and for easy access.
.4 Filters Inspection: visually inspect each filter installation. Verify adjustment of latching devices, installation of end spacers in filter boxes, and proper latching and sealing of access doors. Verify the installation of new (clean) filter media after Contractor's start-up procedures.
.5 Pre-start-up Inspection:
  .1 Verify proper equipment mounting and setting.

.2 Verify that control, interlock, and power wiring are complete.
.3 Verify proper alignment of motors and drives.
.4 Verify proper piping connections and accessories.
.5 Verify that lubrication is complete.

.6 First Run Observation:
.1 Verify direction of rotation.
.2 Verify setting of safety controls.
.3 Monitor heat build-up in bearings.
.4 Check motor loads against nameplate ratings.

.7 Equipment Checkout:
.1 Verify the proper overload heater sizes.
.2 Verify function of safety and operating controls.
.3 Verify proper operation of equipment.
.4 Report on inspection, observation, and checkout procedures.

.8 Motor Rotation: visually inspect and verify the direction of motor rotation. It is possible for motor rotation to have been checked by the electrician when power connections were made on temporary electric power, then when final connections were made to the permanent transformer bank, crossed phasing may reverse the rotation of all three-phase motors on the system.

.9 Overload Heaters: verify supply voltage to each equipment. If the applied voltage is different from the motor nameplate, determine whether the applied voltage is within the range allowed under the motor guarantee. If not, take the necessary action to have the Contractor change the motor or the applied voltage. When the voltage is off the nameplate value, but within the allowable range, compute the equivalent amperage at nameplate voltage and compare to the overload heater amperage rating range. Then, consider whether the ambient temperature of the starter is above, below, or the same as the ambient temperature are not the same. Advise the Contractor to use overload heaters of higher range for "hot area" starters or ones of lower range for "cold area" starters to compensate the heater trip point for heat gains or losses with the environment.

.10 Alignment of Drives: verify the alignment of drives, belt and direct coupled, and the adjustment of belt tension.

.11 Control Diagrams and Sequences: provide for coordination with work under the automatic control systems to have the control diagrams and sequences of operation corrected to "as installed", reflecting changes brought about in response to contract modifications and to the more pragmatic changes in diagrams and sequences to make the installed system control the building systems as intended by the designer.

.12 Safety and Operating Control Setpoints: systematically verify the safety and operating controls of equipment, including an operational check of associated control sequences.

.13 Fin Straightening: inspect finned surface heat transfer coils for damages fins and advise Contractor of repairs required.

.14 Verify that manufacturer's start-up procedures have been performed and that equipment is installed in accordance with the manufacturers written installation recommendations.

.16 Where work is noted to be done in stages a complete air balance and verification report will be required at the end of each stage.

End of Section

1 General

1.1 GENERAL REQUIREMENTS

.1 Comply with General Requirements of Section 15010.

1.2 SECTION INCLUDES

.1 Piping insulation.
.2 Jackets and accessories.

1.3 REFERENCES

.1 ASTM B209 - Aluminum and Aluminum-Alloy Sheet and Plate.
.2 ASTM C177 - Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.
.3 ASTM C195 - Mineral Fibre Thermal Insulating Cement.
.4 ASTM C335 - Steady-State Heat Transfer Properties of Horizontal Pipe Insulation.
.5 ASTM C449/C449M - Mineral Fibre Hydraulic-setting Thermal Insulating and Finishing Cement.
.6 ASTM C518 - Steady-State Thermal Transmission Properties by Means of the Heat Flow Metre Apparatus.
.7 ASTM C533 - Calcium Silicate Block and Pipe Thermal Insulation.
.8 ASTM C534 - Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
.9 ASTM C547 - Mineral Fibre Pipe Insulation.
.10 ASTM C552 - Cellular Glass Thermal Insulation.
.11 ASTM C578 - Rigid, Cellular Polystyrene Thermal Insulation.
.12 ASTM C585 - Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System).
.13 ASTM C591 - Unfaced Preformed Cellular Polyisocyanurate Thermal Insulation.
.14 ASTM C610 - Moulded Expanded Perlite Block and Pipe Thermal Insulation.
.15 ASTM C921 - Properties of Jacketing Materials for Thermal Insulation.

1.4 SUBMITTALS

.1 Product Data: Provide product description, list of materials and thickness for each service, and locations.
.2 Manufacturer's Installation Instructions: Indicate procedures which ensure acceptable workmanship and installation standards will be achieved.

1.5 QUALITY ASSURANCE

.1 Materials: Flame spread/smoke developed rating of 25/50 or less to ULC S102 and ASTM E84.

1.6 QUALIFICATIONS

.1 Applicator: Company specializing in performing the work of this section with minimum three years experience.

1.7 DELIVERY, STORAGE, AND HANDLING

.1 Transport, handle, store, and protect products.
.2 Deliver materials to site in original factory packaging, labelled with manufacturer's identification, including product density and thickness.
.3 Store insulation in original wrapping and protect from weather and construction traffic.
.4 Protect insulation against dirt, water, chemical, and mechanical damage.

1.8 ENVIRONMENTAL REQUIREMENTS

.1 Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.

.2 Maintain temperature during and after installation for minimum period of 24 hours.

2 Products

2.1 GLASS FIBRE

.1 Manufacturers:
- .1 Manufacturer: Owens Corning Fiberglas

.2 Other acceptable manufacturers offering equivalent products:
- .1 Manson
- .2 Knauf Fiber Glass
- .3 Schuller

.2 Insulation: ASTM C547; rigid moulded, noncombustible.
- .1 'ksi' value : ASTM C335, 0.035 at 75°F (24°C).
- .2 Minimum Service Temperature: -20°F (-28.9°C).
- .3 Maximum Service Temperature: 302°F (150°C).
- .4 Maximum Moisture Absorption: 0.2 percent by volume.

.3 Vapour Barrier Jacket
- .1 ASTM C921, White kraft paper reinforced with glass fibre yarn and bonded to aluminized film.
- .2 Moisture Vapour Transmission: ASTM E96; 0.02 perm.
- .3 Secure with self sealing longitudinal laps and butt strips.
- .4 Secure with outward clinch expanding staples and vapour barrier mastic.

.4 Tie Wire: 1.3 mm stainless steel with twisted ends on maximum 12" (300 mm) centres.

.5 Vapour Barrier Lap Adhesive
- .1 Compatible with insulation.

.6 Insulating Cement/Mastic
- .1 ASTM C195; hydraulic setting on mineral wool, VOC content not to exceed 80 g/L.

.7 Fibrous Glass Fabric
- .1 Cloth: Untreated; 9 oz/sq yd (305 g/sq m) weight.
- .3 Blanket: 1.0 lb/cu ft (16 kg/cu m) density.

.8 Indoor Vapour Barrier Finish
- .1 Vinyl emulsion type acrylic, compatible with insulation, white colour, VOC content not to exceed 250 g/L.

.9 Outdoor Vapour Barrier Mastic
- .1 Vinyl emulsion type acrylic, compatible with insulation, white colour.

.10 Insulating Cement
- .1 ASTM C449, VOC content not to exceed 80 g/L.

2.2 PHENOLIC INSULATION

.1 Manufacturers:
- .1 Manufacturer: Resolco International bv "Insul-Phen"
- .2 Other Manufacturers: in accordance with 15010.2.3

.2 Insulation: ASTM C-1126 Phenolic Foam Thermal Insulation, CFC and HCFC free, rigid moulded, noncombustible insulation fabricated in required shapes by Resolco International approved fabricators to ASTM C-450 and C-585.
- .1 Density: 2.5-lb/ft^3 (40-kg/m^3)
- .2 Temperature range: -290°F to +250°F (-129°C to +107°C)
- .3 Closed cell content: 92%
- .4 Compressive strength: 29 psi (2 bar)
- .5 Thermal conductivity: 0.13 BTU-in/hr-ft2-°F (18.72 W-mm/m^2-°C)
- .6 Fire resistance rating: 25/50 to ASTM E84 on plain and faced product up to 3" (75mm) Thick

.3 Joint Sealer:

.1 vapour barrier type, moisture and water resistant, 97% solids by weight, non-hardening, flexible in temperature range from -5°F to +200°F (-20.5°C to +93.3°C), Daxcel 161D, Fosters 30-45, Childers CP-76.

.4 Vapour Barrier Mastic / Reinforcing:

.1 Vimasco Vapor-Block, Fosters 30-80, #749 or Childers' Chil-Perm #SP-35, or aproved equal with the following minimum requirements:

.1 Wet Fammability: No flash to boiling

.2 Water Vapor Permeance: Maximum 0.08 US perms

.3 Average Non Volatile: 58% by volume

.4 Service Temperature Range: -20°F to +190°F (29°C to 88°C)

.5 Application: Two Coats

.2 The membrane for reinforcement of vapor retardant mastic shall be 6 X 6 or 10 X 10 glass fiber reinforcing mesh, Chil Glas #5 made by Chilers or PC-79 Fabric, 5 X 6 mesh, by Pittsburgh Corning, or approved equal.

.5 Vapour Barrier (Indoor Service)

.1 Vapor barrier for indoor service shall be ASJ All Service Jacket as manufactured by Compac Corp or Lamtec Corp as per the Resolco UL E84 test reports, constructed from 0.009 mm thick aluminum foil laminated to 30lb. Kraft paper by flame retardant adhesive (VOC content not to exceed 650 g/L for clear or 350 g/L for pigmented). The complete laminated product shall be reinforced with tri directional fiberglass yarn with yarn spacing of 5 per inch.

.2 Venture 1555U factory applied zero perm jacket system shall be used in areas of high humidity or where there is a risk of mould/mildew growth.

.3 In areas of heavy mechancal abuse or high pressure wash down areas use product for Outdoor Service.

.6 Vapour Barrier (Outdoor Service)

.1 The vapor barrier used to seal any plain pipe insulation for outdoor service prior to application of cladding shall be Polyguard Insulrap 30 rubberized bitumen adhesive laminated to a 4 mil polyethylene film. Total thickness shall be 30 mils (0.76mm), permeance; 0.015 max, or approved equal.

.2 Polyguard 650 LT Liquid Adhesive is required at appliaction temeratures below 50°F (10°C) or with dusty insulation surfaces. As an alternative to the use of Liquid Adhesive, a light pass may be made with a heat gun over the face of the adhesive mass, just prior to application.

.3 Peel & Seal, self-stick, aluminum embossed finish; by Polyguard Products may be considered as an alternative, outdoors. It eliminates the need for metal cladding, however, it is recommended for installation above +60°F (+16°C) and in no case, below +40°F (4°C).

.4 All outdoor jacket systems shall be banded using 1/2" (12 mm) aluminum banding with wing seals at 12" (300 mm) centers.

.7 Fabrication Adhesive

.1 Fabriaction adhesive for Insul-Phen shall be H.B. Fuller's SC-1454, a contact adhesive or H.B. Fuller's HL-2278, hot melt adhesive, or approved equal.

.8 Pipe and Hanger Supports

.1 Pipe suport load bearing insulation shall be fabricated by a Resolco approved fabricator from Resolco CFC & HCFC free heavy density Insul-Phen in 3.75lb/ft^3 density in accordance with the table in attachment 1. The upper 1870° section of the support can be fabricated from standard 2.5lb./ft^3 density Insul-Phen and 2.5lb./ft^3 can be used at the support point up to a certain pipe diameters (contact your local Resolco fabricator or technical rep) with a 12" (300 mm) long saddle.

.2 The pipe support insulation shall be supported by a saddle. Stainless steel saddles shall be used where edible food or open product is exposed. For all other applications it is acceptable to use painted, galvanied or carbon steel.

.9 PVC Cladding (Indoor Use only)

.1 The jacketing to provide protection to insluation and vapor barrier shall be 0.030" (0.8 mm) thick Ceel-Co 300 Series UVR PVC Jacketing or Proto LoSmoke 25/50 UVR PVC. Jacketing shall be tough all purpose, UV resistant capable of enduring frequent washing with hot water or other cleaning agents. All joints of PVC jacket shall be solvent welded with Ceeltite or Proto PVC Adhesive. As an alternative a high density (3.75lb) phenolic along with 0.020 PVC jacket can be used.

.2 Ceel-Co 300 Series or Proto LoSmoke UVR PVC Jacket .040" (1 mm), or a double wrap of .030" (0.8 mm) thick shall be used where protection from mechancal abuse or high pressure washing is required.

.3 A stainless steel diamond-mesh expanded metal lath cage shall be installed with spacers a minimum of 1" (25 mm) away from and over top of the pipe and insulation sealed with PVC Jacket in areas where it is possible for knives, etc. to damage jacket system.

.4 In food preparation/hygenic areas cladding must withstand scalding water washdowns; wherever a higher temperature material is required: Proto EXOD (R), a CPVC material, light grey and is rated to +225°F (107°C). EXOD (R) shall be ordered "cut and precurled" for pipe insulation jacket.

.10 Aluminum Cladding (Outdoor Use only)

.1 The metal cladding weather barrier to provide protection from weather, mechanical wear or other damage shall be aluminum alloys 3003, 1100 or 3105 meeting ASTM B209 with H-14 temper, 0.016" (0.4 mm) thick with Polysurlyn moisture barrier on the back side. Themetal jacketing shall be RPR Incul-mate, Childers Products or approved equal.

.2 .016 inch thick aluminum is acceptable for all piping except where excessive abuse is anticipated; use .024" (6 mm) thick. .024" (6 mm) thick shall be used on all equipment as minimum, however .032" (8 mm) thick is preferred.

.3 The metal cladding where frequent washing is antcipated, shall be smooth for all piping and horizontal equipment and 1-1/4" (30 mm) corrugated for all vertical equipment above 30" (762 mm) insulation OD. Stucco embossed finish may be used for other areas.

.4 Where foot traffic is likey and increased strength of jacket is necessary use rolls of pipe jacketing; Childers Corrolon or RPR Rib-Cor, 3/16" (0.2 mm) corrugated in the circumferential direction

.11 Fastening Accessories

.1 Tape for fastening plain pipe covering insulation shall be 3/4" (20 mm) Fiberglass reinforced strapping tape made by National Tape Co. or apporved equal.

.2 Stainless steel type T304/T316 or .020 aluminum strapping for fastening aluminum jacketing outdoors and outer layer of vessel and/or large diameter (above 16 inches O.D.) pipe insulation shall be 1/2" x .020" (15 mm x .5 mm) thick with stainless steel or aluminum wing seals made by RPR Products, Childers Products or approved equal. RPR no. 7 or breather spring 4 inches long made from stainless steel type T305 shall be used for securing large diameter vessels metal jacketing.

.3 Polypropylene 1/2" (15 mm) wide, 1/2" (15 mm) thick banding and clips, Q-Band/Q-Clip made by Band-It Inc. shall be used for securing PVC jaceting indoors. The banding shall not be used in food processing areas where bacterial growth is anticipated. Banding may be used for temporary securement until PVC joint adhesive cures. The PVC Jacketing must be complete sealed at all joints to prevent entry of water or moisture. In non food processing areas PVC jacketing should be glued using manufacturers adhesive(VOC content not to exceed 510g/L).

.12 Inspection Plugs

.1 NDT Inspection plugs made from EPDM and aluminum metal cap as manufactured by Parker Special Products shall be installed on pipe and equipment requiring frequent inspections. Use 1-1/2" (40 mm) NDT plug for pipe and equipment insulation jacket OD of less than 9" (225 mm). Use 2-1/2" (65 mm) and 3" (75 mm) NDT plug for pipe and equipment between 9" (225 mm) and 24" (600 mm) insulation jacket OD. Use 5" (125 mm) NDT plug for pipe and equipment insulation jacket OD above 24" (600 mm).

.13 Expansion/Contraction Joints

.1 Expansion/contraction joint material shall be 1lb/ft^3 density fiberglass blanket.

2.3 JACKETS

.1 PVC Plastic

.1 Jacket: ASTM C921, One piece moulded type fitting covers and sheet material.

.1 Minimum Service Temperature: -31°F (-35°C).

.2 Maximum Service Temperature: 151°F (66°C).

.3 Moisture Vapour Transmission: ASTM E96; 0.03 perm inches.

.4 Maximum Flame Spread: ASTM E84; 25 or less.

.5 Maximum Smoke Developed: ASTM E84; 50 or less.

.6 Thickness: 20 mil (0.4 mm) minimum.

.2 Colour: standard off-white **OR** coloured to suit pipe identification.

.3 Covering Adhesive Mastic

.1 Compatible with insulation, maximum VOC content of 50 g/L.

.4 Manufacturer;

.1 Ceel-Co 300 series

.2 Speedline *Smoke Safe*

.2 Aluminum Jacket: ASTM B209.

.1 Thickness: 0.02" (0.40 mm) sheet.

.2 Finish: Smooth.

.3 Joining: Longitudinal slip joints and 2" (50 mm) laps.

.4 Fittings: 0.02" (0.40 mm) thick die shaped fitting covers with factory attached protective liner.

.5 Metal Jacket Bands: 3/8" (10 mm) wide; 0.01" (0.38 mm) thick aluminum.

2.4 REMOVABLE / REUSABLE INSULATION COVERS

.1	Material:	Teflon coated, woven fibreglass fabric
.2	Weight:	16.5 oz/sq.yd. (± 10%)
.3	Thickness:	0.015" (± 10%)
.4	Colour:	Gray
.5	Tensile Strength:	400 x 330 lb. (W x F)
.6	Tarp Tear strength:	60 x 40 lb. (W x F)
.7	Mullen Burst Pressure:	650 psi
.8	Insulation thickness:	Match connecting piping
.9	Temperature Range:	-67°F to 500°F
.10	Lacing Hooks:	Stainless Steel
.11	Tie Wire:	16-ga stainless steel

2.5 ACCESSORIES

.1 Adhesives and finishes shall be as recommended by the insulation manufacturer and shall comply with Section 15100.2.2. Accessories such as adhesives, mastics and cements shall have the same properties as listed above and shall not detract from any of the system ratings specified.

.2 Vapor retarder lap adhesive shall be water based, fire retardant

.3 Tapes shall be of cloth reinforced aluminum, soft adhesive with minimum 2" (50 mm) width.

.4 Tie wire shall be of 1/16" (1.5 mm) ø stainless steel.

