

Part 1 General

1.1 COMMENCEMENT OF WORK

- .1 Construction shall commence and shall continue without interruption until completion of all Work included in the Contract.
- .2 The Contractor shall schedule an initial jobsite meeting for the purpose of laying out and phasing the Work as required.

1.2 SCHEDULING DELIVERIES

- .1 All materials shall be delivered to the site in ample time for proper incorporation into the Work in accordance with the normal progress of the job.

1.3 LAYOUT OF WORK

- .1 The Contractor's superintendent on the jobsite shall lay out the Work correctly, establishing schedules and shutdowns, etc.

1.4 SCHEDULE OF WORK

- .1 Within one week of award of Contract, the Contractor shall submit a schedule showing the times at which he proposes to do the various items of Work. This schedule shall include the following items:
 - .1 Schedules/length of time required for shut-downs.
 - .2 The Subcontractors schedule shall recognize and incorporate the following basic requirements:
 - .1 Timing of power and equipment interruptions and the amount of interruptions shall be kept as short as possible/to a minimum.
 - .2 Timing of all noise creating Work shall be coordinated with the City's Representative.

1.5 WORK PERIODS

- .1 All Work shall be scheduled by the Contractor and approved by the City.
- .2 It is imperative that all Work be carried out such that the period of interruption of services is minimized. All required interruptions must be scheduled with and co-ordinated with the City. Obtain signed services shutdown notice from The City prior to proceeding with each shutdown required. Sample shutdown notice is included at the end of this section. Where deemed necessary by The City's representative, this Work shall be carried out at night and on weekends.
- .3 All Work shall be done in such a manner that it does not disrupt the normal operation of the Building. All additional costs for overtime, or for Work required at other than normal working hours shall be included in the Bid Opportunity price.

1.6 SECURITY

- .1 All mechanical room doors and doors leading to roof, crawlspace & mechanical rooms access shall be kept closed and locked.

1.7 ADDITIONAL REQUIREMENTS OF CONTRACTOR

- .1 Comply with the following additional requirements as set out by the City:
 - .1 The City must be notified of all Subcontractors involved in the project, including a contact name and telephone number.
 - .2 Building Permit will be posted at the job site.
 - .3 Delivery or removal of building materials must be scheduled with the City.
 - .4 Co-ordinate with The City for weight restrictions, cab dimensions, door openings, etc.
 - .5 Carts for moving supplies will be supplied by Contractor.
 - .6 Requests for access must be submitted to the City with list of names for approval.
 - .7 Entrance keys must be issued to Subcontractors by the City.
 - .8 Public corridors are to be kept free of construction materials, tools or debris and are NOT to be used as storage areas.
 - .9 Contractor will leave all public areas in a neat and tidy appearance.
 - .10 WHMIS product data sheets will be supplied to the City prior to use on job site. This includes all chemicals, paints, glues, cleaners, or odour causing substances, etc. The City reserves the right to deny permission for use of substances deemed to be a health or safety hazard to building occupants.
 - .11 Use of all odour producing substances will be restricted to hours agreed to by The City.
 - .12 All garbage must be removed from the site by the Subcontractors. The City's garbage bins are NOT available to Subcontractors. Subcontractors must co-ordinate storage of garbage disposal bins on The City's property with The City.
 - .13 Contractor is responsible for after construction cleanup.
 - .14 Contractor will supply vacuums, brooms, etc. for use at the job site - equipment belonging to The City will NOT be used by Contractor's staff..
- .2 Fire Safety Precautions:
 - .1 While brazing, soldering, grinding, cutting or welding, protect building and contents against heat, sparks and fire by shielding. Maintain a fire extinguisher (ABC Multipurpose Class, minimum 10 lb. capacity) in working order, at each workstation, within close reach of all personnel located at that station, including stations where lead or lead joints are heated and where materials are heated with torches or open flames.
 - .2 Maintain cleanliness and order in all areas at all times. DO NOT ALLOW RUBBISH TO COLLECT. Keep fire alarm pull stations, alarm panels, doorways, exits and corridors free of obstructions. Do not use wood wedges or other objects to hold open fire doors.
- .3 Personnel shall know location of fire alarm pull stations, fire extinguishing equipment and fire exits and evacuation routes for areas in which they are working.
- .4 Personnel shall know proper method of operating portable fire extinguishers, be familiar with various classifications of fire and appropriate method of extinguishers agent for each classification.
- .5 Store flammable or combustible gases used on construction site in ULC containers. Use and storage of these materials is subject to approval of The City.