.5 Fasteners shall be of 1/8" (4 mm) Ø pins, with 35 mm square clips. Clip length to suit insulation thickness.

.6 Bands shall be 1/2" (12 mm) wide 1/4" (6mm) thick galvanized steel.

.7 Facing shall be of 1" (25 mm) galvanized steel hexagonal wire mesh attached on both faces of insulation.

2.6 CELLULAR GLASS

.1 Manufacturer: Pittsburgh Corning FOAMGLAS.
.2 Insulation: ASTM C552 "Standard Specification for Cellular Glass Thermal Insulation",
  .1 'k' Value: 0.039 at 24 degrees C.
  .2 Maximum Service Temperature: 482 degrees C.
  .3 Maximum Water Vapour Transmission: 0.1 perm.
  .4 Maximum Moisture Absorption: ASTM C240, 0.2% by volume.
  .5 Density: 128 kg/cu m.
.3 FOAMGLAS® pipe insulation shall be fabricated according to the requirements of ASTM C1639 "Standard Specification for Fabrication of Cellular Glass Pipe and Tubing Insulation".

3 Execution

3.1 EXAMINATION

.1 Verify that piping has been tested before applying insulation materials.
.2 Verify that surfaces are clean, foreign material removed, and dry.

3.2 INSTALLATION

.1 Install piping insulations to TIAC National Installation Standards.
.2 Apply insulation materials, accessories, jackets and finishes in accordance with manufacturer' written instructions and as specified.
.3 On exposed piping, locate insulation and cover seams in least visible locations.
.4 Insulated dual temperature pipes or cold pipes conveying fluids below ambient temperature:
  .1 Provide vapour barrier jackets, factory applied or field applied.
  .2 Insulate fittings, joints, and valves with moulded insulation of like material and thickness as adjacent pipe.
  .3 Finish with glass cloth and vapour barrier adhesive.
  .4 PVC fitting covers may be used.
  .5 Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations.
  .6 Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.
.5 For insulated pipes conveying fluids above ambient temperature:
  .1 Provide standard jackets, with or without vapour barrier, factory applied or field applied.
  .2 Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe.
  .3 Finish with glass cloth and adhesive.
  .4 PVC fitting covers may be used.
  .5 For hot piping conveying fluids 140°F (60°C) or less, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation.
  .6 For hot piping conveying fluids over 140°F (60°C), insulate flanges and unions at equipment.
.6 Inserts and Shields:
  .1 Application: Piping 1-1/2" (40 mm) diameter or larger.
  .2 Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.
  .3 Insert Location: Between support shield and piping and under the finish jacket.
  .4 Insert Configuration: Minimum 6" (150 mm) long, of same thickness and contour as adjoining insulation; may be factory fabricated.
  .5 Insert Material: hydrous calcium silicate insulation.
.7 Finish insulation at supports, protrusions, and interruptions.
.8 Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass mesh reinforced vapour barrier cement.
.9 Provide integral vapour barrier jacket on insulation on pipe and fittings for exterior applications.
.10 Provide PVC jacket and fitting covers for pipe in mechanical equipment rooms and where exposed in finished spaces.

.12 Provide aluminum jacket and fitting covers with seams located on bottom side of horizontal piping for exterior applications, in boiler rooms and where subject to temperatures > 200°F (93°C).

.11 For buried piping, provide factory fabricated assembly with inner all-purpose service jacket with self sealing lap, and asphalt impregnated open mesh glass fabric, with one mil (0.025 mm) thick aluminum foil sandwiched between three layers of bituminous compound; outer surface faced with a polyester film.

.12 For heat traced piping, insulate fittings, joints, and valves with insulation of like material, thickness, and finish as adjoining pipe. Size large enough to enclose pipe and heat tracer. Cover with aluminum jacket with seams located on bottom side of horizontal piping.

3.3 TOLERANCE

.1 Substituted insulation materials: Thermal resistance within 10 percent at normal conditions, as materials indicated.

3.4 PIPE INSULATION

.1 Insulate new or altered piping with rigid pipe insulation and re-insulate existing piping where insulation has been removed or damaged as follows:

Service	**Operating Temperature Range °F (°C)**	**Pipe Diameter in. (mm)**	**Insulation Thickness in. (mm)**
Cold water (outside building)	0 to 850 (-18 to 454)	All sizes	2 (50)
Condensate (cold)	0 to 850 (-18 to 454)	All sizes	1/2 (13)
Domestic cold water	0 to 850 (-18 to 454)	All sizes	1 (25)
Domestic hot water & hot water recirculation	105 (41) and higher	2 (50) and smaller 2-1/2 (65) and larger	1 (25) 1-1/2 (40)
Sanitary drainage	40 to 55 (4 to 13)	All sizes	1 (25)
Storm drainage	40 to 55 (4 to 13)	All sizes	1 (25)
Hydronic heating (hot water gn glycol/water	105 to 140 (41 to 60) 105 to 140 (41 to 60) 141 to 200 (61 to 93)	4 (100) and smaller 5 (125) and larger All sizes	1 (25) 1-1/2 (40) 1-1/2 (40)

Note: Phenolic insulation may be used in place of rigid fibreglass pipe insulation, thickness to provide equivalent thermal resistance.

.2 Insulate with flexible insulation as follows:

Service	Thickness
Horizontal storm and sanitary drainage	1" (25 mm)

.3 Insulate valves, flanges and pipe connections with removable / reusable insulation covers.

.4 Wrap butt joints with a 4" (100 mm) strip of fire resistant vapour barrier jacket cemented with lagging adhesive.

.5 Where the pipe hanger is around the insulation, provide an insulation protection shield within the pipe saddle. Coordinate with installation of hangers.

.6 Insulate all fittings, flanges and valves on pipes to provide equivalent insulation to that on adjoining pipe.

.7 Continue insulation through sleeves including specified finish.

.8 Cut back covering on strainers and finish off to expose removable head insulation.

.9 Cover expansion joints first with 24 gauge (0.7 mm) galvanized metal sleeve and then insulate to provide equivalent thickness to that on adjoining pipe.

.10 Protect insulation with protection saddles where insulated pipe is supported by rollers.

.11 Insulate pipe hangers supporting new piping carrying water at 70°F (21°C) or less to prevent condensation. Extend insulating material along hanger rod to height 4 times thickness of insulation. Seal insulation with vapourproof sealant.

.12 Extend pipe insulation and covering through walls, floors, ceilings, and concrete beams, unless indicated otherwise on drawings. protect exposed insulation extending through floors with 4" (100 mm) wide strip of 18 gauge (1.3 mm) galvanized iron.

.13 Pack annular space between pipe sleeves and piping or pipe covering with glass fibre insulation or rockwool insulation. In fire rated assemblies use Dow Silicon RTV or other ULC listed materials. Seal exposed insulation with mastic.

.14 Recover exposed surfaces of insulated piping installed in exposed areas, mechanical rooms, and equipment rooms with PVC jacketing and PVC fitting covers installed in accordance with manufacturers instructions.

.15 Insulate and cover exposed surfaces of waste connections, traps, hot and cold supply risers and valves at each lavatory and sink designated for "handicapped" or "barrier free" use with: PVC insulated fitting covers specifically designed for this application. Vinyl material is not to exceed flame spread rating of 150, and if intended to be used in high buildings, its smoke developed classification does not exceed 300. Zeston or other equivalant material. or foamed plastic type insulation finished with two coats of Armstrong Armflex or other equivalent material.

.16 Provide aluminum metal cladding over the insulation on the following services;

.1 All exposed piping located outdoors.

.17 Insulate sprinkler and standpipe main from take-off from domestic water to a point approximately 6 feet (1800 mm) after electrically supervised valve.

.18 Oversize insulation of Domestic hot water piping complete with heating cable for pipe sizes 1-1/4" (35 mm) dia. and smaller by 1/4" (6 mm) in inside diameter to allow for installation over heating cable.

.19 **ALL EXPOSED HYDRONIC PIPING IN THE BOILER ROOMS / MECHANICAL ROOM SHALL HAVE PVC COVERING ON THE INSULATION WITH PROPER PVC WHITE COLOR ELBOW COVERING ETC**.

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End of Section

1 General

1.1 GENERAL REQUIREMENTS

.1 Comply with General Requirements of Section 15010.

1.2 SECTION INCLUDES

.1 Duct work insulation.
.2 Insulation jackets.

1.3 REFERENCES

.1 Section 23 01 01: Requirements for references and standards.
.2 ASTM B209 - Aluminum and Aluminum-Alloy Sheet and Plate.
.3 ASTM C518 - Steady-State Thermal Transmission Properties by Means of the Heat Flow Metre Apparatus.
.4 ASTM C553 - Standard Specification for Mineral Fibre Blanket Thermal Insulation for Commercial and Industrial Applications.
.5 ASTM C612 - Standard Specification for Mineral Fibre Block and Board Thermal Insulation.
.6 ASTM C921 - Properties of Jacketing Materials for Thermal Insulation.
.7 ASTM C1071 - Fibrous Glass Duct Lining Insulation(Thermal Sound Absorbing Material).
.8 ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
.9 ASTM E96 - Water Vapour Transmission of Materials.
.10 ASTM E162 - Standard Test Method for Surface Flammability of Materials Using a Radiant Heat Energy Source.
.11 ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
.12 NAIMA National Insulation Standards.
.13 NFPA 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials.
.14 SMACNA - HVAC Duct Construction Standards - Metal and Flexible.
.15 UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials.
.16 CGSB-Canadian General Standards Board.
.17 CAN/CGSB-51.9 Mineral Fiber Thermal Insulation for Piping and Round Ducting.
.18 CAN/CGSB-51.10 Mineral Fiber Board Thermal Insulation
.19 CAN/CGSB-51.11 Mineral Fiber Thermal Insultation Blanket.
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1.4 SUBMITTALS FOR REVIEW

.1 Section 15010: Procedures for submittals.
.2 Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.

1.5 SUBMITTALS FOR INFORMATION

.1 Section 15010: Procedures for submittals.
.2 Manufacturer's Instructions: Indicate installation procedures which ensure acceptable workmanship and installation standards will be achieved.

1.6 QUALITY ASSURANCE

.1 Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
.2 Applicator Qualifications: Company specializing in performing the work of this section with minimum 6 years documented experience.

1.7 REGULATORY REQUIREMENTS

.1 Materials: Flame spread/smoke developed rating of 25/50 to the requirements of the Ontario Building Code.

1.8 DELIVERY, STORAGE, AND PROTECTION

.1 Section 15010: Transport, handle, store, and protect products.
.2 Accept materials on site in original factory packaging, labelled with manufacturer's identification, including product density and thickness.
.3 Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

1.9 ENVIRONMENTAL REQUIREMENTS

.1 Section 15010: Environmental conditions affecting products on site.
.2 Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.
.3 Maintain temperature during and after installation for minimum period of 24 hours.

2 Products

2.1 GLASS FIBRE, FLEXIBLE

.1 Manufacturer: Owens Corning Fiberglas
.2 Other acceptable manufacturers offering equivalent products:
  .1 Manson
  .2 Knauf Fiber Glass
  .3 Schuller
3 Insulation: ASTM C553; flexible, noncombustible blanket.
  .1 'ksi' value : ASTM C518,0.045 at 75.2 °F (24 °C).
  .2 Maximum service temperature: 250 °F (121 °C).
  .3 Maximum moisture absorption: 0.20 percent by volume.
.4 Vapour Barrier Jacket:
  .1 Kraft paper with glass fibre yarn and bonded to aluminized film.
  .2 Moisture vapour transmission: ASTM E96; 0.02 perm.
  .3 Secure with pressure sensitive tape.
.5 Vapour Barrier Tape:
  .1 Kraft paper reinforced with glass fibre yarn and bonded to aluminized film, with pressure sensitive rubber based adhesive.
.6 Outdoor Vapour Barrier Mastic:
  .1 Vinyl emulsion type acrylic or mastic, compatible with insulation, black colour.
.7 Tie Wire: Annealed steel, 1/16" (1.5 mm).

2.2 GLASS FIBRE, RIGID

.1 Manufacturer: Owens Corning Fiberglas Model Vapour-Seal.
.2 Other acceptable manufacturers offering equivalent products:
  .1 Manson
  .2 Knauf Fiber Glass
  .3 Schuller
  .4 Substitutions: Refer to Section 01 62 00.
.3 Insulation: ASTM C612; rigid, noncombustible blanket.
  .1 'ksi' value : ASTM C518,0.036 at 75.2 °F (24 °C).
  .2 Maximum service temperature: 250 °F (121 °C).
  .3 Maximum moisture absorption: 0.20 percent by volume.

.4 Density: 48 kg/cu m.

.4 Vapour Barrier Jacket:
- .1 Kraft paper with glass fibre yarn and bonded to aluminized film.
- .2 Moisture vapour transmission: ASTM E96; 0.04 perm.
- .3 Secure with pressure sensitive tape.

2.3 JACKETS

.1 Canvas Jacket: UL listed.
- .1 Fabric: ASTM C921, 220 g/sq m, plain weave cotton treated with dilute fire retardant lagging adhesive.
- .2 Lagging Adhesive: Compatible with insulation.

.2 Mineral Fibre (Outdoor) Jacket: Asphalt impregnated and coated sheet, 2.45 kg/sq m.

.3 PVC Jacket (Indoor):
- .1 Jacket: ASTM C921, One piece sheet material.
  - .1 Minimum Service Temperature: -31 °F (-35 °C).
  - .2 Maximum Service Temperature: 150 °F (66 °C).
  - .3 Moisture Vapour Transmission: ASTM E96; 0.03 perm inches.
  - .4 Maximum Flame Spread: ASTM E84; 25 or less.
  - .5 Maximum Smoke Developed: ASTM E84; 50 or less.
  - .6 Thickness: 20 mil (0.4 mm) minimum.
- .2 Colour: standard off-white **OR coloured to suit duct identification**
- .3 Covering Adhesive Mastic
  - .1 Compatible with insulation, maximum VOC content of 50 g/L.
- .4 Manufacturer;
  - .1 Ceel-Co 300 series
  - .2 Speedline *Smoke Safe*

.4 Aluminum Jacket: ASTM B209M.
- .1 Thickness: 0.40 mm sheet.
- .2 Finish: Smooth.
- .3 Joining: Longitudinal slip joints and 2" (50 mm) laps.
- .4 Fittings: 0.4 mm thick die shaped fitting covers with factory attached protective liner.
- .5 Metal Jacket Bands: 3/8" (10 mm) wide; 0.015" (0.38 mm) thick aluminum.

2.4 ACCESSORIES

.1 Adhesives and finishes shall be as recommended by the insulation manufacturer and shall comply with Section 15100.2.2. Accessories such as adhesives, mastics and cements shall have the same properties as listed above and shall not detract from any of the system ratings specified.

.2 Vapor retarder lap adhesive shall be water based, fire retardant

.3 Tapes shall be of cloth reinforced aluminum, soft adhesive with minimum 2" (50 mm) width.

.4 Tie wire shall be of 1/16" (1.5 mm) ø stainless steel.

.5 Fasteners shall be of 1/8" (4 mm) Ø pins, with 35 mm square clips. Clip length to suit insulation thickness.

.6 Bands shall be 1/2" (12 mm) wide 1/4" (6mm) thick galvanized steel.

.7 Facing shall be of 1" (25 mm) galvanized steel hexagonal wire mesh attached on both faces of insulation.

3 Execution

3.1 EXAMINATION

.1 Verify that ductwork has been tested before applying insulation materials.
.2 Verify that surfaces are clean, foreign material removed, and dry.

3.2 INSTALLATION

.1 Install duct insulations to TIAC National Installation Standards.
.2 Apply insulation materials, accessories, jackets and finishes in accordance with manufacturer' written instructions and as specified.
.3 Insulated ductwork conveying air below ambient temperature:
  .1 Provide insulation with vapour barrier jackets.
  .2 Finish with tape and vapour barrier jacket.
  .3 Continue insulation through walls, sleeves, hangers, and other duct penetrations.
  .4 Insulate entire system including fittings, joints, flanges, fire dampers, flexible connections, and expansion joints.
.4 Insulated ductwork conveying air above ambient temperature:
  .1 Provide with or without standard vapour barrier jacket.
  .2 Insulate fittings and joints. Where service access is required, bevel and seal ends of insulation.
.5 Ductwork Exposed in Mechanical Equipment Rooms or Finished Spaces below 3 metres above finished floor: Finish with canvas jacket sized for finish painting.
.6 Exterior Applications: Provide insulation with vapour barrier jacket. Cover with outdoor jacket finished as specified**.**
.7 External Duct Insulation Application:
  .1 Secure insulation with vapour barrier with wires and seal jacket joints with vapour barrier adhesive or tape to match jacket.
  .2 Secure insulation without vapour barrier with staples, tape, or wires.
  .3 Install without sag on underside of duct work. Use adhesive or mechanical fasteners where necessary to prevent sagging. Lift duct work off trapeze hangers and insert spacers.
  .4 Seal vapour barrier penetrations by mechanical fasteners with vapour barrier adhesive.
  .5 Stop and point insulation around access doors and damper operators to allow operation without disturbing wrapping.
.8 Duct and Plenum Liner Application:
  .1 Adhere insulation with adhesive for 90 percent coverage.
  .2 Secure insulation with mechanical liner fasteners. Refer to SMACNA Standards for spacing.
  .3 Seal and smooth joints. Seal and coat transverse joints.
  .4 Seal liner surface penetrations with adhesive.
  .5 Duct dimensions indicated are net inside dimensions required for air flow. Increase duct size to allow for insulation thickness.

3.3 DUCT INSULATION

.1 Insulate new or altered ductwork and re-insulate existing ductwork where insulation has been removed or damaged as follows:

Service	Type	Thickness
Air supply rectangular	rigid	1" (25 mm)
Air supply round	flexible	1" (25 mm)
Exhaust 6' (2m) from outside) rectangular	rigid	3" (75 mm)
Exhaust 6' (2m) from outside) round	flexible	3" (75 mm)
Fresh air intake rectangular	rigid	3" (75 mm)
Exhaust air plenums	rigid	3" (75 mm)
Ductwork outdoors	rigid	3" (75 mm)
Rectangular air supply runouts to terminal units <10' (3m) in length	rigid	1" (25 mm)
Round air supply runouts to terminal units <10' (3m) in length	flexible	1" (25 mm)
Duct mounted cooling coils	rigid	1 ½" (40 mm)

End of Section

1 General

1.1 GENERAL REQUIREMENTS

.1 Comply with General Requirements of Section 23 01 01.