- .6 Contractor shall provide additional staff to act as spotter for "hot Work" operations. Spotter's responsibility shall be to observe welding, soldering, flammable operations and to extinguish any sparks or fires resulting from Work.

1.8 PROJECT PHASING

- .1 Contractor shall coordinate with operations staff for timing of Work to be performed. Facility to remain in operation throughout construction process. Work for project will need to be phased to ensure minimal interruptions to operations.

1.9 CONSTRUCTION MEETINGS

- .1 The Contractor shall hold regular, bi-weekly, construction meetings on site at a time suitable for The City and Contract Administrator. Contractor shall lead the meetings and produce/issue meeting minutes within 5 working days after completion of the meeting.

END OF SECTION

Part 1 General

1.1 BARRIERS

- .1 Erect and maintain guard rails, fences, temporary enclosures, gates, warning signs and lighting, etc., as may be required by local by-laws, ordinances, and regulations, etc.

1.2 SECURITY

- .1 All temporary doors, or other access to the Work shall be equipped with secure locking devices, and upon completion of each day's Work all such accesses shall be securely closed and locked.

1.3 PROTECTION OF WORK AND PROPERTY

- .1 Weather Protection: This shall include protection of the Work from damage due to rain, water and snow. Provide and maintain temporary weathertight enclosures for all exterior openings as the need arises.
- .2 Provide protective plywood walkways on all new and existing roof sections subject to roof traffic, including tie-ins, water stops, and overnight seals in order to maintain integrity during all phases of construction.

1.4 FIELD OFFICES

- .1 Space for a field office will **not** be provided in existing building by The City.

1.5 STORAGE OF MATERIALS ON SITE

- .1 Some exterior space can be made available just west of gridline 56 and around gridline C for storage of materials on site as long as buses can still enter into the Track 12 overhead door. Additional space can also be made available north of the building in the fenced compound.

1.6 PARKING

- .1 Comply with all local Parking Regulations.

END OF SECTION

1.1 GENERAL

- .1 In addition to the standard cleanup requirements, the following shall apply.
- .2 Conduct cleaning and disposal operations to comply with local ordinances and anti-pollution laws.
- .3 Store volatile wastes in covered metal containers, and remove from premises daily.
- .4 Prevent accumulation of wastes which create hazardous conditions.
- .5 Provide adequate ventilation during use of volatile or noxious substances.

1.2 MATERIALS

- .1 Use only cleaning materials recommended by manufacturer of surface to be cleaned, and as recommended by cleaning material manufacturer.

1.3 CLEANING DURING CONSTRUCTION

- .1 Maintain The City's grounds, and public properties free from accumulations of construction waste materials and rubbish.
- .2 Provide trash receptacles where Work is being done, for storing trash and construction debris. Construction debris shall be removed from the premises in accordance with job progress.
- .3 Dispose of waste materials, and rubbish at designated areas, or at authorized public refuse grounds.
- .4 Vacuum clean interior building areas when ready for substantial completion or occupancy.
- .5 Contain all Work that generates dust and contamination. Protect The City's Work areas to eliminate any cross contamination.
- .6 If instructed to do so by the Contract Administrator or the City, the Contractor will clean any areas in question immediately.

END OF SECTION

Part 1 GENERAL

1.1 SECTION INCLUDES

- .1 Provide all labour, materials, methods, equipment and accessories to do all demolition, renovations, alterations, removals Work.
 - .1 Temporary, permanent shoring, protective devices, etc.
 - .2 Co-ordinate Work of trades, schedule elements of demolition, renovations Work, by procedures, methods to expedite completion.
 - .3 Cut, move or remove items as necessary to provide access, to allow alterations, new Work to proceed. Include such items as:
 - .1 Break through new openings, fill in openings, etc. in remaining construction indicated.
 - .2 Repair or remove hazardous conditions.
 - .3 Remove abandoned items, items serving no useful purpose, such as abandoned ductwork.
 - .4 Clean surfaces, remove surface finishes as required to install new Work, and finishes.
 - .5 Other existing Work, materials, etc. required for new Work in this Contract.
 - .4 Patch, repair, refinish existing items and surfaces to remain to new condition for each material, with approved transition to adjacent new construction.
 - .5 Repair all damage done to remaining existing walls, other materials, surfaces, properties, etc. caused by Work of this Contract.