1.2 SECTION INCLUDES

.1 Pipe and pipe fittings for:
- .1 Heating water piping system.
- .2 Equipment drains and overflows.

.2 Valves:
- .1 Gate valves.
- .2 Globe or angle valves.
- .3 Ball valves.
- .4 Check valves.
- .5 Circuit balancing valves
- .6 Drain valves.

1.3 REFERENCES

.1 ASME -Welding and Brazing Qualifications.
.2 ASME B16.3 - Malleable Iron Threaded Fittings Class 50 and 300.
.3 ASME B16.5 Pipe Pumps & Fittings.
.4 ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
.5 ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
.6 ASME B31.5 - Refrigeration Piping and Heat Transfer Components.
.7 ASME B31.1 - Code for Power Piping.
.8 ASTM A53/A53M - Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
.9 A183 Carbon Steel Track Bolts and Nuts.
.10 ASTM A234/A234M - Piping Fittings of Wrought-Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
.11 ASTM B32 - Solder Metal.
.12 ASTM B88 - Seamless Copper Water Tube.
.13 ASTM D1785 - Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
.14 ASTM D2235 - Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings.
.15 ASTM D2241 - Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR-Series).
.16 ASTM D2310 - Machine-Made Fibreglass' (Glass Fibre-Reinforced Thermosetting Resin) Pipe.
.17 ASTM D2466 - Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
.18 ASTM D2467 - Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
.19 ASTM D2680 - Acrylonitrile-Butadiene-Styrene (ABS) and Poly(Vinyl Chloride) (PVC) Composite Sewer Piping.
.20 ASTM D2683 - Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing.
.21 ASTM D2751 - Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings.
.22 ASTM D2855 - Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings.
.23 ASTM D3309 - Polybutylene (PB) Plastic Hot-and Cold-Water Distribution Systems.
.24 ASTM F477 - Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
.25 ASTM F708 - Design and Installation of Rigid Pipe Hangers.
.26 ASTM F876 - Crosslinked Polyethylene (PEX) Tubing.
.27 ASTM F877 - Crosslinked Polyethylene (PEX) Plastic Hot - and Cold - Water Distribution Systems.

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1.4 SUBMITTALS

.1 Product Data: Include data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalogue information. Indicate valve data and ratings.
.2 Welders Certificate: Include welders certification of compliance with ASME SEC 9.
.3 Manufacturer's Installation Instructions: Indicate hanging and support methods, joining procedures.

1.5 PROJECT RECORD DOCUMENTS

.1 Record actual locations of valves.

1.6 OPERATION AND MAINTENANCE DATA

.1 Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.

1.7 QUALIFICATIONS

.1 Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
.2 Installer: Company specializing in performing the work of this section with minimum 3 years documented experience.
.3 Welders: Certify to ASME SEC 9.

1.8 REGULATORY REQUIREMENTS

.1 Conform to ASME B31.9 code for installation of piping system.
.2 Welding Materials and Procedures: Conform to ASME SEC 9 and applicable provincial labour regulations.
.3 Provide certificate of compliance from authority having jurisdiction indicating approval of welders.

1.9 DELIVERY, STORAGE, AND HANDLING

.1 Accept valves on site in shipping containers with labeling in place. Inspect for damage.
.2 Provide temporary protective coating on cast iron and steel valves.
.3 Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
.4 Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.10 ENVIRONMENTAL REQUIREMENTS

.1 Do not install underground piping when bedding is wet or frozen.

1.11 EXTRA MATERIALS

.1 Provide two repacking kits for each size and valve type.

2 Products

2.1 VALVES - GENERAL

.1 Conform to requirements of ANSI, ASTM, ASME, and applicable MSS standards.
.2 Provide valves of the same manufacturer where possible.
.3 Manufacturer's name and pressure rating clearly marked on body to MSS-SP-25.
.4 Valid CRN (Canadian Registration Number) required for each valve.
.5 Materials:
- .1 Bronze: ASTM B62 or B61 as applicable
- .2 Brass: ASTM B283 C3770
- .3 Cast Iron: ASTM A126 Class B

.6 End Connections:
- .1 Threaded ends: ANSI B1.20.1
- .3 Flanged ends: ANSI B16.1 (Class 125), ANSI B16.5
- .4 Face-to-face dimensions: ANSI B16.10

.7 Design and Testing:
- .1 Bronze Gate & Check valves: MSS-SP-80
- .2 Ball Valves: MSS-SP-110
- .3 Cast Iron Gate Valves: MSS-SP-70
- .4 Cast Iron Globe Valves: MSS-SP-85
- .5 Cast Iron Check: MSS-SP-71
- .6 Butterfly Valves: MSS-SP-67

.8 First named product as indicated in paragraphs below; other acceptable manufacturers, subject to equivalent products include:
- .1 Kitz.
- .2 Crane, Jenkins
- .3 Conbraco.
- .4 Nibco

2.2 HYDRONIC SYSTEMS TO 150 PSIG, ABOVE GROUND

.1 Nominal Operating Pressure 125 psig
.2 Design Pressure 150 psig
.3 Test Pressure 225 psig
.4 Design Temperature 350°F
.5 Corrosion Allowance 0.0625 in.
.6 Steel Pipe ASTM A53 Gr. B or ASTM A106 Gr. B, schedule 40, black steel, seamless
.7 Joints, 2" and smaller screwed
.8 Screwed Fittings 150 Lb. malleable iron
.9 Unions Cl.150, ASTM A-47 malleable iron, ASTM A-153 galvanized, ANSI B2.1 threads.
.10 Joints, 2-1/2" and larger welded, with flanges at connections to equipment
.11 Butt weld fittings ASTM A234 Gr. WFB
.12 Flanges ASTM A105, Class 150, raised face, weld neck or slip on
.13 Bolts ASTM A307 C.S. bolts, sq. head; ASTM A563 nuts, hex head
.14 Gaskets 1/16" (1.6 mm) thick preformed non-asbestos graphite fibre.
.15 Copper Tubing, 2" and Smaller ASTM B88, Type L, hard drawn.
.16 Joints: Solder, lead free, ASTM B32, 95-5 tin-antimony, or tin and silver, with melting range 220°C to 280°C.
.17 Fittings: ASME B16.18, cast brass, or ASME B16.22, solder wrought copper
.18 Dielectric Unions Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.
.19 Valves, 2" and smaller ASTM A105
Gate Valves (Isolating) 300 psig non-shock WOG, ASTM B62 bronze body, solid wedge disc, rising stem, bronze trim, threaded ends, Kitz #25

	Globe Valves (Throttling)	300 psig non-shock WOG, ASTM B62 bronze body, composition (Teflon) disc, rising stem, bronze trim, threaded ends, Kitz #09
	Check Valves (Backflow)	300 psig non-shock WOG, ASTM B62 bronze body, Y-pattern horizontal, swing type disc, threaded ends, Kitz #29
	Ball Valves (Drain)	600 psig non-shock WOG, forged brass, 2-piece, chrome ball and stem, full port, blow-out proof PTFE seats & stem, lever handle, threaded ends, Kitz #68AC.

.20 Valves, 2-1/2" and larger ASTM A216 WCB

Gate Valves (Isolating)	200 psig non-shock WOG, ASTM A126 Class B cast iron body, bolted bonnet, bronze mounted, solid wedge disc, OS&Y, non-asbestos packing, flanged ends, Kitz #72.
Globe Valves (Throttling)	200 psig non-shock WOG, ASTM A126 Class B cast iron body, bolted bonnet, bronze mounted, bevelled wedge disc, OS&Y, non-asbestos packing, flanged ends, Kitz #76.
Check (Backflow)	200 psig non-shock WOG, ASTM 126 Class B cast iron body, bolted cover, bronze mounted, swing type disc, flanged ends, Kitz #78

.21 Provide stem extensions for insulated piping.

.22 Provide gear operator and chain on valves installed above 10-ft AFF.

.23 Strainers, 2" and smaller screwed — Class 250, 400 psig WOG, cast iron body, Y-pattern, cap and ends, A167 304 stainless steel screen with 1/32" perforations. Mueller Steam 11M.

.24 Strainers, 2-1/2" and larger — Class 250 psig non-shock WOG, cast iron, Y-pattern, bolted flange cover, blow-out plug, A167 304 stainless steel screen with 1/32" perforations, flanged ends, Mueller Steam 752 .

2.5 EQUIPMENT DRAINS AND OVERFLOWS

.1 Copper Tubing: ASTM B88, Type M and DWV, hard drawn.

.1 Fittings: ASME B16.18, cast brass, or ASME B16.22 solder wrought copper.

.2 Joints: Solder, lead free, ASTM B32, 95-5 tin-antimony, or tin and silver, with melting range 4428°F to 536°F (220°C to 280°C).

2.6 CIRCUIT BALANCING VALVES

1. Circuit Balancing Valves; 2" (50 mm) and smaller)
   - .1 Screwed connection, globe style design, nonferrous, pressure die-cast, nonporous Ametal Copper Alloy. Each valve shall be such that when installed in any direction, it will not affect flow measurement.
   - .2 Valves shall provide the following functions:
     - .1 Precise flow measurement.
     - .2 Precision flow balancing.
     - .3 Positive shut off with no drip seat and teflon disc.
     - .4 Drain connection with protective cap.
   - .3 Valves shall have four 360° adjustment turns of handwheel for maximum vernier-type setting with "Hidden Memory" feature to program the valve with precision tamper-proof balancing setting.
   - .4 Valves shall be shipped in a 4.5 R factor polyurethane container that shall be used as insulation after valve in installed.
   - .5 Provide valves suitable for maximum working pressure of 250 psi (1720 kPa) and maximum operating temperature of 250°F (121°C).
   - .6 Acceptable Products: S.A. Armstrong CRV I indicated or Tour & Anderson STA-D or Newman Hattersley.
2. Circuit Balancing Valves 2 1/2" (65 mm) and larger
   - .1 Flanged, line size connection, globe style design, nonferrous, pressure die-cast, nonporous Ametal Copper Alloy.
   - .2 Valves, shall provide the following functions:
     - .1 Precise flow measurement.

.2 Precision flow balancing.

.3 Positive shut off with no drip seat and teflon disc.

.3 Valves shall have twelve 360° adjustment turns of handwheel for maximum vernier-type setting with "Hidden Memory" feature to program the valve with precision tamper-proof balancing setting.

.4 Valves shall be suitable for maximum working pressure of 250 psi (1720 kPa) and maximum operating temperature of 250°F (120°C).

.5 Acceptable Products: S.A. Armstrong CBV II indicated or Tour & Anderson STA-F or Newman Hattersley.

3 Execution

3.1 PREPARATION

.1 Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

.2 Remove scale and dirt on inside and outside before assembly.

.3 Prepare piping connections to equipment with flanges or unions.

.4 Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.

.5 After completion, fill, clean, and treat systems. Refer to Section 15515.

3.2 APPLICATIONS

.1 Where more than one piping system material is specified, ensure system components are compatible and joined to ensure the integrity of the system is not jeopardized. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.

.2 Where permitted, install grooved mechanical couplings and fasteners in accessible locations.

.3 Install unions, flanges, and couplings downstream of valves and at equipment or apparatus connections. Do not use direct welded or threaded connections to valves, equipment or other apparatus.

.4 Provide non-conducting dielectric connections whenever jointing dissimilar metals in open systems.

.5 Provide pipe hangers and supports to CSA B51 unless indicated otherwise.

.6 Use gate valves for shut-off and to isolate equipment, part of systems, or vertical risers.

.7 Use globe valves for throttling, bypass, manual flow control services, for balancing & in bypass around control valves.

.8 Use spring loaded check valves on discharge of condenser water pumps.

.9 Use wafer check valves where required to suit space and or weight limitations

.10 Use 3/4 inch (20 mm) gate or ball valves with cap and chain for drains at main shut-off valves, low points of piping, bases of vertical risers, and at equipment. Pipe to nearest floor drain.

.11 Use lug end butterfly valves to isolate equipment..

.12 Butterfly valves may be used isolation and throttling duty for large pipe sizes 2-1/2" (65 mm) and above.

.13 Gasket material shall be Grade 'E' EPDM compound conforming of ASTM D2-2000 and suitable for an operating temperature range of -34ºC to 110ºC.

.14 Small runouts, size 3/4" (20 mm) and less for extension of domestic make-up piping may be constructed using hand drawn copper tube type 'K' or "L" and comply to ASTM B88.

3.3 INSTALLATION

.1 Install to manufacturer's instructions.

.2 Install heating water, glycol, chilled water, condenser water piping to CSA B51.

.3 Route piping in orderly manner, parallel to building structure, and maintain gradient.

.4 Install piping to conserve building space, and not interfere with use of space.

.5 Group piping whenever practical at common elevations.

.6 Sleeve pipe passing through partitions, walls and floors.

.7 Slope piping and arrange to drain at low points.

.8 Install piping to allow for expansion and contraction without stressing pipe, joints, or connected

equipment.

.9 Inserts:
- .1 Provide inserts for placement in concrete formwork.
- .2 Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
- .3 Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4" (100 mm).
- .4 Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
- .5 Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.

.10 Pipe Hangers and Supports:
- .1 Install to CSA B51.
- .2 Support horizontal piping as scheduled.
- .3 Install hangers to provide minimum 1/2" (13 mm) space between finished covering and adjacent work.
- .4 Place hangers within 12" (300 mm) of each horizontal elbow.
- .5 Use hangers with 1-1/2" (38 mm) minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
- .6 Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.
- .7 Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
- .8 Provide copper plated hangers and supports for copper piping.
- .9 Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

.11 Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.

.12 Provide access where valves and fittings are not exposed.

.13 Slope piping and arrange systems to drain at low points. Use eccentric reducers to maintain top of pipe level.

.14 Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer (VOC content not to exceed 250 g/L) to welds.

.15 Prepare unfinished pipe, fittings, supports, and accessories, ready for finish painting.

.16 Install valves with stems upright or horizontal, not inverted.

.17 Air vents shall be selected to suit the system operating pressures and shall be automatic and complete with isolating vavles.

.18 All strainers 1-1/2" & larger shall be fitted with chain valves.

.19 Unless specified otherwise, drain piping shall be sloped down in the direction of flow not less than 1" in 40 feet.

.20 Eccentric reducers shall be provided to keep the bottom of sloped piping aligned in order to minimize risk of water hammer and to facilitate drainage.

.21 Valves shall be installed with stems upright or angled 45 deg. above horizontal unless instructed otherwise.

.22 Pipe all discharge from temp. & safety relief valves to a point of safe discharge directly into a floor drain, hub drain or safe outdoor location.

3.4 EQUIPMENT CONNECTIONS

.1 Install unions or flanges at connections to all equipment and specialty components.

.2 Arrange piping connections to allow ease of access and removal of equipment.

.3 Align and independently support piping adjacent to equipment connections in order to prevent piping stresses from being transferred to equipment.

.4 Piping reducers shall be used where equipment connections differ from pipe sizes indicated. The use of bushings will not be permitted.

.5 Install removable sections of pipe 12" (300 mm) spool pieces on the suction side of pumps and where needed for ease of maintenance.

3.5 VALVES, COCKS AND FAUCETS

.1 Use valves of line size unless noted otherwise.
.2 Provide isolating valves in each branch from the main line and where indicated.
.3 Provide isolating valves at all equipment connections.
.4 Provide globe valves or ball valves complete with memory stop at the discharge of each pump and where valves are used for regulating or throttling purposes.
.5 Provide 1/2" (13 mm) brass hose bibbs at all low points of each system, where the system cannot be drained through the main floor or return piping.
.6 Where new valves are installed to replace existing valves and it is impractical to shut-down and drain the entire system, valves shall be replaced using pipe freezing techniques.

3.6 HYDRONIC SPECIALTIES

.1 Air Vents
.1 Provide 1" (25 mm) diameter air vent chamber at each riser feeding terminal units. Install chambers as high as possible within unit, and provide manual air vent connected to air chamber by flexible tubing.
.2 Provide a float type automatic air vent at any high points of hot water supply and return piping not vented through a convector etc. and at high point of piping for each hot water coil. The discharge of air vent shall terminate over a floor drain in mechanical rooms or over a sink in service rooms. A shut-off valve shall be provided on each automatic air vent and an access door and frame shall be provided for air vents located above ceilings.
.2 Automatic Feed Valves: provide automatic feed valve on the cold water make-up line to each new hot water heating system.

.3 Air Cushion Tanks
.1 Provide air cushion tanks of size noted where indicated.
.2 Provide housekeeping pad for floor mounting of tank.
.3 Terminate drainout line at nearest funnel floor drain, or service sink.
.4 Adjust charge to system static pressure at point of connection plus 5 psi (35 kPa).
.4 Air Eliminators: provide an air eliminator at each new air cushion (expansion) tank.
.5 Circuit Balancing Valve (CBV): provide a CBV in each branch serving a heating and/or cooling terminal unit and where indicated on drawings. Installation shall be in accordance with manufacturer's installation instructions. Ensure that manufacturer's recommended clearances are maintained to minimize turbulence and to promote accuracy.
.6 Supply and install threaded couplings or half coupling for flow switches that are supplied under Section 15900.
.7 Install flow switches as supplied under Section 15900.

3.7 TESTING AND INSPECTION

.1 Test liquid heat transfer piping hydrostatically at not less than 150% of operating pressure or not less than 125 psi (860 kPa) whichever is the greater. Test period shall be not less than six (6) hours duration during which time each joint shall be inspected, given a sharp tap with a hammer and checked for leaks.
.2 Arrange and pay for inspection by authorities having jurisdiction.

3.8 ADJUSTING AND BALANCING

.1 Instruments used for this work shall be accurately calibrated and maintained in good working order, and shall include:
.1 one set of pressure gauges and fittings.
.2 dry bulb thermometer.
.3 wet bulb thermometer.
.4 thermocouple unit and thermocouple.
.5 set of balancing cock adjustment wrenches.
.6 portable field flow meter.
.2 Prepare the liquid heat transfer systems as follows:
.1 Install any additional devices required for effective balancing as advised by the Systems Verification Agency.