1.2 EXAMINATION

- .1 Examine all areas undergoing renovation, alteration and demolition Work, and determine nature and extent of existing materials to remain.

1.3 ALTERATIONS, CUTTING, PROTECTION

- .1 Assign Work of moving, removal, cutting and patching to trades qualified to perform Work in manner to cause least damage to each type of Work.
- .2 Perform cutting, removal Work to remove minimum necessary, in manner to avoid damage to adjacent Work.
- .3 Provide temporary enclosures to separate Work areas from existing areas occupied by The City, provide protection, as required.

Part 2 PRODUCTS

2.1 SALVAGED PRODUCTS

- .1 Salvage sufficient quantities of cut or removed materials to replace damaged Work of existing construction, when material is not readily obtainable on current market.

- .2 Items not required for use in repair of existing Work shall remain the property of The City. Legally dispose off site when advised by The City.
- .3 Incorporate salvaged or used material in new construction only with permission of Contract Administrator, as specified, indicated.

2.2 MATERIAL FOR PATCHING, EXTENDING MATCHING

- .1 Patch, replace any portion of remaining existing finished surfaces with matching material.

Part 3 EXECUTION

3.1 PERFORMANCE

- .1 Make smooth, workmanlike transition when new Work abuts, finishes flush with existing Work.
- .2 Terminate existing surface in neat manner along straight line. Provide trim appropriate to finished surfaces.

3.2 RENOVATION ALTERATION

- .1 Co-operate fully, Work in conjunction with other trades for removal, breaking through, patching, repairing in existing building.
- .2 Execute all Work in orderly, careful manner, with due consideration for occupants of existing buildings. ARRANGE RENOVATION/ALTERATION SO USE OF EXISTING BUILDING REQUIRED BY THE CITY IS MAINTAINED.
- .3 Note that adjacent building areas will remain in continual occupancy.
- .4 Provide, maintain temporary access indicated, required, as directed.
- .5 Arrange renovation, alteration so operations required, used in present function of adjacent existing building is/are maintained in full use.
- .6 Arrange to disconnect, relocate items at time satisfactory to The City. Phase all operations to suit The City. Co-operate with The City.
- .7 Comply with Section 8, National Building Code for all Work.
- .8 Do not allow accumulation of scrap materials on jobsite.
- .9 Rebuild, restore Work demolished, damaged beyond limits shown, at no cost to The City.
- .10 Provide adequate protection to persons, property. Execute Work in manner to avoid interference with use of, passage to, from adjoining buildings, facilities.

3.3 CLEANING

- .1 Clean The City's occupied areas daily.

- .2 Provide temporary filters on return air openings; turn off ventilation systems, etc. all as required to minimize dust migration during dust producing operations.
- .3 Clean spillage, overspray, and heavy collection of dust in The City's occupied areas immediately.
- .4 Contain all Work that generates dust and contamination. Protect The City's work areas to eliminate any cross contamination.

END OF SECTION

General

1.1 REFERENCE STANDARDS

- .1 Submit a report showing that the specified roofing system has been tested for Wind Uplift Resistance in accordance with FM 4470 Standard. The test results shall demonstrate that the roofing system provides a resistance of -1.1 psf for the field surface of the roof. Edges and corners must be installed according to the requirements listed in FM PLPDS 1-29.
- .2 Membranes must meet or exceed requirements of CGSB 37.56-M (9th Draft), *Membrane, Modified, Bituminous, Prefabricated, and Reinforced for Roofing*.
- .3 Membranes must meet or exceed requirements of ASTM D 6164, Standard Specification for Styrene Butadiene Styrene (SBS) Modified Bituminous Sheet Materials Using Polyester Reinforcements.
- .4 Polyisocyanurate thermal insulation boards must meet or exceed requirements of CAN/ULC S704-011, *Thermal Insulation, Polyurethane and Polyisocyanurate, Boards Faced*.
- .5 Extruded polystyrene insulation boards must meet or exceed requirements of CAN/ULC-S701-11, *Expanded Polystyrene Insulation Board and Pipe Covering*.
- .6 Roofing system must meet or exceed requirements of CAN/ULC-S107-10, *Methods of Fire Tests of Roof Coverings, Class A*.