.2 Open all valves, and return line balancing cocks.
.3 Remove and clean all strainers.
.4 Check pump rotation.
.5 Check expansion tanks to make sure they are not air bound and that the system is full of water.
.6 Check all air vents at high points of water systems to make sure they are installed properly and are operating freely. Make certain all air is removed from circulating system.
.7 Set all temperature controls so that all coils are calling for full cooling. This should close all automatic bypass valves at coil and chillers. To balance hot water coils, set systems to call for full heating.
.8 Check operation of automatic bypass valve.
.9 Check and set operating temperature of heat exchangers to design requirements.

.3 Balance the liquid heat transfer systems as follows:
.1 Complete air balance must have been accomplished before water balance is begun.
.2 Set chilled water, hot water and glycol pumps to proper gpm delivery.
.3 Adjust flow of hot water through heat exchangers.
.4 Check leaving water temperatures and return water temperatures, and pressure drop through heat exchangers. Reset to correct design temperatures.
.5 Check water temperature at inlet side of cooling and heating coils. Note rise or drop of temperatures from source.
.6 Balance each chilled water and hot water coil.
.7 Upon completion of flow readings and coil adjustments, mark all settings and record all data.
.8 After making adjustments to coils, recheck settings at pumps, and heat exchangers. Readjust if required.
.9 Install pressure gauges on each coil, then read pressure drop through coil at set flow rate on call for full cooling and full heating. Set pressure drop across bypass valve to match coil full flow pressure drop. This prevents unbalanced flow conditions when coils are on full bypass.
.10 Check and record the following items at each cooling and heating element:
.1 Inlet water and air temperature.
.2 Leaving water and air temperature.
.3 Pressure drop of each coil.
.4 Pump operating suction and discharge pressures and final t.d.h.
.5 Pressure drop across bypass valve.
.6 All mechanical specifications of pumps.
.7 Rated and actual running amperage of pump motor.

.4 After completion of adjusting and balancing and submittal of records notify the Systems Verification Agency and the Consultant and assist in verifications. If systems fail verification, readjust and balance systems to the satisfaction of the Consultant.

End of Section

TABLE OF CONTENTS

END OF SECTION

1 GENERAL

1.1 WORK INCLUDED

1.1.1 Install a Building Management System (BMS), also known as Building Automation System, incorporating Direct Digital Control (DDC), equipment monitoring; microcomputer based Standalone Direct Digital Controllers (DDCs) shall be interfaced directly with sensors, actuators and environmental delivery systems (i.e., HVAC units, boilers, chillers, lighting systems, etc.); controls and mechanical devices for all items indicated on drawings described herein including dampers, valves, panels, and a primary communication network to allow data exchange.

1.1.2 Install control wiring for field mounted boiler, chiller, duct heater and humidifier safety controls, sump pump level controls, excess pressure pump, line voltage thermostats, motorized dampers, DX split systems, and cooling tower/fluid cooler remote panels to the extent that such devices are specified in Division 15 drawings.

1.1.3 Install any necessary power wiring for control components over and above whatever power drops are specifically shown on the drawings, from 120/1/60 circuits provided by Division 16.

1.1.4 Submittals, data entry, electrical installation, programming, start up, test and validation acceptance documentation, and system warranty.

1.2 INTENT

1.2.1 BMS contractor shall provide articles, materials, equipment, labour and incidentals shown, noted, specified or required to complete work of this Section whether specifically detailed, noted or referenced.

1.2.2 High limit and low limit alarms shall be provided for all suitable points with lockouts, and time delays to preclude nuisance alarms. Standard messages shall be provided showing point in alarm and current valve. Alarms for heating functions shall be automatically disabled during warm weather to prevent nuisance alarms.

1.2.3 Where multiple pumps, fans or other equipment is started by a single BMS control point provide:

1.2.3.1 Multiple contact control relays to isolate each piece of equipment,

1.2.3.2 Local time delay relays for each controlled piece of equipment and adjust to prevent simultaneous starting of the equipment,

1.2.3.3 Minimum 30 second time delay between starts.

1.3 SUBMITTALS

1.3.1 BMS Contractor shall submit the following:

1.3.1.1 A points list identifying the following for each DDC shall be submitted:

• PHYSICAL POINT IDENTIFIER ON THE DDC • POINT TYPE (AI, AO, BI, BO) • POINT NAME • POINT DESCRIPTOR • PERIPHERAL DEVICE PART NUMBER • WIRE NUMBER • COMMENT	• SIGNAL TYPE • TREND / TANTALIZATION • ALARM • CALIBRATED • COMMISSIONED

1.3.1.2 Controller schedule incorporating the BACnet addressing practices followed by DPCDSB.

1.3.1.3 Submittal sheet or catalogue cut for all field devices.

1.3.1.4 A plain English language Sequence of Operations for each system, explaining in detail, how each function will be programmed and the points used to satisfy the Sequence of Operation.

1.3.1.5 Testing and commissioning plan.

1.3.1.6 A general arrangement of each control panel clearly showing construction and dimensions, location of internal and external components and wiring shall be provided. Identify all components in accordance with specifications and sequence of operation.

1.3.1.7 Schematic of each control system showing electrical/electronic connections including terminal numbers, component locations and operations together with system description, component names and numbers shall be provided.

1.3.1.8 An electrical connection wiring diagrams of control panels showing internal wiring connections between all components with terminal numbers and outgoing terminal blocks including necessary field interlocks to give system operations specified.

1.3.2 All data, plans, specifications, drawings, sketches, correspondence and documents of any kind, originals or copies, respecting the work or the project, whether produced by Dufferin-Peel Catholic District School Board (hereinafter called the Board), or the BMS Contractor, or any subcontractors, shall be

deemed to be the property of the Board, and the BMS Contractor shall not be entitled to make use of any such data, plans specifications, drawings, sketches, correspondence or documents of any kind for any purpose whatsoever, without the Board's written consent.

1.4 AS BUILT DRAWINGS AND INFORMATION

1.4.1 Upon completion of the work, the BMS Contractor shall submit three (3) copies of all Operating and Maintenance Manuals for equipment and materials supplied, and one set of "As- Built" plans showing reasonably exact routes of all cabling, specifications marked "As-Built", plans and specifications marked "As-Built".

1.4.2 A description of all maintenance procedures for each system's components, including inspection, periodic preventive maintenance, fault diagnosis and repair or replacement of defective module shall be provided. This shall include calibration, maintenance and repair of sensors, transmitters, transducers and panels plus diagnostics and repair or replacement of all system hardware.

1.4.3 Control damper schedules with construction details and dimensions. Identify dampers in accordance with specification and drawings. Dampers shall be identified as parallel or opposed blade, c/w frame style and actuator position.

1.4.4 Specifications and data sheets for all control system components including relays, switches, thermostats, controllers, dampers, indicators, flow switches, sensors and similar components.

1.4.5 Valve schedules with construction details, calculated CVs, selected valve CV, pressure drops and flows.

1.4.6 Two (2) copies of all software programs for controlled systems on disk

1.4.7 Provide a manual divided into 3 sections describing the following functions:

1.4.7.1 System Hardware Specification Manual, which provides a functional description of all hardware component installation/configuration with detailed instructions.

1.4.7.2 System Operator's Manual, which provides concise instructions for operation of each system an explanation recovery route for all system alarms.

1.4.7.3 System Data Manual, which provides the applications data, programmed into the system including a list of virtual points and a print out of the programs and point labels.

1.4.7.4 A complete English language description of each control program for each system shall be provided. Clearly identify the function of each point reference used in the program for each system and/or equipment.

1.4.7.5 Calibrate these points and establish units, limits and alarms;

1.4.7.6 Incorporate these points in screen displays and reports;

1.4.7.7 Incorporate these points in software sequences and control loops.

1.4.7.8 Incorporate these points dynamically in graphic displays.

1.4.7.9 Modify designation of control and virtual points.

1.4.8 Revised points list, panel schedule and sequences of operations and all other information submitted with the original shop drawings, reflecting the “as built” condition.

1.4.8.1 The point list shall consist of the following information

• PHYSICAL POINT IDENTIFIER ON THE DDC • POINT TYPE (AI, AO, BI, BO) • POINT NAME • POINT DESCRIPTOR • PERIPHERAL DEVICE PART NUMBER • WIRE NUMBER • COMMENT	• SIGNAL TYPE • TREND / TANTALIZATION • ALARM • CALIBRATED • COMMISSIONED

1.4.8.2 The as-built drawings shall consist of a single page showing the system architecture with BACnet (MSTP & I/P) network numbers, instance and MAC address.

1.5 UNITS

1.5.1 All equipment and instrumentation shall be graduated in System International (SI) Units.

1.6 TRAINING

1.6.1 Training shall be provided after successful system demonstration and before system acceptance.

1.6.2 The Contractor shall provide two level of training: Operator level and advanced level.

1.6.2.1 Operator training program shall include the following:

- DDC Operation Concept,

- System Data Reading,
- Equipment Operation and Software Commands,
- Operator Monitoring and Control Intervention,
- Calibration of Data Acquisition Devices,
- Troubleshooting and repair of the Automation System.

1.6.2.2 Advanced Level Training Program, 2 days for 6 persons (16 hours classroom instruction) shall include the following:

- System Architecture and design considerations. System configurations ,
- Software installation details, configuration details,
- DDC Operation and Programming techniques,
- Graphics development,
- Scheduling and trending,
- Maintaining server software,
- Preventive maintenance of the building automation hardware and software,
- Troubleshooting and repair of the Automation System

1.6.3 Board personnel will participate in the workshops and the Board reserves the right to videotape the sessions for use in future operator training and review programs.

2 BUILDING MANAGEMENT SYSTEM

2.1.1 All applications programs shall be pre-engineered and pre-tested.

2.1.1.1 All the controllers used on the project must use the same programming language, and programs developed for one model of controller must be cross platform transferable to any other model of controller that has sufficient RAM and suitable input/output points.

2.1.2 Temperature control system shall be completely microprocessor based Direct Digital Control (DDC) electrically and /or electronically operated except where otherwise stated. System shall be installed by competent mechanics and electricians regularly employed by the BMS Company. Energy management system shall be an integral part of BMS.

2.1.3 In event of power or system failure, equipment shall fail safe, and heating valves open, dampers closed, humidifiers off, cooling off. Provide spring return feature on all valves to ensure this condition. (Exception: valve and

damper actuators on radiation, reheat valves, and unit heaters. VAV terminals and cabinet heaters shall be fully modulating type.) Floating point valves shall not be accepted. Wax valves shall not be acceptable

2.1.4 All system hardware and associated equipment shall be standard OEM items regularly manufactured for this and/or other systems and not custom designed especially for this project. All components shall have been thoroughly tested and proven in actual use. All electronic circuits shall be self-diagnostic.

2.1.5 Design scope documents establish minimum acceptable system and component capability. They are not all inclusive. All additional construction, equipment, interfaces and software required for a complete and operating systems providing the specified functions are required.

2.1.6 The fire/life safety system (F/LS) shall have priority with respect to control of equipment that is subject to control by both the F/LS and BMS. The BMS Contractor shall coordinate installation of the BMS to ensure that interfacing and connection of BMS to such equipment and H-O-A switches shall not pass or interfere with F/LS operation under either normal mode or failure mode operation of the BMS.

2.1.7 Freeze stats and other safety controls shall have priority with respect to control of equipment that is also controlled by the BMS. Consultant shall co-ordinate installation of the BMS to ensure that interfacing and connections of the BMS and H-O-A switches to such equipment shall not by-pass or interfere with freeze stats or other safety controls.

2.1.8 System shall be fully modular, permitting point expansion by adding computer memory, remote terminal units, or applications software without obsolescence of existing communication or processing equipment.

2.1.8.1 Provide licences for the software packages normally used by the BMS contractor to create, modify and add programming and graphics to the system. The software shall enable Board to add points to system and to program complex routines. Board shall be able to add and modify all point information. Board accessible software shall include:

- Direct Digital Control Library
- Report Generation Library
- Energy Management Library
- Graphics Library
- Programming Tool
- Engineering Graphics Tool

2.1.8.2 Once programmed, the results may be used to start/stop points, and readjust set points, sequence equipment, report abnormal conditions, etc.

2.1.8.3 Provide three (3) copies of all programs, any required hardware, three (3) hardware/software keys, licenses, manuals and instruction to

permit use by the Board and full functionality.

2.1.9 Set points and values given are for initial set-up only. All points shall be adjustable from the host station.

2.1.10 All electrical and electronic components shall be CSA; ULC, UL or Ontario Hydro approved where such approvals are required by the regulatory authorities.

2.1.11 Failure of any Direct Digital Controller Unit (DDC) or its communication link in the system shall not affect the proper operation of the Host computer or any other Direct Digital Controllers.

2.1.12 If the Host Computer (CPU) or transmission network fails but power to the DDC does not, the DDC shall continue to monitor all changes of state and/or values and shall retain the most recent values. The DDC shall also maintain all analog set points and command positions.

2.2 ACCEPTABLE SUPPLIERS

2.2.1 Unless otherwise noted, acceptable installers/manufacturers of BMS components and systems shall be:

2.2.1.1 Setpoint Building Automation / Reliable Controls Only.

2.2.1.2 NIL

2.2.1.3 NIL

2.2.1.4 NIL

2.2.2 Mechanical Contractor shall verify that selected BMS supplier fully complies with requirements of the Contract.

2.2.3 **ALL BAS CONTROLLERS FOR THE PROJECT SHALL BE FROM ONE MANUFACTURER.**

3 MATERIALS

3.1.1 Building Management System (BMS) shall be fully integrated and installed as complete package of controls and instrumentation. System shall be stand-alone energy management using direct digital control (DDC) solid state technology of modular construction with high reliability and simple user friendly operation. Intelligent heat pump controllers shall be fully integrated with BMS so that heat pumps and all other controls are integrated as one intelligent system.

3.1.1.1 DDC Systems installed under this specification shall strictly adhere to the following characteristics:

- Building Automation System (BAS) Direct Digital Controls (DDC) shall consist of **native BACnet**, microprocessor-based, peer-to-peer, networked, distributed devices utilizing the BACnet communication protocol in an open, interoperable system. The BAS also includes operator interface devices, programming and

configuration software applications, DDC input/output devices, non-DDC automatic temperature controls, enclosures and interconnecting conduit and wire.

- The BACnet operating stack must be embedded directly in every Device at the board level, and in all operator interface software packages.
- No Gateways, Communication Bridges, Protocol Translators or any other device that translates any proprietary or other communication protocol to the BACnet communication protocol shall be permitted as a part of the BAS installation pursuant with this specification section. Gateways may only be used as required for communication to existing systems or systems installed pursuant with other specification sections.
- DDC controllers that are not BACnet compliant shall not be acceptable under this specification and are strictly prohibited.
- The BAS shall be modular in nature and comprised of a network of stand-alone DDC devices. The System shall be designed and implemented in such a way that it may be expanded in both capacity and functionality through the addition of DDC Devices, sensors, actuators, etc,
- All BAS controllers shall be tested, certified, clearly stamped and listed by the BACnet Testing Laboratories (BTL)[i]
- Program database, data acquisition, and all control sequence logic shall reside in each DDC Device. The Building Level Communication Network (BLCN) shall not be dependent upon connection to a Server or Master Controller for performance of the Sequence of Control as outlined in this specification. Each individual Device shall, to the greatest possible extent, perform its programmed sequence without reliance on the BLCN.
- BAS shall be provided with a complete Web enabled operator interface. The Webserver application shall reside in a virtual server in the board data center. Proprietary server hardware or “Black Boxes” will not be acceptable. Third party Web enabled applications are not acceptable.
- The system shall follow the BACnet addressing scheme that will be set by the owner.
- The Owner at the Owner’s expense shall provide connection to the Internet for the BAS. The LAN connection type and configuration (TCP/IP addressing scheme, etc.) will be information provided to the System Contractor from the Owner, or Owner’s representative.

- All BAS DDC Devices at all levels shall be fully custom-programmable in the field using the standard Operators Workstation Software. No configurable, canned program application specific controllers will be permitted.

- All BAS DDC Devices shall be capable of updating firmware using software via internetowrk without replacing any hardware, microprocessors or chips.
- The BAS shall be capable of sending system alarms and Event Notifications to pagers, and email services.
- Actuation of control devices shall be [electronic] [pneumatic]. Spring return fail-safe actuation shall be provided when loss of property and/or property damage is possible and where specified.
- DDC Automatic Temperature Control (ATC) System shall prevent all controlled equipment from simultaneously restarting after a power outage. The order in which equipment (or groups of equipment) is started; along with the time delay between starts shall be user-selectable.
- All binary output points shall be protected from short cycling via output configuration and/or programming. This feature shall allow minimum on time and off-time to be configurable

3.1.2 Components shall not require any customizing other than setting of jumpers and switches, adding of firmware modules or software modules or any software programming to perform required functions. System shall be a true distributed processing system without any form of network management device used. All software control functions shall be performed by intelligent field panels and by intelligent unit controllers as appropriate.

3.1.3 All equipment, unless specified to contrary, shall be fully proportioning, modulating in operation.

3.1.4 Local equipment cabinets shall be provided for each controller or group of controllers, of free standing or wall mounted type. Respective controllers, transducers, shall be mounted within cabinet. Relays, transformers and any other devices using a voltage above 24 VAC must be housed in a separate enclosure from the controllers. Transformers may be enclosed type, mounted outside of the enclosures. Panel instruments shall be designated as to type and function of black Lamicoid tags 6.4 mm white engraved, secured with drive screws. Cabinets shall be located where shown or as later directed and may be grouped per Mechanical Room.

3.1.5 Enclosures for DDC components must be metal, NEMA 1, or a higher NEMA rating if required to resist conditions in the area where the enclosure is being installed. If the DDC controllers come with plastic enclosures, the plastic enclosures must be themselves enclosed in a metal enclosure. Enclosures for controllers with more than 30 points capacity shall have hinged covers with cylinder locks.

3.1.6 Local field panels shall perform all of the functions described in these specifications, including all of the options described even if the options are not required in the initial work. Local field panel shall have an allowance of a minimum of 10% in spare points for each type of point. If a certain type of

point is not associated with a specific panel, the required minimum spare points shall be two (2).

3.1.7 Provide integral or supplementary power conditioning equipment for all hardware so as to ensure that power line noise or electrical spikes, noise, bursts, sags or surges shall not damage equipment or software or cause erroneous computations.

3.1.8 The CPU and peripheral equipment shall operate in the following conditions:

- Temperature 15 C to 27 C
- Humidity 20% to 80% (non condensing)
- Power 120 VAC +/-10%
- Frequency 60HZ +/-3HZ
- Power factor 0.6 to 1.0

3.1.9 Local field panels and peripheral equipment shall be rated to operate in following conditions:

- Temperature 0º C to 50º C
- Humidity 10% to 90% RH (non condensing)
- Power 120 VAC + 10% on primary side of control transformers and plus or minus 25% of nominal voltage on the secondary side.
- Frequency 60 Hz + 3 Hz
- Power Factor 0.6 to 1

3.1.10 Install all DDC controllers in heated space. Keep all electronic equipment away from temperature extremes and wild fluctuations, and shielded from electromagnetic interference.

3.1.11 Proposed panel locations shall approved by Engineer/Board. Panels containing controllers shall be installed only in heated areas not subject to extremes of temperature or rapid temperature variations.

3.1.12 Panels shall use only following signal types to interface with field data points:

3.1.13 Binary Input (BI) also known as Digital Input (DI) contacts. Internal voltage source shall be dry contact or 0-5 V.D.C.

3.1.14 Analogue Input (AI) is to be standard 4 - 20 ma transmitter, 0 – 5 VDC, 2-10 VDC or 0-10 VDC.

3.1.15 Binary Output (BO) also known as Digital Output contacts rated at 24 V.D.C., 20 mA.

3.1.16 Each output on major controllers shall have an ON, OFF, AUTO select with status indication lamp and internal voltage source. Triacs may also be used.

3.1.17 Analogue Output (AO) to be standard 4 to 20 mA or 0-10 V.D.C. @ 20 mA maximum.

3.1.18 Provide engraved black and white Lamicoid plastic nameplates, 25 x 65 mm minimum at all duct mounted instruments, reset controls, thermometers and panels so as to clearly indicate service of particular device. All manual switches unless they come with standard nameplate shall be similarly labeled.

3.1.19 Controls shall be D.D.C. solid state type as noted elsewhere, and with exception of actuators, contain no moving parts.

3.1.20 Sensor accuracy shall be within 0.6% of maximum range, maximum ± 0.25 C. Mixed air sensors must give a true average across duct cross section.

3.1.21 Enclosures shall be large enough to accommodate the components without crowding, after allowing sufficient space for good wiring management. In all cases, the local field panel must have a minimum of 25% free mounting area within the enclosure

3.1.22 All din rail or screw mounted transmitters, shall be mounted in steel box of suitable size with removable cover and secured in place.

4 FIELD DEVICES

4.1 GENERAL

4.1.1 Space and duct sensors shall be electronic suitably located for specific application. Space sensing units shall be mounted 1500 mm from floor to centre unless otherwise noted or agreed to by Architect/Engineer.

4.1.2 Sensors shall meet or exceed following standards:

4.2 ROOM TEMPERATURE SENSORS (SUPERVISED AREAS)

4.2.1 Classrooms, Offices, Staff Rooms, Workrooms and other supervised areas:

- Element — 10Kthermistor complete with sensor, temperature setpoint slide and override switch.
- Output — Resistive
- Range — 0 C to 40 C
- Accuracy — 5% max. range, maximum ± 0.50
- Features — Set-point adjustment and mode override button with LED acknowledgement of mode override

4.3 ROOM TEMPERATURE SENSORS (UNSUPERVISED AREAS)

4.3.1 Gymnasiums, Stage, Cafeterias, Hallways, Washrooms, Change Rooms and other unsupervised areas:

- Element — 10K wire, bonded to reverse side of stainless steel blank switch plate
- Output — Resistive
- Range — 0^{o} C to 40^{o} C
- Accuracy — 0.05% max. range, maximum ± 0.1^{o}C

- Features No setpoint adjustment or mode override.

4.3.2 STANDARD OF ACCEPTANCE:

4.3.2.1 Enercorp TS-PL-R-1000

4.4 OUTSIDE TEMPERATURE SENSOR

4.4.1 The sensor is to be mounted in box on north exterior wall, including sun visor capable of protecting it from hockey sticks, balls, etc. It must be thermally isolated from indoor conditions.

- Element PT - l00 platinum 3 wire RTD with hockey puck transmitter
- Output 4 to 20 mA or resistive
- Range -40° C to 40° C
- Accuracy 0.05% of max. range, max. ± 0.10 C
- Thermistors Are not acceptable for OAT applications.

4.4.2 STANDARD OF ACCEPTANCE:

Enercorp TS-O-R-1000.

4.5 SUPPLY AIR TEMPERATURE SENSOR

4.5.1 Mounted in ductwork

- Element 10K thermistor averaging element
- Output Resistive
- Range 5° C to 120° C
- Accuracy 0.05% of max. range, max. ± 0.10° C

4.5.2 STANDARD OF ACCEPTANCE:

4.5.2.1 Enercorp TS-D-12-R-1000

4.6 LIQUID TEMPERATURE SENSOR

4.6.1 Mounted in pipework

- Element 10K thermistor
- Output 4 to 20mA or resistive
- Range Appropriate
- Stem Minimum length of l50 mm with brass well
- Accuracy 0.05% of maximum range, max. 0.1° C

4.6.2 STANDARD OF ACCEPTANCE:

4.6.2.1 Greystone TE-300 or Enercorp TS-P-12-R-1000.

4.7 SEPARABLE BRASS THERMOWELLS

4.7.1 These shall be provided with immersion type bulbs for installation by plumbing section. (Stainless steel shall be used for immersion in glycol solutions.) Wells shall be packed with thermal conductive grease to increase speed of response. Thermowells shall have ½" IPS threads to receive sensor, and be of suitable length for the pipe diameter.

4.7.2 STANDARD OF ACCEPTANCE:

4.7.2.1 Enercorp TW - B - (length in inches)

4.7.2.2 (Stainless Steel): Enercorp TW - S - (length in inches)

4.8 STRAP-ON SENSORS

4.8.1 Are acceptable only on retrofits of existing systems, where copper pipe is used, and for copper pipe of diameters too small to accommodate thermowells.

4.8.2 STANDARD OF ACCEPTANCE for strap on sensors:

4.8.2.1 Enercorp TS-SO-R-100 with TT-HP-R-100 Transmitter

4.9 MIXED AIR SENSOR

4.9.1 Mixed air temperature reading must be averaged across duct cross-section using sensor with same specifications as supply air sensor. Probe to be at least 24 feet long with 9 encapsulated sensor elements and shall indicate the average value of the 9 sensors. Probe to be neatly mounted on tubular copper supports.

4.9.2 STANDARD OF ACCEPTANCE:

4.9.2.1 Enercorp TS-A-20- 9 – R-1000

4.10 HUMIDITY SENSOR

4.10.1 Range from 0% to 100% RH ± 2% between 10% and 90% RH.

4.10.2 Use Humicap or equal.

4.10.3 STANDARD OF ACCEPTANCE:

4.10.3.1 Enercorp HTC-D-420.

4.10.3.2 (Outdoor Humidity Sensor): General Eastern

4.11 AIR QUALITY SENSOR

4.11.1 Q.E.L. Model QTS 2000 non-dispersive infrared carbon dioxide transmitter sensor capable of monitoring return air concentration of CO2.

- Method N.D.I.R.
- Gas Carbon Dioxide

- Range 0-5000 PPM
- Accuracy ± 3% of full VDC
- Power Source 12 VDC
- Output Signal 4-20 mA DC Linear
  Zero drift at ambient Less than 0.02% CO2 per degree centigrade.
- Operating Temp. 10º to 60º C

4.12 CONTROL INTERFACE

4.12.1 Shall meet or exceed following standards:

4.12.2 Watt Transducer

- Current input 0 to 5 amps
- Voltage input 0 to 120 VAC, 60 Hz
- Power requirement 120 VAC, 60 Hz
- Output 4 to 20 mA or pulsed
- Accuracy 1.3% of reading
- Measurement type 3 phases, 4 wires

4.12.3 Interface Relay

- Input 10 VDC
- Contact rating 10 A at 120 VAC, 60 Hz & 10 A at 28 VDC
- Contact action DPDT

4.12.4 Power Relay

- Input 120 VAC, 60 Hz
- Contact rating 30 A at 250 VAC, 60 Hz
- Contact action DPDT

4.12.5 Contactors

- Input 120 VAC, 60 Hz
- Contact rating As per application
- Contact 3 poles, N.O. contact, 1 aux. contact, N.C. arrangement
- Control 347 v. /120 VAC, 60 Hz with protection transformer
  Metal cabinet (enclosing contactor, transformer, protection, etc.), NEMA rating appropriate to environment.

4.12.6 STANDARD OF ACCEPTANCE:

4.12.6.1 Contactors shall be Allen-Bradley or approved equal.

4.13 MOTORIZED DAMPERS

4.13.1 All dampers shall be heavy duty, low leakage, aluminum opposed blade, designed to withstand static pressure specified. Damper shall have nylon bushings, edge and end seals, and thrust washers.

4.13.2 The damper linkages shall be installed on the blades within the air stream for ease of access, maintenance and adjustment. The damper blade hardware shall be provided with corrosive resistant material. The damper assemblies, linkages and motors shall be properly mounted and fitted for airtight and trouble free operation.

4.13.3 Dampers on O.A. and Exhaust shall be T.A. Morrison Series 9000 insulated. Return air dampers and other internal dampers shall be un-insulated TAMCO Series 1000. Alternatives shall not be considered.

4.14 DAMPER OPERATORS

4.14.1 Install electric damper operators to suit the control dampers, operators shall be adequately sized to provide smooth and full travel in both directions. Under no circumstances shall pneumatic actuators be installed.

4.14.2 Damper operators shall be maintenance free 24 volt direct coupled actuators with 95 degree rotation, position indicator, non overloading. Direction of rotation shall be reversible without wiring change.

4.14.3 A separate damper operator shall be provided where individual dampers are installed. On multi-section dampers, install separate damper operators for each section except where a jack shaft drive arrangement is indicated.

4.14.4 Install damper linkage where direct coupling of motor to damper shaft is not possible. Where multiple damper actuators are driven from a single DDC point, provide a positioner for each. Similarly, if a major air handler does not have a separate minimum fresh air damper, provide a positioner for each of the outdoor, recirculating and exhaust air dampers.

4.14.5 Ensure failure position of damper actuator meets safety requirements of item controlled. Provide spring return upon power failure feature for all damper actuators. The 24VAC power for the dampers shall be wired through through the safety circuits (freeze stat) to ensure the dampers will fail safe when the safety circuits trip.

4.14.6 STANDARD OF ACCEPTANCE:

4.14.6.1 BELIMO/Siemens positioner. Smaller actuators may be used provided the torque rating is 150% of the calculated torque necessary to close the dampers against the maximum static pressure for which it was designed. Where feedback of damper position is required by either the sequence of operations, drawing or points list, use a model with the feedback potentiometer/auxiliary contact feature. No

alternatives shall be considered.

4.14.7 Damper actuators for VAV applications to be with a minimum rating of 32 inch-pounds of force, and clutch release mechanism.

4.15 CONTROL VALVES

4.15.1 Shall have the following minimum specifications:

4.15.1.1 Consultant shall select valves for the operating pressures and temperature conditions of the system and shall ensure that valves shall close against system operating differential pressures. Consultant shall select modulating valves from CVs., and shall select valves for full shut off applications (i.e. two position valves) on the basis of full line size.

4.15.1.2 Consultant shall select valves with characteristics to suit the application. Straight through two port water valves shall be single seated with equal percentage flow characteristics.

4.15.1.3 Three port valves shall be linear for each port to give constant total flow. Butterfly valves are not acceptable, except for “full shutoff“ applications and heat pump loop heat injection valves greater than 65mm. “Shoe” valves shall not be used and shall not be confused with the use of ball valves

4.15.1.4 All valves shall be equipped with stainless steel stems.

4.15.1.5 Valves 50 mm and smaller shall be Belimo or Siemens characterized ball valves with stainless steel stems, stainless steel balls, and screwed bronze bodies suitable for a maximum working pressure of 1200 pa. No alternatives. Do not select models without characterizing disks for modulating applications. Models with chrome plated brass balls shall not be used.

4.15.1.6 Valves 65mm and larger shall have flanged cast iron bodies suitable for a maximum working pressure of 1400 pa., Belimo G series with suitable Belimo electronic actuators or Siemens equivalent.

4.15.1.7 Use positive positioning relays on valves that are sequenced with other actuators.

4.15.1.8 Valves shall be equipped with fully modulating Belimo/Siemens electronic actuators with sufficient torque for the application. All actuators for valves 2-1/2” and smaller shall be spring return type, except for reheat valves not exposed to outside air radiation and differential pressure valves. Control signal shall be 2 – 10 VDC. Where feedback is specified in the points list or implied by the sequence of operations, provide Belimo actuators with feedback potentiometers. All the spring return actuator 24VAC power shall be wired through the safety circuits (freeze stat) to ensure the valves will fail safe when the safety circuits trip.

4.15.1.9 Valves for radiator and reheat applications to have manual opener and position indicator for use in the event of actuator failure and during maintenance operations.

4.15.2 STANDARD OF ACCEPTANCE for radiation, reheat and other control valves up to 50 mm:

- Belimo/Siemens characterized ball valves with brass balls and Belimo/Siemens electronic actuators. No alternatives. Do not select models without characterizing disks for modulating applications.
- For globe valve applications, use Belimo G series with suitable Belimo electronic actuators or Siemens equivalent.

4.15.3 Under no circumstances shall pneumatic or wax type actuators be considered for new valves.

4.16 HIGH LIMIT THERMOSTATS

4.16.1 Thermostats shall have liquid filled insertion probe.

4.16.2 Range shall be -3.9 to 101.7 C

4.16.3 Switch shall be snap acting and rated for 16 amperes at 120 VAC or 8 amperes at 575 VAC as required.

4.16.4 Thermostat shall have manual reset feature.

4.16.5 Provide one thermostat for each 1 sq. m of duct area.

4.16.6 Thermostats shall be CSA approved and enclosure dust tight.

4.16.7 Thermostats shall be SPDT or DPDT to facilitate monitoring by BMS.

4.16.8 STANDARD OF ACCEPTANCE:

4.16.8.1 Johnson Controls A25CN-1

4.17 LOW LIMIT THERMOSTATS

4.17.1 Thermostats shall have 6000 mm vapour tension sensing element sensitive to a temperature below its setpoint over 300 mm of its length.

4.17.2 Range shall be 1.7 to 7.2 degrees C.

4.17.3 Switch shall be snap acting and rated for 16 amperes at 120 VAC or 8 amperes at 575 VAC as required.

4.17.4 Thermostat shall have manual reset feature.

4.17.5 Provide one thermostat for each 1 sq. m of coil face area or part thereof.

4.17.6 Thermostats shall be DPDT to facilitate monitoring by BMS.

4.17.7 STANDARD OF ACCEPTANCE:

4.17.7.1 Johnson Controls AH70HA-1.

4.17.8 Mount sensing element rigidly and as close as possible to the downstream face of the coil being protected or where shown on schematic diagrams. Freeze controls shall have 6 m capillary arranged in ducts for best possible protection.

4.17.9 Provide freeze stat for each 5.5 square meters of duct area where necessary, wired in series. Sensing element shall extend at least to two diagonally opposite corners of the coil.

4.18 DIFFERENTIAL PRESSURE TRANSMITTERS

4.18.1 The transmitter shall have an operating range to suit the application such that the controlled value is mid range.

4.18.2 The transmitter output shall be a linear proportional signal over the full operating range, for 0 to 5 volts or 4 to 20 mA.

4.18.3 STANDARD OF ACCEPTANCE:

4.18.3.1 Enercorp WGT-420

4.19 CURRENT SENSORS A.K.A. CURRENT TRANSFORMERS

4.19.1 Status inputs for motors (pumps and fans) shall use inductive coils to monitor current draw from one phase of power.

4.19.2 Current transformers shall be selected and configured for appropriate amperage range, and shall have 0 to 5 Volt output.

4.19.3 BMS shall use AI points to monitor current transformers.

4.19.4 STANDARD OF ACCEPTANCE:

4.19.4.1 Enercorp A100 series

4.20 FILTER BANK STATUS DIFFERENTIAL PRESSURE SWITCHES (DI)

4.20.1 Select the differential pressure range of the switch to suit the application.

4.20.2 Provide switches with adjustable setpoint.

4.20.3 Provide switches with SPDT contacts rated at 9 amperes at 120 VAC and be CSA approved.

4.20.4 Mounted switches with diaphragm in a vertical plane.

4.20.5 STANDARD OF ACCEPTANCE: Enercorp AFS-22

4.21 POSITIVE POSITIONING RELAYS

4.21.1 Positive positioning relays shall be used on valves and dampers to maintain control accuracy and sensitivity, proper sequencing, constant driving force at all positions and shall have the following minimum specifications:

4.21.1.1 Belimo type SGA-24/SGF-24.

4.21.1.2 Input 0 to 10 volts. Output 2 to 10 volts.

4.22 FLOW SWITCHES (DI)

4.22.1 Select flow switches for the pipe size and flow rate.

4.22.2 The flow switch shall have a paddle with 3 segments for selecting optimum size suited for pipe sizes from 25 mm to 150 mm.

- Temperature rating 121º C
- Pressure rating 1030 pa
- Contact rating 8 amps at 120 VAC

4.22.3 Switch shall be CSA approved.

4.22.4 Flow switch to be DPDT, if possible to facilitate monitoring by BMS.

4.22.5 STANDARD OF ACCEPTANCE:

4.22.5.1 McDonnell-Miller

4.23 ELECTRONIC TO PNEUMATIC TRANSDUCER

4.23.1 In retrofit projects, where the specification clearly indicates that existing pneumatic actuators are to be reused, and controlled by DDC, provide transducers to convert the DDC output signals to pressure. Protect each transducer with a 0.2 micron coalescing filter.