1.2 EXISTING ROOF ABOVE TRACK 1-12

- .1 The existing roof has a one year labour warranty that ends at the end of the 2017 summer. The bidders may use any Roofing Subcontractor that meets the requirements of the Bid Opportunity and this specification.

1.3 COMPATIBILITY

- .1 All waterproofing materials will be provided by the same manufacturer.

1.4 TECHNICAL DOCUMENTS

- .1 Submit two (2) copies of the most current technical data sheets. These documents must describe the physical properties of materials and explanations about product installation, including restrictions, limitations and other manufacturer recommendations.

1.5 QUALITY ASSURANCE AND ENVIRONMENTAL MANAGEMENT

- .1 The manufacturer of elastomeric bitumen products will provide proof of ISO 9001 and ISO 14001 Certifications.

1.6 CONTRACTOR QUALIFICATIONS

- .1 Roofing Contractor and Subcontractors must, when tendering and during works, possess a Roofing Contractor operating license.
- .2 Roofing Contractor and Subcontractors must also be registered with SOPREMA's PAQ + S program, and provide the architect with a written certificate issued by SOPREMA to this effect before beginning any roofing work.

1.7 MATERIALS STORAGE AND DELIVERY

- .1 All materials will be delivered and stored in their original packaging, in conformance with the requirements described in the manufacturer's technical documentation.
- .2 At all times, materials will be adequately protected and stored in a dry and properly ventilated area, away from any welding flame or spark, and sheltered from the elements and any harmful substances.
- .3 Store adhesives and solvent-based mastics at a minimum of 5 °C.
- .4 Materials delivered in rolls will be carefully stored upright; flashings will be stored to avoid wrinkling, buckling, scratches or any other possible damage.
- .5 Avoid gathering construction materials on the roof, which may affect the structural integrity by imposing loads exceeding what is admissible.

1.8 FIRE PROTECTION

- .1 Prior to the start of work, conduct a site inspection to ensure its safety in order to minimize fire risks and hazards.
- .2 Respect safety measures recommended by the related local authorities.
- .3 At the end of each workday, use a heat detector gun to spot any smouldering or concealed fire. Job planning must be organized to ensure workers are still on location at least 2 hours after welding works. An inspection must be performed by an employee of the Roofing Contractor who specializes in this kind of job at the end of works and, if necessary, with the help of a member of the fire protection service of the city.
- .4 Never apply the torch directly to flammable materials.
- .5 Throughout roofing installation, maintain a clean site and have a fire hose (when possible) and at least one ULC-approved Class A, B or C fire extinguisher, charged and in perfect operating condition, within 6 m (20 ft) of each torch. Respect all safety measures described in technical data sheets of sealants. Welding torches must never be placed near combustible or flammable products, nor be used where the flame is not visible or cannot be easily controlled.

1.9 WARRANTIES

- .1 The membrane manufacturer will issue a written and signed document in the The City's name, certifying that the roofing membranes are free of manufacturing defects for a period of ten (10) years, starting from the date of completion of membrane installation. This warranty will cover the removal and replacement of defective roof membrane products, including workmanship. The warranty must remain full and complete for the duration of the period specified. The warranty certificate must reflect these requirements.
- .2 The Contractor will provide a written and signed document to the The City's name certifying that the work executed will remain in place and free of waterproofing defect for a 2-year period from the date of acceptance.

Part 2 Products

2.1 VAPOUR BARRIER SUPPORT PANELS

- .1 NA

Gypsum-Fibre Roof Board

- .2 NA

2.2 VAPOUR BARRIER

Self-Adhesive Vapour Barrier

- .1 Description: Self-adhesive membrane composed of SBS modified bitumen, with a surface screen made of high-density polyethylene laminated between two layers of polyethylene films. The width of the membrane is 1.14 m (45 in) to allow the membrane to fit on the top of most structural steel deck profiles. The self-adhesive underface is protected with a silicone plastic release film.
- .2 Specified product: SOPRAVAP'R by SOPREMA.