- I/P or V/P
- Input signal 4.20 mA or 2.10 VDC.
- Input Impedance 500 ohms
- Output Signal 0 – 15 pig

4.23.2 STANDARD OF ACCEPTANCE:

4.23.2.1 Enercorp VIP-9000 Transducer with VIP-F02 coalescing filter.

4.24 PHOTO SENSOR (DI)

4.24.1 Weathertight

4.24.2 Operating Temperature –30 to +70 C

4.24.3 Resistance at 0 Lux 15 Kohms minimum

4.24.4 Resistance at 10 Lux 3 Kohms typical

4.24.5 STANDARD OF ACCEPTANCE:

4.24.5.1 Enercorp LC-O

4.25 DC POWER SUPPLY

4.25.1 Output: 1 amp at 24V at 20º C in free air

4.25.2 Input: 24 VAC

4.25.3 STANDARD OF ACCEPTANCE:

4.25.3.1 Enercorp PS24DCF

4.26 VAV AIR FLOW SENSOR

4.26.1 STANDARD OF ACCEPTANCE:

4.26.1.1 Kalvico or Honeywell MicroBridge

Hot wire technology is not acceptable.

5 SOFTWARE DESCRIPTION

5.1.1 The software characteristics specified shall establish minimum requirements. The Contractor is responsible for the software used and its applications in reference to the automation system. The Contractor shall deliver a complete an operational system in compliance with contract drawings and specifications.

5.1.2 The BMS Contractor shall provide all software required for efficient operation of all functions required by contract documents. Software shall be modular in design for flexibility all software expansion or revisions shall be included.

5.1.3 The interface between the local field panels shall allow the operator to use the command centre in a conversational alphanumeric mode (by means of questions/answers). The programming of points, event related alarms any other related software functions should be programmable using clear conversational statements. The operating system shall have the following characteristics:

- Multi Tasking
- Real-time clock Routines,
- Memory Map Support with Memory Protect,
- Input/Output Control,
- User Programmable,
- Error Detection, Recovery,
- System Self Testing,
- User Friendly,
- Menu Driven,
- On-Line Help Screens,
- Minimum of Five Level Security Password Access.

5.1.4 Programming with the use of codes shall not be acceptable.

6 SYSTEM

6.1 DDC SYSTEM

6.1.1 DDC system shall be modular in design and of standard microprocessor architecture shall strictly adhere to the following characteristics:

- Building Automation System (BAS) Direct Digital Controls (DDC) shall consist of native BACnet, microprocessor-based, peer-to-peer, networked, distributed devices utilizing the BACnet communication protocol in an open, interoperable system. The BAS also includes operator interface devices, programming and configuration software applications, DDC input/output devices, non-DDC automatic temperature controls, enclosures and interconnecting conduit and wire.

- The BACnet operating stack must be embedded directly in every Device at the board level, and in all operator interface software packages.

- No Gateways, Communication Bridges, Protocol Translators or any other device that translates any proprietary or other communication protocol to the BACnet communication protocol shall be permitted as a part of the BAS installation pursuant with this specification section. Gateways may only be used as required for communication to existing systems or systems installed pursuant with other specification sections.

- DDC controllers that are not BACnet compliant shall not be acceptable under this specification and are strictly prohibited.

- All DDC controllers shall be tested, certified, clearly stamped and listed by the BACnet Testing Laboratories (BTL)

- Program database, data acquisition, and all control sequence logic shall reside in each DDC Device. The Building Level Communication Network (BLCN) shall not be dependent upon connection to a Server or Master Controller for performance of the Sequence of Control as outlined in this specification. Each individual Device shall, to the greatest possible extent, perform its programmed sequence without reliance on the BLCN.

- The DDC database shall have the capability to be modified backed up and restored to the controller over the owners IT network infrastructure. DDC that require direct connection at school level device network to do these function is not acceptable.

6.1.2 Major controllers must have real time clocks. Time keeping methods that depend on the clock speed of the processor chip are not accurate enough, and are not acceptable. One designated controller shall keep the time for the entire system.

6.1.3 The network shall permit the automatic transferring of all point values from one controller to the other on a planned, prioritized basis. The transfer of point values shall be performed directly between controllers. Systems that relay on a control, network, master or gateway controllers to perform these functions are not acceptable.

6.1.4 Firmware must be flash upgradeable over the network.

6.1.5 Digital system controller shall perform its assigned control and energy management functions as "stand alone" unit, in event of loss of communications with CPU.

6.1.6 Control algorithms shall be available and resident in digital system controller to permit proportional, integral derivative, incremental, floating and two position control modes in any combination to meet requirements of application.

6.1.7 Canned packages shall not be permitted in controllers. Controllers must be flexible enough to accommodate custom programs and additional points. Easy down and upload of database over the Board's WAN shall be incorporated to allow for changes and control storage of database. "Applications Controllers" shall not be used.

6.1.8 All control shall be performed in digital manner using digital signal from microprocessor based controller converted through electronic circuitry for operation of electric actuators.

6.1.9 Digital system controller shall be expandable by adding additional field interface units that operate through processor of digital controller to expand its control loop and energy management point capacity, without making any of the original equipment redundant.

6.1.10 To maintain long term analog accuracy in controller sensing circuits, digital controller shall sense voltage being supplied to resistance sensing element and through firmware compensate for power supply.

6.1.11 The non-volatile EPROM memory shall, as a minimum, support the operating system. Tape or disk media is not acceptable. All control languages, application functions and operating data or software shall reside in SuperCap or battery backed RAM. Data or control software (such as I/0 point characteristics, schedules, set points and alarm limits) must remain in RAM and, hence, modifiable on-line through an operators terminal connected to any panel on the system without the use of specialized software not provided in this contract. Controllers using batteries that require periodic replacement shall not be used. Standard off the shelf communications software packages are acceptable but in no case shall a hardware key or any other protection method be permitted that restricts the Board from connection to the system from multiple remote locations to display system command language and graphics displays. Digital system controller shall be supplied with minimum of 250 hours of backup for RAM with automatic battery charger.

6.1.12 All BMS components must be internally protected from loss of memory or operation due to power surges and brown outs. Controllers must be capable of operating without overheating or other damage at as little as 75% of nominal voltage, and as much as 125% of nominal voltage on the secondary side of the control transformers.

6.2 COLOR GRAPHICS SOFTWARE

6.2.1 Install all software necessary to permit the operator to create, modify, delete, file and recall all graphics. The package shall encompass all graphics, control, control schematics and wiring details for all points and systems contained in the Input/output Point Summary. Provide a separate, valid license, complete with manuals, disks, and documentation for the graphics engineering software for each school project. Provide a separate valid license for of the software necessary to view the graphics with each Operator Work Station

6.2.2 Provide facility to import photographic images, and industry standard graphics drawn by third party graphics software developers, including Paint Shop Pro and AutoCAD, and use them as backdrops to dynamic displays.

6.2.3 Graphics Symbols Software: Shall maintain a library of the symbols provided. Additionally, the feature shall be implemented to allow the operator to define a minimum of 10 unique symbols. In the development of a graphic picture, the graphics software shall support all operator actions necessary to:

- Define the background;
- Establish colours;
- Locate, orient and size the symbols;
- Position and edit alphanumeric descriptors;
- Establish connecting lines;
- Establish sources of real time data and location of their readouts.

6.2.4 Any proprietary or copy write clause should not be present on the graphics.

6.2.5 The graphic file shall follow the naming convention of the board. All graphics to be submitted for preapproval.

6.2.6 The Graphics Library: Shall contain Contractor prepared displays for each system included in the point schedule and library of standard symbols with the following as a minimum:

- Chiller
- Boiler
- 3-Way Control Valve
- Damper
- Motor
- Coil
- Damper Motor
- Duct
- Sensor
- Fan
- Filter
- Pipe
- Switch
- Air Measuring Device
- Average Duct Temperature

- Air Quality Sensor
- Bulb Temperature Sensor
- Pump
- Convector
- 2-Way Valve
- Check Valve

6.3 DYNAMIC UPDATING

6.3.1 On-line data, displayed as an integral part of a schematic, shall be updated not less than every 5 seconds with the exception of alarm/change of state information, which shall be updated upon its receipt at the operator's terminal.

6.4 INFORMATION SCREEN DISPLAY

6.4.1 Individual schematics shall include, where applicable:

- Status of monitored and controlled on/off points;
- Current value of analog input;
- Identification for each point;
- Current value of the setpoint & DDC output for each control loop;
- Current state of each control loop (computer auto/computer manual);
- Schematic and systems identification;
- Point alarm lock-out status;
- Equipment symbolic information (pump, fan, etc);
- Alarm/normal indication;

6.4.2 All points pertinent to one system shall be on one screen.

6.4.3 Symbols shall have the ability to change colour, depending on the status.

6.4.4 Animations are to indicate point status. Animations are to include pumps, fans and boilers. The BMS contractor shall obtain from the Board the final numbering and name convention to be used for all spaces in the school for incorporation in the “As Built” drawings and manuals.

6.5 EXTERNAL COMMUNICATION

6.5.1 BMS supplier shall supply and install a bridge from the main LAN of the Building Management System to the Board’s Wide Area Net. The BMS shall be accessible with full functionality via TCP/IP protocol at any workstation on the WAN that has the necessary front-end software, even if the local front end is turned off.

6.5.2 Dial up connections that require use of telephone lines shall not be considered as an alternative.

6.5.3 Install software, set-up and program Board's central monitoring station to provide complete and total remote control.

6.5.4 This access over the WAN is fundamental to the Board's operation. The capability shall be fully developed, field proven and released by the DDC manufacturer for general use at time of tender. Prototypes shall not be used.

6.5.5 The BMS system shall have the capability of communicating with third party computerized building systems using BACnet protocol.

7 OPERATORS' CONSOLES (NOT APPLICABLE)

8 TESTING, COMMISSIONING AND OPERATION

8.1.1 Adjust and set sensors, valves, damper operators and relays to proper settings to give required performance. Co-operate with other trades and Sections during testing and balancing of each mechanical system to ensure each total system operates to approval.

8.1.2 Testing shall include pre-delivery testing, field testing, and adjustment of all major components and of the complete BMS and an on-site final operational acceptance test of the complete system.

8.1.3 All tests to be witnessed and approved by Consultant and a Performance Certificate issued by the Contractor.

8.1.4 When installation of the BMS is complete, calibrate all sensors and other equipment, and verify transmission operation.

8.1.5 Final operational test shall be a minimum of 30 days, 24hrs/day, for complete installed and operational BMS to demonstrate that it functions in accordance with the contract drawings and specification. Correct any defects in hardware or software as it occurs before resumption of tests.

8.1.6 Include for carrying out the following tests by Contractor and verification by Consultant:

8.1.6.1 Automatic restart after power outage

8.1.6.2 BMS software program downloading and uploading to and DDC controllers and floppy disks

8.1.6.3 System by system point displays

8.1.6.4 System by system graphic displays

8.1.6.5 Change of output status

8.1.6.6 Response of system to field alarm conditions

8.1.6.7 Response of system to field communication failure

8.1.6.8 Display of and alterations to, time schedules

8.1.6.9 Presence and proper functioning of On-screen Help menu

8.1.6.10 Correct operation of safety circuits, in both "Hand" and "Auto" modes.

8.1.7 Demonstrate the ability of each DDC panel to maintain proper control strategies during a communications failure with the central control facility and the field interface with a DDC panel using a portable terminal provided by the Contractor.

8.1.8 Provision for remote access to complete direct access to BMS to monitor, or change, setpoints, sequence of operation etc.

9 SERVICE & WARRANTY

9.1.1 Temperature control system shown and specified herein shall be warranted free from defects in materials and workmanship and shall be serviced without charge (except for damage from lack of maintenance or other causes) for **three years** after date of start of acceptance. If, within this period, any equipment is proved to be defective in workmanship or materials, it shall be replaced or repaired without charge.

9.1.2 Any component replaced during warranty shall be guaranteed for general system warranty or for one year from date of replacement whichever is the greater length of time.

9.1.3 Provide, at a minimum, one of each manufacturer’s hardware and/or software tools required to service the system, including all manuals and licenses. In the case of multiple types of service tools, one of each type shall be provided.

9.1.3.1 During the first 12 months from the date of acceptance the BMS Contractor shall respond and be totally responsible for making all adjustments, modifications, upgrades any other necessary changes to maintain the system to operate in accordance with the Consultant's design intent, contract documents maintenance of comfort conditions.

9.1.3.2 Services will be provided by factory trained local area service representatives, regularly employed by the BMS Contractor.

9.1.3.3 All software/firmware updates for the system.

9.1.3.4 Quarterly inspections to verify proper, operation and to perform preventive maintenance as required.

9.1.3.5 Provide during first year of warranty a 24 hour monitoring of critical alarms from control contractor's office.

9.1.3.6 Maintain a local office within an 80 km radius of this installation, staffed with trained software engineers and technicians fully capable of providing instructions, routing maintenance and emergency service within four hours notice on a 24 hour/day basis.

9.1.3.7 Provide new to the owner at time of acceptance. Do not use these Service Tools for commissioning of the system. Provide all service tools preconfigured for system use and tested as required to:

- Perform hardware configuration (hardware addressing, communication configuration, &c.) of installed equipment, devices, sensors, etc.
- Perform network administration, configuration maintenance and changes
- Perform Graphical modification and program changes

10 EXECUTION - ELECTRICAL

10.1 RULES AND REGULATIONS

10.1.1 All of the installation requirements, be they temporary or permanent, shall comply with the Canadian Electrical Code and all local and Provincial codes.

10.1.2 The Contractor shall supply, install and connect all conduits, boxes and wires between all the different components related to the centralized control system including all required line voltage to the equipment. All power shall be provided from appropriately sized new circuits at the nearest electrical panel with space provided by the Contractor.

10.2 CONDUITS

10.2.1 All line voltage power wiring shall be in conduit.

10.2.2 All exposed wiring shall be in conduit.

10.2.3 Wiring in finished areas shall be concealed in structure.

10.2.4 All conduits shall be installed in a concealed manner where possible and shall be installed parallel to the lines of the building.

10.2.5 All flexible conduits shall not exceed 2 m in length and shall be used only in areas where vibrations and/or expansion joints are present.

10.2.6 All conduits and other wiring shall be supported at least every 2 m, supports shall also be located at the connector's end of the conduit.

10.2.7 When flexible conduits are used for connecting an element to its rigid conduit or EMT then the length of this flexible conduit shall not exceed 500mm.

10.2.8 In damp areas, the conduit and related equipment shall be suitable for the application.

10.2.9 All wiring shall be properly identified.

10.3 WIRING AND IDENTIFICATION

10.3.1 All conductors shall be in one continuous length from a point to its source.

10.3.2 The two- (2) extremities shall be identified using the same code.

10.3.3 The terminal strips shall also be identified with this same code.

10.3.4 The identification shall be done using a self-adhesive yellow band marker, Model WBC from Thomas & Betts or approved equivalent.

10.3.5 All power wiring to be copper stranded RW 90 type, with appropriate gauge in accordance with the Canadian Electrical Code.

10.3.6 All control wiring to be copper stranded TEW-105, with appropriate gauge in accordance with the Canadian Electrical Code. The minimum gauge used to be 18 AWG.

10.3.7 All the conductors used for signals from the local field panel (BI, AI, AO, BO) and the communications network shall be a 2-wire, or 4 wire twisted pair with grounded shield around each pair, No. 18 AWG, plenum rated. Multi-conductor cables are acceptable providing that each conductor pair is shielded. Conductor Model 8760 from Belden or approved equivalent shall be used.

10.3.8 All the equipment and panels shall have a Lamicoid nameplate indicating its name, number and all pertinent information. "DYMO" tape will not be accepted.

10.3.9 Surge transient protection shall be provided in each digital system controller unit for the purpose of suppressing induced voltage transients.

10.4 POWER CONDITIONING

10.4.1 If the power conditioning built into the DDC components is insufficient to protect them from damage under the conditions specified, provide external power conditioning for all the DDC components.

10.4.2 Power conditioning filters shall when possible utilize silicon avalanche diode technology rather than metal oxide varisters. (M.O.V.) Life expectancy 10 years or better.

10.5 GROUNDING

10.5.1 All low voltage grounds (shields) must be connected to ONE COMMON GROUND at ONE SPECIFIC POINT in the building at one end of the wire run. No low voltage wire ground may be connected to this common specific point ground in more than one point. This specific point ground must be approved by Dufferin-Peel in writing. Building construction materials or plumbing that are ground loops or have a thermocouple effect may not be considered an acceptable ground connection point. Once the ground has been established the contractor must ensure no in or out of phase potential exists within the ground.

10.5.2 Contractor shall comply with manufacturer’s recommendations for network wiring and grounding.

11 OPERATION FUNCTIONS

11.1 OCCUPIED/UNOCCUPIED MODE OF OPERATION

11.1.1 Provide all controls and application programs for time of day scheduling, optimum start/stop, night setback, duty cycling, load shedding etc.

11.1.2 Provide mode override for all zones. Mode override is to be accomplished by pushbuttons on all adjustable DDC thermostats. For areas controlled by non-adjustable DDC temperature sensors, mode override shall be accomplished through the Operator Console.

11.1.3 During unoccupied mode, all fans serving the zone shall be off, and temperature setpoint will revert to heating setback/cooling set up settings.

11.1.4 If the mode is overridden in a heating zone, the temperature setpoint reverts to the occupied setpoint for a period of two hours (adjustable at Operator Console within the 1 to 8 hour ranges.) If half the zones in an area served by an air-handling unit are overridden, the operation of the air-handling unit resumes until the override period has ended.

11.2 TIME SCHEDULING (T/S)

11.2.1 Time scheduling (T/S) can be assigned on all the start/stop points.

11.2.2 The time scheduling table shall have unlimited OCCUPIED, UNOCCUPIED, START and STOP assignments per day for any selected equipment at 1 minute intervals, 24 hours per day and shall be suitable for daily, weekly and annual scheduling for any piece of equipment on an individual basis.

11.2.3 Install an override control so that a period of override may be scheduled at least 30 days in advance. The program shall then automatically reset to normal schedule. The outside dampers shall open to their minimum position within an operator adjustable time period after commencement of the warm up cycle.

11.2.4 During a cool down cycle, the fan system shall operate with the outside damper in the minimum position, except for those systems which also have the enthalpy economizer program specified in the control strategies. For systems with the economizer program, an enthalpy comparison between outside and return air shall be made. If the economizer program determines that outside air can be used for free cooling, then the maximum outside air dampers shall be opened during the cool down cycle. In any event, the outside dampers shall be opened no later than an operator adjustable time period after commencement of the cycle.