Vapour Barrier Continuity Strip

- .3 Description: Waterproofing membrane with composite reinforcement and SBS modified bitumen. The surface is sanded and the underface is self-adhesive and covered with a silicon release film.
- .4 Specified product: SOPRALENE STICK ADHESIVE by SOPREMA.

2.3 INSULATION

Polyisocyanurate Insulation

- .1 Description: Closed-cell polyisocyanurate foam insulation board laminated on both sides with a fiberglass yarn-reinforced organic paper.

- .2 Specified product: SOPRA-ISO by SOPREMA

Description: Closed-cell polyisocyanurate foam insulation board laminated on both sides with a coated glass fibre facer.

- .3 Specified product: SOPRA-ISO PLUS by SOPREMA

Tapered Insulation Board

- .4 Description : Tapered insulation panel made of EPS designed to create a min 2 percent (%) slope to the roof system.

- .5 Specified product : Plastifab

Sump Insulation Board for Drain Location

- .6 NA

2.4 INSULATION SUBSTRATE OVERLAY

Bituminous Board

- .1 NA

2.5 MEMBRANES.

Base Sheet Membrane for Field Surface

- .1 Description: Roofing membrane composed of SBS modified bitumen and a glass mat reinforcement. The surface is covered with a thermofusible plastic film, the underside is covered with a release protection film. The surface must be marked with three (3) chalk lines to ensure proper roll alignment.

- .2 In conformance with: CGSB 37.56-M (9th Draft).

.3 Properties:	MD	XD
.1 Strain energy (kN/m)	1.8	1.2
.2 Breaking strength (kN/m)	12	8
.3 Ultimate elongation (%)		15
15		
.4 Tear resistance (N)	30	
.5 Static puncture resistance (N)	160	
.6 Dimensional stability (%)	0	0
.7 Plastic flow (°C)	≥ 90	
.8 Cold bending at -30 °C cracking		No
.9 Lap joint strength (kN/m)	Pass > 4 kN/m	

- .4 Specified product: COLVENT BASE 810 by SOPREMA

Base Sheet Membrane for Flashings and Parapets

- .5 Description: Membrane composed of SBS modified bitumen and glass mat reinforcement. The surface is covered with a thermofusible plastic film and the underface is covered with a release protection film. The surface shall be marked with three (3) chalk lines to ensure proper roll alignment.
- .6 In conformance with: CGSB 37.56-M (9th Draft).
- .7 Properties: MD XD
- .1 Strain energy (kN/m)
 - .2 Breaking strength (kN/m)
 - .3 Ultimate elongation (%)
 - .4 Tear resistance (N)
 - .5 Static puncture resistance (N)
 - .6 Dimensional stability (%)
 - .7 Plastic flow (°C) ≥
 - .8 Cold bending at -30 °C cracking No
 - .9 Lap joint strength (kN/m)
- .8 Specified product: SOPRALENE FLAM STICK by SOPREMA

Colour Choices for Roofing Cap Sheet Membrane Granules

- .9 For field surfaces: grey
- .10 For walkway surfaces: red

Roofing Cap Sheet Membrane for Field Surfaces

- .11 Description: Roofing membrane composed of SBS modified bitumen with a composite reinforcement and elastomeric bitumen. The surface is protected by coloured granules. The underface is covered with a thermofusible plastic film.
- .12 In conformance with: CGSB 37.56-M (9th Draft).
- .13 Properties: MD XD
- .1 Strain energy (kN/m) 7.8 7.2
 - .2 Breaking strength (kN/m) 15 13.5
 - .3 Ultimate elongation (%) 65 60
 - .4 Tear resistance (N) 125
 - .5 Static puncture resistance (N) 560
 - .6 Dimensional stability (%) 0.2 0
 - .7 Plastic flow (°C) ≥ 110
 - .8 Cold bending at -30 °C cracking No

.9 Lap joint strength (kN/m) Pass > 4 kN/m

.14 Specified Product: COLVENT TRAFFIC CAP 860 by SOPREMA

Roofing Cap Sheet Membrane for Flashings and Parapets

.15 Description: Roofing membrane composed of SBS modified bitumen with a composite reinforcement and elastomeric bitumen with flame-retarding agent. The surface is protected by coloured granules. The underface is covered with a thermofusible plastic film.

.16 In conformance with: CGSB 37.56-M (9th Draft).

.17 Properties:	MD	XD
.1 Strain energy (kN/m)	7.8	7.2
.2 Breaking strength (kN/m)	15	13.5
.3 Ultimate elongation (%)		60
65		
.4 Tear resistance (N)	125	
.5 Static puncture resistance (N)	560	
.6 Dimensional stability (%)	0.2	0
.7 Plastic flow (°C)	≥ 110	
.8 Cold bending at -30 °C cracking		No
.9 Lap joint strength (kN/m)	Pass > 4 kN/m	

.18 Specified Product: COLVENT TRAFFIC CAP 860 by SOPREMA

Starter Roll

.19 Description: Waterproofing membranes composed of SBS modified bitumen, covered with granules on surface, with a 100 mm (4 in) selvedge on both sides. The underface is covered with a thermofusible plastic film.

.20 In conformance with: CGSB 37.56-M (9th Draft).

.21 Properties:	MD	XD
.1 Strain energy (kN/m)	13	10
.2 Breaking strength (kN/m)	25	21
.3 Ultimate elongation (%)		66
93		
.4 Tear resistance (N)	118	
.5 Static puncture resistance (N)	432	
.6 Dimensional stability (%)	-0.2	0.2
.7 Plastic flow (°C)	≥ 110	
.8 Cold bending at -30 °C cracking		No

.9 Lap joint strength (kN/m)

Pass > 4 kN/m

.22 Specified Product: STARTER FLAM GR by SOPREMA

2.6 ACCESSORY MEMBRANES

Cover Strip

- .1 Description: Membrane strip of 330 mm (13 in) 240 mm (9.45 in) made of SBS modified bitumen with a composite reinforcement. Both faces are covered with a plastic thermofusible film. The strip ensures water-tightness in the end laps.
- .2 In conformance with: ASTM D6162.
- .3 Specified product: SOPRALAP by SOPREMA.

2.7 PRIMER

Primer for Thermofusible Membranes

- .1 Description: Primer made of bitumen, volatile solvents and adhesive resins. Used as primer to improve the adhesion of thermofusible waterproofing membranes.
- .2 Specified product: ELASTOCOL 500 by SOPREMA.

Primer for Self-Adhesive Membranes

- .3 Description: Primer composed of SBS synthetic rubber, adhesive resins and volatile solvents. Used as primer to improve the adhesion of self-adhesive membranes.
- .4 Specified product: ELASTOCOL STICK by SOPREMA.

2.8 ADHESIVES

Insulation Adhesive

- .1 Description: Two-component, quick-setting, low-expansion foam urethane adhesive that can be applied at any temperature.
- .2 Specified product: DUOTACK by SOPREMA

2.9 FLAME-STOP MEMBRANE

- .1 Description: Self-adhesive membrane composed of SBS modified bitumen and a glass mat reinforcement, designed to prevent flames from penetrating into voids, cavities and openings before installing heat-welded membranes.
- .2 Specified products: SOPRAGUARD tape by SOPREMA
- .3 Description: Membrane composed of a reinforced glass mat coated with oxidized bitumen. Both faces are sanded.

- .4 Specified products: SOPRAGLASS 40 by SOPREMA

2.10 FASTENERS

Insulation Fasteners

- .1 Description: #14 Phillips
- .2 Specified products: Dekfast

2.11 COMPLEMENTARY WATERPROOFING PRODUCTS

Waterproofing Mastic

- .1 Description: Multi-purpose mastic composed of SBS modified bitumen, fibres, aluminium pigments, mineral fillers and solvents.
- .2 Specified product: SOPRAMASTIC ALU by SOPREMA