11.2.5 Provide summaries for each system, as applicable, the following:

11.2.5.1 Programmed occupancy and unoccupied times and desired occupant comfort levels.

11.2.5.2 Times at which system was actually started and stopped.

11.2.5.3 Outside and inside temperatures at the time a system was started.

11.2.5.4 Outside and inside temperature at the time of occupancy.

11.3 DUTY CYCLE (DC)

11.3.1 All the equipment associated with a start/stop program shall be suitable for duty cycling. The following items are requirements of duty cycling:

11.3.1.1 Be applicable with the peak demand limiting program or work as a stand-alone program.

11.3.1.2 A minimum and maximum onetime setting and a minimum and maximum OFF-time setting.

11.3.1.3 Duty cycling shall be automatically deferred if maximum or minimum space temperatures are exceeded.

11.4 TREND GRAPHING

11.4.1 System shall have ability to display points on a trend graph, individually or in groups, of up to 6 points. Graph limits shall be auto set and also manual programmable.

11.4.2 Trends must be easily exportable from within the graphics program to Microsoft Excel, for future graphing, custom report formatting, manipulation, and printing.

11.5 RUNTIME TOTALIZATION

11.5.1 The system shall keep track of equipment "on" time for all binary status points. A program shall totalize runtime for each individual point based on open or closed contact conditions.

11.5.2 Runtime points shall be assigned individual runtime limits. The system shall output a 60 character maintenance message when the runtime for a point has exceeded its limit.

11.5.3 The runtime program shall be capable of storing totalized values to 9999 hours in increments of 5 minutes.

11.5.4 A runtime totalization summary shall be provided which contains a listing of all runtime points; their current totals and operator set runtime limits.

11.5.5 The system shall automatically output a runtime totalization summary based upon a pre-selected time as detiled under the program function description.

11.5.6 An operator command shall be made available to reset or pre-set the accumulated runtime for any point.

12 TRENDS AND REPORTS

12.1.1 Provide point trending capabilities for any system information of operating point. Generate reports based on specific point or group of points; e.g. -

status, room temperatures, etc. Write the trend-logged data to a file for screen review by the operator.

12.1.2 Implement trends on all physical points, and for all “mode” variables for all systems. System shall have sufficient RAM to accommodate a minimum of 100 samples per trend in the panel before scrolling to OWS hard drive.

12.1.3 Digital points on major equipment shall be trended using Change of State trending**.**

12.1.4 Analogue points on major equipment shall be trended using Change of Value trending.

12.1.5 Conventional trending shall be used for other types of points.

12.2 ALARM

12.2.1 Install alarming capabilities on all points by assigning a max or min values, incorrect state or error state status. Generate an alarm message from a standard library or a 25 character alphanumeric text.

12.2.2 Install interlock and time delay functions so that alarms shall be locked out.

12.2.3 No alarm shall be reset until acknowledged unless status of point returns to normal condition. In such event a record of the alarm shall be made in an alarm history file for storage of a minimum of 3 months.

12.2.4 Provide for automatic call out to remote terminal for alarms.

12.2.5 Implement alarms and dial outs for all logical conditions. Examples include HWST out of range, Flame Failure Space Too Cold, Pump Failed to Start, Fan Failed to Start, Bad Thermostat, etc.

12.2.6 Program all Critical Alarms to be dialed out in Real Time

12.2.7 Program all other alarms to be dialed out during normal business hours.

12.2.8 Dial outs shall be directed to the BMS contractor’s central monitoring station. As part of the tender price, the BMS contractor shall provide 24/7 monitoring of the installation until one year after Substantial Completion.

12.3 ADVISORIES

12.3.1 The system shall continuously interrogate its hardware for failure and/or tampering and report to the operator, in English language, all changes in hardware status. Advisories shall include at least the following:

12.3.1.1 System can/cannot communicate with point.

12.3.1.2 System can/cannot communicate with field processing unit/DDC system controller.

12.3.1.3 Field processing unit is operational/not operational.

12.3.1.4 System can/cannot communicate with operator device(s).

12.3.1.5 A power failure has been detected at (time) (date).

12.4 MAINTENANCE TIME REMINDERS

12.4.1 Maintenance time reminders shall be generated based on run time or calendar date.

13 CONTROL STRATEGIES AND SEQUENCES OF OPERATIONS

13.1 TEMPERATURE BASED LOAD CONTROL PROGRAM

13.1.1 The system shall provide an interlocking capability between any energy control load and an analog temperature point. A comfort or safe range zone shall be defined by high/low alarm limits. If load under control is presently within comfort or safe range, load will operate normally as either an operator specified programmed start/stop point, demand limit point, or cycling point. If load is outside its limits, interlock sequence shall take effect until load control point returns to comfort or safe zone at which time it will resume operation as either programmed start/stop load, demand limit load, or cycling load.

13.1.2 This program in conjunction with programmed start/stop, shall permit load cycling for reduced night temperature setback during unoccupied periods in conjunction with space temperature analog points.

13.2 ENTHALPY ECONOMIZER

13.2.1 Provide control of fresh air, and relief air dampers during the cooling season based on inside and outside enthalpy comparisons. Provide all sensors and controllers required for the proper operation of this feature whether or not they are identified in the point schedule. These points shall include OAT, OAH and RAH.

13.2.2 The program shall monitor outside and inside temperatures and humidifies and fan cooling coil discharge temperature. Based on these inputs, the outside/return air dampers shall be controlled as follows:

13.2.2.1 Minimum outside air damper fully open. When the supply air discharge temperature setpoint is less than the mixed air temperature, obtained when operating on minimum outside air only, the maximum outside air, return air and exhaust air dampers shall modulate to satisfy the supply air discharge temperature setpoint.

13.2.2.2 Minimum outside air damper fully open. When the supply air discharge temperature setpoint is greater than mixed air temperature, obtained when operating a minimum outside air only, calculations shall be made to determine if the use of 100% outside air or minimum outside air provides the smallest enthalpy change across the cooling coil.

13.2.3 The calculations shall take into consideration the total enthalpy in the outside and return airstrips.

14 AIR SYSTEMS

14.1 CONSTANT VOLUME SINGLE ZONE (MULTI SPACES) SINGLE HEATING COIL

14.1.1 Provide a program that automatically adjusts fan discharge setpoint temperature as high as possible (cooling) or as low as possible (heating) to satisfy the space with the greatest cooling or heating load. Provide all sensors required for the proper operation and clearly identify in the point schedule.

14.1.2 Zone heating/cooling requirements shall be determined by monitoring space temperature. Supply air discharge temperature shall be adjusted up or down as appropriate until at least one of the measured inputs is at its comfort limit, indicating additional reset would cause zone discomfort.

14.1.3 A comparison shall be made with the mixed air temperature, obtained with minimum outside air only, and supply air discharge temperature setpoint. If the outside air temperature is suitable the maximum outside air, mixed air, and exhaust air damper shall modulate to satisfy the supply air discharge temperature setpoint without energizing the main heating coil. Heating coil shall only energized if the supply air discharge temperature setpoint cannot be attained when the system is operating on minimum outside air.

14.1.4 An operator adjustable time delay shall be provided to establish a stabilization period between consecutive setpoint adjustments.

14.1.5 Provide a summary for each fan system:

14.1.5.1 Space temperatures or thermostat signals and comfort range limits.

14.1.5.2 Current discharge temperature setpoints.

14.1.5.3 Status of freezestats and firestats.

14.1.5.4 Position of each AHU outside air, return air, and exhaust damper as sensed by the feedback potentiometer in the damper actuator.

14.2 CONSTANT VOLUME, SINGLE ZONE (MULTI SPACES) HEATING COIL AND SPACE TERMINAL HEATING COILS

14.2.1 BMS adjusts the supply air discharge temperature setpoint, as required to satisfy the warmest space and make up the difference by operating the reheat coils. Provide all sensors required for the proper operation and clearly identify in the point schedule.

14.2.2 Zone heating/cooling requirements shall be determined by monitoring space temperature. Supply air discharge temperature shall be adjusted up or down as appropriate until at least one of the measured inputs is at its comfort limit, indicating additional reset would cause zone discomfort.

14.2.3 In conjunction with the economizer controls, a comparison shall be made with the mixed air temperature, obtained with minimum outside air only, and the supply air discharge temperature setpoint. If the outside air temperature is suitable the maximum outside air, mixed air, and exhaust air dampers shall

modulate to satisfy the supply air discharge temperature setpoint without energizing the main heating coil or any space terminal reheat coil.

14.2.4 In the event that the outside air temperature is not suitable to maintain a minimum fixed mixed air temperature of 12.7□C (55 □F) with minimum outside air only, the main heating coil shall be energized to maintain a minimum fixed supply air discharge temperature setpoint of 12.7ºC. Required zone heating shall be supplied by the space terminal reheat coil. In the event that the outside air temperature is suitable to maintain a mixed air temperature ranging from 12.7º C (55ºF) to 18.3º C (65º F), using more that minimum outside air volume, without energizing the main heating coil, but is below the supply air discharge temperature setpoint, any further heating required shall be supplied via the space terminal reheat coil.

14.2.5 Whenever possible only one source of reheat, i.e. main heating coil or space terminal reheat coil, shall be used to satisfy the space temperature requirements.

14.2.6 An operator adjustable time delay shall be provided to establish a stabilization period between consecutive setpoint adjustments.

14.2.7 Provide a summary for each fan system:

14.2.7.1 Space temperatures or thermostat signals and comfort range limits.

14.2.7.2 Current discharge temperature setpoints.

14.2.7.3 Status of freezestats and firestats.

14.2.7.4 Position of each AHU outside air, return air and exhaust damper as sensed by the feedback potentiometer in the damper actuator.

14.3 CONSTANT VOLUME, SINGLE ZONE (MULTIPLE SPACES) HEATING AND COOLING COILS

14.3.1 Provide a program that automatically adjusts the supply air discharge temperature setpoint as high as possible (cooling) or as low as possible (heating to satisfy the space with the greatest cooling or heating load. Provide all sensors required for the proper operation and are clearly identified tin the point schedule.

14.3.2 Zone heating/cooling requirements shall be determined by monitoring space temperature. Supply air discharge temperature shall be adjusted up or down as appropriate until at least one of the measured inputs is at its comfort limit, indicating additional reset would cause zone discomfort.

14.3.3 In conjunction with the economizer controls, a comparison shall be made with the mixed air temperature, obtained with minimum outside air only, and supply air discharge temperature setpoint. If the outside air temperature is suitable the maximum outside air, mixed air, and exhaust air damper shall modulate to satisfy the supply air discharge temperature setpoint without energizing the main heating or cooling coil. The heating or cooling coil shall only be

energized if the supply air discharge temperature setpoint cannot be attained, but simultaneously.

14.3.4 In conjunction with the economizer control, when mechanical cooling is required to satisfy the supply air discharge temperature setpoint, the return air humidity shall be used to determine the supply air discharge temperature setpoint. If the supply air discharge temperature setpoint has been determined in accordance with the preceding, and the return air humidity level exceeds an operator adjustable setpoint level, indicating insufficient dehumidification is occurring, the supply air discharge temperature setpoint shall be decreased until the return air humidity level is below the setpoint limit.

14.4 CONSTANT VOLUME, SINGLE ZONE (MULTI SPACES) MAIN HEATING AND COOLING COILS, SPACE TERMINAL REHEAT COILS

14.4.1 This shall be the same as describe in item 3 above except that the space terminal reheat coil shall not be allowed to be energized until the space temperature falls 5.5 C below the lower limit of the operator adjustable comfort range

15 HYDRONIC SYSTEMS

15.1 SINGLE HEATING DISTRIBUTION SYSTEM

15.1.1 Where a single heating distribution system is used to serve air-handling units and/or any other terminal heating device, the supply water temperature shall be scheduled in accordance with outdoor temperature.

15.2 PRIMARY/SECONDARY HEATING DISTRIBUTION SYSTEM

15.2.1 Primary distribution system shall be constant temperature.

15.2.2 Secondary distribution system shall be scheduled in accordance with outside temperature. In addition, where the output of a terminal device is controlled via two-way valve, these control valves shall be monitored and if 4 or more control valves are not fully open the supply water temperature shall be decreased at a rate of 0.5 C - 1 C, at 2 minute intervals, until valves are fully open.

15.3 COIL CONTROL USING THREE WAY MIXING VALVE

15.3.1 The supply air discharge temperature controller, in sequence with the economizer controls, shall mix supply water with return water via 3-way to satisfy the supply air discharge temperature setpoint.

15.4 CO_2 CONTROL

15.4.1 Provide CO_2 controls to override economizer controls to allow more outside air to enter. Limit excess outside air in order to prevent mixed air temperature falling below 7ºC unless a glycol heating coil is installed.

15.5 HUMIDIFICATION

15.5.1 Modulate humidifier output under DDC control to satisfy return air humidity.

15.5.2 Hard wired safety controls shall include a high limit humidistat and air flow switch, supplied by the humidifier manufacturer, and installed and wired by the Controls Contractor, and a hard wired interlock with the supply fan starter.

15.5.3 DDC points shall include RAH, SAH, humidifier enable/disable, humidifier output modulation, and humidifier alarm.

15.5.4 Interlock the humidifier in software with the associated fan system, so that the humidifier is enabled only when the fans are commanded to run, and status points indicate that they are, in fact, running.

16 CONTROLS

16.1 EXTERIOR LIGHTING CONTROL

16.1.1 The exterior lighting system has been zoned and is provided with relays for control (relays by Division 16).

16.1.2 Morality lighting (including building flood lighting, and Parking Lot Lighting shall have separate schedules).

16.1.3 The above zones shall be on time of day schedules. Provide a schedule for each zone. Lighting shall be off from 09:00 hours to 17:00 hours, regardless of photosensor signal.

16.1.4 Morality Lighting shall be enabled, subject to photosensor status, every evening from 17:00 hours until 09:00 hours the following day. (Operator adjustable)

16.1.5 Parking Lot Lighting shall be enabled, subject to photosensor status every week night from 17:00 hours until 24:00 hours. (Operator adjustable

16.1.6 An exterior photometric sensor shall be monitored as an digital input point.

16.1.7 The BMS shall report an alarm if the photosensor senses light between 23:00 hours and 04:00 hours, or darkness between the 10:00 hours and 15:00 hours. This shall be an indication that either the photosensor is not working, or the BMS system clock is incorrectly set.

16.1.8 Install “Hand-Off-Auto” switches so that exterior lighting can be conveniently tested and re-lamped during daylight hours by staff not conversant with BMS operation.

16.1.9 The BMS shall monitor the status of the fire alarm system. If the fire alarm is active, subject to photo-sensor status, the BMS shall turn on all exterior lighting under its control, and leave it on four hours after the alarm is cleared.

16.1.10 The corridor lighting shall be controlled by the BMS. The BMS shall monitor the security system. When the security system is armed and is free of any

alarm the volt free contact shall close and the BMS shall turn off the corridor lights 15 min after it senses the closure of the contact. When the security system in unarmed or there is an alarm in the security system the volt free contact shall open and the BMS shall turn on all the corridor lights

16.1.11 Install “Hand-Off-Auto” switches so that corridor lighting can be operated when required.

16.2 BOILER, CIRCULATING PUMP AND HEATING PUMP CONTROL (GENERAL)

16.2.1 The DDC control system shall monitor the status, flame failure and alarm condition of each modular unit or large boiler, using the dry contacts provided by the boiler manufacturer.

16.2.2 Install DDC lead and lag control and sequential operation for modular units and large boilers and associated circulating pumps on a rotational basis. Where boilers are fitted with modulating or low/high firing burners, monitor the status of boiler firing. Standalone boiler/pump sequencing panels shall not be acceptable.

16.2.3 Status of boilers and boiler stages and boiler alarms shall be indicated by LEDs mounted on the front cover of the BMS boiler controller cover.

16.2.4 Emergency operation of boilers shall be achieved by putting the Boiler “Hand-Off-Auto” switch in the “Hand” position. When in “Hand”, the boiler shall be controlled by its own operating aquastat. The high temperature limit aquastat and other safety devices shall remain in the circuit regardless of switch position

16.2.5 Emergency operation of pumps shall be achieved by putting the “Hand-Off-Auto” switch on the starter in the “Hand” position

16.2.6 Where a primary/secondary loop system is designed the primary loop shall be constant temperature. Implement outside air temperature reset of secondary loop clearly showing design parameters.,

16.2.7 Where there is only a primary loop serving all heating equipment, implement outside air temperature reset of the primary loop and monitor return water temperature to ensure that the return hot water temperature is above the minimum necessary to prevent condensation inside the boiler.

16.2.8 This section shall take precedence over the burners and controls paragraphs of the boilers, pumps and starters specifications.

16.2.9 New boilers shall be complete with modulating burners.

16.2.10 New boilers shall be complete with factory wired safety controls, including flow proving switch, low water cutoff, high temperature limit aquastat, operating aquastat and “Hand-Off-Auto” switch. The equipment specification shall clearly indicate that if a device is to be field wired, the wiring shall be

the responsibility of the Controls Contractor**.** Otherwise, the cost of field wiring boiler components shall be the responsibility of the boiler vendor.

16.2.11 New boilers shall also be complete with alarm package and clearly labeled terminal strip. The terminal strip shall have connections for the following:

16.2.11.1 "Enable/Disable" or "Start/Stop"

16.2.11.2 "Modulation" (Company's choice of 0 – 10 VDC or 4 – 20 mAmps)

16.2.11.3 "Flame Status" (Dry Contacts)

16.2.11.4 "Flame Failure" (Dry Contacts)

16.2.12 The Consultant shall forward a copy of the shop drawings for boiler, circulating pumps and pump starters for review by the BMS contractor. BMS contractor shall certify these drawings as complying with these interface requirements, and being free of superfluous controllers. Shop drawings shall not be certified by the BMS contractor unless they are complete with legible internal and external wiring diagram.

16.2.13 The Consultant shall be responsible for ensuring that the installed equipment is complete with specified terminal strips and without standalone controllers to enable BMS to have direct control of the equipment

16.3 AIR HANDLING UNITS AND FANS

16.3.1 The DDC system shall control, adjust setpoints and monitor the status of air handling unit and components, control status of supply, return, and exhaust fans larger than .1 kW. Status of fans shall be determined by a current transformer. Actual amp draw in real time and calculated status shall be available at the Operator Console. Connection to an auxiliary starter contact is not an acceptable alternative method. Alarm setpoints are to be set in software high enough that the current drawn by a free wheeling motor with a broken fan belt or coupling shall not be high enough to confirm "ON" status. Fan status shall be presented on the graphical display as an animation

16.3.2 If the drawings or fan schedule stipulate that a specific fan is to be complete with Back Draft Damper, the BMS contractor shall not include for a Motorized Damper for that fan.

16.3.3 The Consultant shall ensure that any fan, heat recovery unit and air handling unit shown on the drawings or in the specification to be complete with motorized dampers, these comply with the Section 15900 Specification i.e. TAMCO dampers and Belimo actuators.

16.4 STATUS OF PUMPS

16.4.1 The DDC system shall control and monitor the status of all HVAC and Domestic Hot Water pumps. Status of pumps shall be determined by a current transformer, in conjunction with an AI point. Actual current draw in real time, expressed in amperes as well as calculated status shall be available at the

OWS. Connection to an auxiliary starter contact is not an acceptable alternative. Pump status shall be presented on the graphical display as an animation.

16.5 CABINET HEATERS, FORCE FLOWS AND UNIT HEATERS

16.5.1 The DDC control system shall control all cabinet and unit heaters. Install plate type room temperature sensor and stop/start for each heater. Status points are not required. Implement night setback. Mode may be overridden only at the OWS.

16.5.2 For unit heaters, cycle supply fan on/off to maintain set point.

16.5.3 For cabinet heaters, cycle supply fan on/off and modulate control valve to maintain setpoint.

16.5.4 The control system shall maintain the following temperatures:

16.5.4.1 Occupied mode 18º C

16.5.4.2 Unoccupied mode 13º C

16.6 ELEVATOR MACHINE ROOM, ELECTRICAL ROOM, STORAGE ROOMS, NODE ROOMS

16.6.1 The DDC control system shall cycle the exhaust fan motorized dampers and heating device, where applicable to maintain a setpoint of 27º C. Status point is not required.

16.7 DIFFERENTIAL PRESSURE CONTROL

16.7.1 Install pressure sensors on the discharge and suction side of the pumps. When the pressure differential increases beyond a pressure differential set point, the BMS shall modulate the bypass valve to maintain the setpoint.

16.8 PERIMETER RADIATION

16.8.1 Radiation valve shall modulate to maintain setpoint of local space temperature sensor.

16.8.2 During unoccupied mode, radiator valve modulates to maintain “unoccupied” set point.

16.8.3 Where adjustable setpoint thermostats are provided, the setpoint wheel shall adjust the Occupied Mode setpoint only. Setpoint adjustment available at the thermostat shall be limited in software to a reasonable range of 20º to 22º C.

16.9 DOMESTIC HOT WATER (GAS FIRED SYSTEM)

16.9.1 The Building Automation System shall control the domestic hot water pump(s) on Time of Day. The BMS shall monitor the status of the DHW pump(s) by means of current transformers, and monitor the supply temperature.

16.10 BOILER AND MECHANICAL ROOM SUPPLY AIR SYSTEMS

16.10.1 The DDC control system shall cycle the exhaust fan, dampers and unit heater or other heating device, and modulate the outside air, return air and exhaust air dampers as required to maintain the temperature between a heating setpoint of 18oC and a cooling setpoint of 24oC. Fan status point is required.

16.11 ROOFTOP AND INDOOR PACKAGED HVAC UNITS

16.11.1 Mechanical contractor shall provide units complete with safety controls, dampers and Belimo MFT actuators, and terminal strips only. The terminal strip shall be the interface between the BMS and the unit, and shall be the means for the BMS to:

16.11.1.1 Directly modulate the damper actuator(s)

16.11.1.2 Directly control the stages of cooling

16.11.1.3 Directly control the heating modulation or stages of heating

16.11.1.4 Directly control any valves which may be provided by unit manufacturer

16.11.1.5 (Unless otherwise specified, this section is responsible for valves)

16.11.1.6

16.11.1.7 Monitor signals from unit's integral safety controls for flame status, flame failure and cooling alarm.

16.11.1.8 Monitor status of filter clogged sensors, if so equipped.

16.11.2 All valves or damper actuators provided by equipment manufacturers shall be suitable Belimo Multifunction Technology, configured to accept a 2 – 10 VDC control signal, but field configurable to other standard control signals, including 0 – 10 VDC and 4 – 20 mAmps.

16.11.3 The BMS shall monitor space temperature, space setpoint, return air temperature, supply air temperature, and mixed air temperature and fan(s) status, and modulate the dampers and cycle the heating and cooling as required to maintain space temperature at setpoint.

16.11.4 The BMS shall coordinate the operations of this unit with any radiation zones that serve the same area. The BMS shall implement heating setback and cooling setup with manual override during unoccupied hours.

16.11.5 The BMS shall register alarms if:

16.11.5.1 Space temperature is out of range

16.11.5.2 Fan status does not match commanded state

16.11.5.3 Unit not heating when commanded, as indicated by SAT

16.11.5.4 Unit not cooling when commanded, as indicated by SAT

16.11.5.5 Flame status as indicated by dry contacts

16.11.5.6 Flame failure or cooling alarm as indicated by dry contacts

16.11.6 Consultant shall submit shop drawings for the above equipment to the BMS contractor for review by the BMS contractor to ensure that they comply with these requirements, and being free of superfluous controllers. Consultant shall then review to ensure they comply with the specified Sequence of Operation.

16.12 RESUMPTION OF POWER

16.12.1 BMS controllers and front end will restart on resumption of power without human intervention.

16.12.2 In the event of a power outage, upon restoration of power, the BMS shall stage on controlled equipment to prevent avoidable power surges

16.12.3 Equipment and systems must be restored in a logical order. For example, in the case of a heat pump system, the pumps should be restored first, followed by the boiler or fluid cooler, and finally the heat pumps.

16.12.4 The time between stages shall be sufficient to permit the first piece of equipment to startup, come up to speed, and settle down to drawing normal “run” amperage before starting up the next piece of equipment.

16.12.5 Specify in the shop drawing submittals the order in which controlled equipment shall be restored to normal operation after resumption of power.

17 ALARM HANDLING

17.1.1 Alarm handling shall be a function of the DDC controllers, rather than the operator interface software, and the following functionality will be available in text mode without sound, even if the Operator Interface Software is running.

17.1.2 Alarms will be designated “Critical” or “Non Critical”.

17.1.3 “Critical” alarms shall be registered for conditions that are serious enough to compromise the ability of the building systems to support normal business activities. Alarms should not be designated “Critical” unless they would justify having the building operator attend the site, or at least dial in to the site after hours.

17.1.4 “Non Critical” alarms shall be registered for conditions that lack that urgency.

17.1.5 “Critical” alarms are designated on the points list as “CR”, while “Non Critical” alarms are shown as digits.

17.1.6 In the event of a “Critical” alarm, the BMS shall:

17.1.6.1 Indicate an alarm at the Operator Workstation (assuming that the OWS is turned on) both on the monitor and by voice message to the

speakers.

17.1.6.2 Print out an alarm at the Operator Workstation (assuming that both OWS and printer are both turned on)(provided printer is specified to be provided).

17.1.6.3 Dial out an alarm to the building operator's pager.

17.1.6.4 Dial out an alarm to the contractor's monitoring station, which in turn notifies contractor's duty technician.

17.1.7 In the event of a "Non Critical" alarm, the BMS shall:

17.1.7.1 Indicate an alarm at the Operator Workstation (assuming that the OWS is turned on) both on the monitor and by voice message to the speakers.

17.1.7.2 Dial out an alarm to the control monitoring station.

17.1.8 If the OWS is not turned on at the time of the alarm, the alarm condition will be reported on the OWS monitor when the OWS is next activated.

18 ASSIGNMENT OF ACCESS LEVELS

18.1.1 Divide operator access to system into 3 basic levels of operation, programming and configuration of system. Each level requires unique access code and operator's initials to sign on.

18.1.2 **Level 1** permits review of status and statistical data in panel being accessed. This includes status and value of points, totalized run time and trend data. Level 1 also allows operator to manually start and stop points and acknowledge alarms.

18.1.3 **Level 2** provides operator with ability to perform level 1 function, and display or modify application program data. Normally issued to senior board staff only, who have responsibility for energy costs.

18.1.4 **Level 3** provides access to programming and safety logic, including limits on adjustment ranges, and will require high level access. This level normally issued only to customer or contractor technicians certified by the manufacturer.

18.1.5 **Interface** shall permit setpoint adjustment through graphics display using pull-down menus, mouse in conjunction with keyboard. Setpoint adjustments shall be password protected as follows:

18.1.6 Adjustment within limited range of nominal setpoint, low level password adjustment outside of limited range above, medium level password alarm setpoints, high level password.

18.1.7 Review of logs/status/system graphics shall be unprotected or low-level password protected.

18.1.8 Programming, graphics display modifications shall be accessible only through medium/high level passwords as directed at system commissioning.

19 SCHOOL SCHEDULING

19.1.1 BAS Contractor to allow for Scheduling as shown in the attached school scheduling flow chart from the board, once the school schedule is programmed into the BAS system update the graphics on the front desk at the Board and review the school scheduling with the Board's representative. Allow for any required changes that may be necessary to meet all the requirements of the Board.

End of Section

1 COIL CLEANING (AHU COILS, FAN COIL UNITS & REHEAT COILS)

Contractor to allow for cleaning of all coils for both the schools, AHU Coils, FCU Coils & Reheat Coils, location of these coils is shown on the mechanical plans.

Coil Cleaning Procedure:

- Cleaning of Heating Coils
- Cleaning of Cooling Coils
- Cleaning of Re-Heat and Heat Pump Coils
- Cleaning of Fan Coil Units/Ventilators
- Heat Reclaim Coils (Main AHU's)
- Access Hatches

1.1 Cleaning of Heating Coils

- Shut down all electrical supply to the unit being worked on, Lockout / Tagout equipment to allow for safe maintenance.
- Follow Confined Space Entry Procedure.
- Remove all loosened debris from the coils using a dry vacuum with bristle brush
- Apply cleaning chemical as per manufacturer's instructions to both sides of the coil to adequately penetrate to the interior surfaces. (MSDS of Cleaning Solution provided)
- Contractor to provide before and after pictures of the coils.
- Pressure readings, before and after the coil cleaning. One taken on the air entry side (before and After the cleaning) and one pressure reading taken on the air existing side (before and after the Cleaning) to indicate the increased air flow.
- Apply cleaning chemical as per manufacturer's instructions to the drip pan located below the coil.
- Remove loosened debris from the coils using clean water
- Wet vacuum all rinse water, debris and/or chemical, from within the HVAC system.
- Repeat as necessary until all dirt and debris is removed from the coils interior and exterior surfaces within the HVAC System as well as drip pan.
- Apply leave on environmentally friendly mold and mildew remediation to prevent future mold and mildew growth on coils and in drain pan. (MSDS provided)
- Leave HVAC duct and pan in a dry condition.
- When finished the cleaning work, remove lock installed in lock installed in Lockout/Tagout.
- Operate the air handling unit to dry the coil completely

1.2 Cleaning of Cooling Coils

- Shut down all electrical supply to the unit being worked on, Lockout / Tagout equipment to allow for safe maintenance.
- - Follow Confined Space Entry Procedure.
- Contractor to provide before and after pictures of the coils.
- Pressure readings, before and after the coil cleaning. One taken on the air entry side (before and After the cleaning) and one pressure reading taken on the air existing side (before and after the Cleaning) to indicate the increased air flow.
- Remove all loosened debris from the coils using a dry vacuum with bristle brush
- Apply cleaning chemical as per manufacturer's instructions to both sides of the coil to adequately penetrate to the interior surfaces. (MSDS of Cleaning Solution provided)
- Apply cleaning chemical as per manufacturer's instructions to the drip pan located below the coil.
- Remove loosened debris from the coils and drip pan using clean water
- Wet vacuum all rinse water, debris and/or chemical, from within the HVAC system.
- Repeat as necessary until all dirt and debris is removed from the coils interior and exterior surfaces within the HVAC System as well as drip pan.

- Clean drip pan drainage piping, ensure there is a free flow of water and there is no blockage within the piping.
- Apply leave on environmentally friendly mold and mildew remediation to prevent future mold and mildew growth on coils and in drain pan. (MSDS provided)
- Leave HVAC duct and pan in a dry condition.
- When finished the cleaning work, remove lock installed in lock installed in Lockout/Tagout.
- Operate the air handling unit to dry the coil completely

1.3 Cleaning of Re-Heat and Heat Pump Coils

- Where access to re-heat or heat pump coils are restricted by drywall ceiling without access, Coil Cleaning Technicians will notify DPCDSB to have access installed
- Shut down all electrical supply to the unit being worked on, Lockout / Tagout equipment to allow for safe maintenance.
- Follow Confined Space Entry Procedure.
- Remove all loosened debris from the coils using a dry vacuum with bristle brush
- Apply cleaning chemical as per manufacturer's instructions to both sides of the coil to adequately penetrate to the interior surfaces. (MSDS of Cleaning Solution provided)
- Remove loosened debris from the coil using clean water. Wet vacuum all rinse water, debris and/or chemical, from within the HVAC system.
- Repeat as necessary until all dirt and debris is removed from the coils interior and exterior surfaces within the HVAC System as well as drip pan.
- Contractor to provide before and after pictures of the coils.
- Pressure readings, before and after the coil cleaning. One taken on the air entry side (before and After the cleaning) and one pressure reading taken on the air existing side (before and after the Cleaning) to indicate the increased air flow.
- Apply leave on environmentally friendly mold and mildew remediation to prevent future mold and mildew growth on coils and in drain pan. (MSDS provided)
- Leave HVAC duct and pan in a dry condition.
- When finished the cleaning work, remove lock installed in lock installed in Lockout/Tagout.
- Operate the air handling unit to dry the coil completely
- Identify on the ceiling the location of the coil using a label/sticker. Label/sticker to be approved prior by the board representative.

1.4 Cleaning of Fan Coil Units/Ventilators

- Shut down all electrical supply to the unit being worked on, Lockout / Tagout equipment to allow for safe maintenance.
- Follow Confined Space Entry Procedure.
- Remove all loosened debris from the coils using a dry vacuum with bristle brush
- Apply cleaning chemical as per manufacturer's instructions to both sides of the coil to adequately penetrate to the interior surfaces. (MSDS of Cleaning Solution provided)
- Apply cleaning chemical as per manufacturer's instructions to the drip pan located below the coil.
- Remove loosened debris from the coils and drip pan using clean water.
- Contractor to provide before and after pictures of the coils.
- Pressure readings, before and after the coil cleaning. One taken on the air entry side (before and After the cleaning) and one pressure reading taken on the air existing side (before and after the Cleaning) to indicate the increased air flow.
- Wet vacuum all rinse water, debris and/or chemical, from within the HVAC system.
- Repeat as necessary until all dirt and debris is removed from the coils interior and exterior surfaces within the HVAC System as well as drip pan.
- Clean drip pan drainage piping, ensure there is a free flow of water and there is no blockage within the piping.
- Apply leave on environmentally friendly mold and mildew remediation to prevent future mold and mildew growth on coils and in drain pan. (MSDS provided)
- Leave HVAC duct and pan in a dry condition.
- When finished the cleaning work, remove lock installed in lock installed in Lockout/Tagout.
- Operate the air handling unit to dry the coil completely

1.5 Heat Reclaim Coils (Main AHU's)

- It is understood that the heat reclaim coils could be Freon based or glycol based. Care shall be taken not to damage any mechanism that may tilt or control the reclaim coil.
- It is understood that the cleaning of the heat reclaim coils shall include both the supply and the exhaust side of the system.
- Where proper air filtration has not been provided on either the supply or exhaust side of the coil, a Promain Technician will notify the DSBN.
- Shut down all electrical supply to the unit being worked on, Lockout / Tagout equipment to allow for safe maintenance.
- Follow Confined Space Entry Procedure.
- Remove all loosened debris from the coils using a dry vacuum with bristle brush
- Apply cleaning chemical as per manufacturer's instructions to both sides of the coil to adequately penetrate to the interior surfaces. (MSDS of Cleaning Solution provided)
- Apply cleaning chemical as per manufacturer's instructions to the drip pan located below the coil.
- Remove loosened debris from the coils and drip pan using clean water.
- Contractor to provide before and after pictures of the coils.
- Pressure readings, before and after the coil cleaning. One taken on the air entry side (before and After the cleaning) and one pressure reading taken on the air existing side (before and after the Cleaning) to indicate the increased air flow.
- Wet vacuum all rinse water, debris and/or chemical, from within the HVAC system.
- Repeat as necessary until all dirt and debris is removed from the coils interior and exterior surfaces within the HVAC System as well as drip pan.
- Clean drip pan drainage piping, ensure there is a free flow of water and there is no blockage within the piping.
- Apply leave on environmentally friendly mold and mildew remediation to prevent future mold and mildew growth on coils and in drain pan. (MSDS provided)
- Leave HVAC duct and pan in a dry condition.
- When finished the cleaning work, remove lock installed in lock installed in Lockout/Tagout.
- Operate the air handling unit to dry the coil completely.

1.6 Access Doors

- If required, provide access opening into the ductwork to facilitate the cleaning of the coils.
- Provide access doors in the ductwork for future access to coils. Install in accordance with the requirements of SMACANA HVAC Duct Construction Standards Metal and Flexible.
- Where required due to size, Technician's will provide multiple access doors to suit and adequately reinforce the ductwork to suit the number of doors installed
- Fabricate access hatches of the same material as duck and metal gauge suitable for the application and size of doors. Swivel locks will be utilized to give a tight closure on the neoprene gasket. All hardware will be made of corrosion resistant material.
- Provide access doors on thermally insulated ducts of double panel construction with the insulation as specified for adjacent ducts sandwiched between panels. Depth of access door stand-off matches the thickness of the thermal insulation finish with minimum 1 inch face for termination of thermal insulation.

End of Section