Pitch Pocket Filler

- .3 Description: Polyester-made precast blocks of various sizes a single-component, polyether-based mastic and a single-component, polyether based sealant and adhesive.
- .4 Specified product: SOPRAMASTIC BLOCK SYSTEM by SOPREMA

Sealing Product

- .5 Description: Bitumen/polyurethane waterproofing mono-component resin and polyester reinforcement.
- .6 Specified products: ALSAN FLASHING and ALSAN REINFORCEMENT by SOPREMA

2.12 ROOF WALKWAYS

Membrane Walkways

- .1 Description: Waterproofing membrane composed of SBS modified bitumen and non-woven polyester reinforcement, used to protect membranes subjected to foot traffic. The surface is covered with black granules; the underface is protected by a thermofusible plastic film.
- .2 In conformance with: CGSB 37.56-M (9th Draft).
- .3 Specified product: SOPRAWALK by SOPREMA
- .4 Description: Waterproofing membrane composed of SBS modified bitumen and unwoven polyester reinforcement, used to protect membranes subjected to foot traffic. The surface is covered with red granules; the underface is protected by a thermofusible plastic film.

- .5 In conformance with: CGSB 37.56-M (9th Draft).
- .6 Specified product: SOPRASAF'T by SOPREMA

Part 3 Execution of Work

3.1 SURFACE EXAMINATION AND PREPARATION

- .1 Surface examination and preparation must be completed in conformance with instructions in the membrane manufacturer's technical documentation.
- .2 Before roofing work begins, the The City's representative and roofing foreman will inspect and approve deck conditions (including slopes and wood grounds) as well as flashings at parapets, roof drains, plumbing vents, ventilation outlets and other construction joints. If necessary, a non-conformity notice will be issued to the Contractor so that required corrections can be carried out. The start of roofing work will be considered as acceptance of conditions for work completion.
- .3 Do not begin any portion of work before surfaces are clean, smooth, dry, and free of ice and debris. Use of calcium or salt is forbidden for ice or snow removal.
- .4 Be sure plumbing, carpentry and all other works have been duly completed.
- .5 No materials will be installed during rain or snowfall.

3.2 METHOD OF EXECUTION

- .1 Roofing work must be completed in a continuous fashion as surfaces are readied and as weather conditions allows it.
- .2 It's preferable to seal all joints that are not covered by a cap sheet membrane the same day. A second cap sheet cannot be installed if any moisture is present in joints.
- .3 Ensure waterproofing of roofs at all times, including protection during installation work by other trades and protection as work is completed (e.g. vents, drains, etc.).

3.3 SITE PROTECTION

- .1 Protect the exposed surfaces of finished work to avoid damage during roof installation and material transportation. Install walkways made of rigid boards 1" SM insulation & plywood or approved equal in accordance with B7 over installed roofing materials to enable passage of people and transport of products. No tools, equipment or materials shall bear directly on unprotected roof surface(s). Access points such as external ladder areas shall also be protected. Assume full responsibility for any damage.

3.4 PREPARATION WORK – METAL DECK

- .1 NA (Install acoustic insulation in deck flutes).

3.5 PREPARATION WORK – CONCRETE DECK

- .1 NA

3.6 INSTALLATION OF VAPOUR BARRIER SUPPORT PANELS ON STEEL DECK

- .1 NA

3.7 APPLICATION OF PRIMER

- .1 Wooden, metallic, concrete, and masonry surfaces or gypsum insulation substrate will receive a coat of primer. (no primer is required for factory-painted metals). All surfaces to be primed must be free of rust, dust or any residue that may hinder adherence. Primed surfaces must be covered with the roofing membrane as soon as possible (on the same day for self-adhesive membranes).

3.8 INSTALLATION OF SELF-ADHESIVE VAPOUR BARRIER

- .1 Primer must be dry prior to the installation of the vapour barrier membrane.
- .2 Starting at the bottom of the slope, without adhering the membrane, unroll it onto the substrate for alignment. Do not immediately remove the silicone release film.
- .3 Align the roll parallel to the ribs of the steel deck. Make sure membrane overlaps are supported along their entire length.
- .4 Remove one end of the silicone release film and adhere this part of the membrane to the substrate. Remove the remaining release film at a 45° angle to avoid wrinkles in the membrane.
- .5 Overlap adjacent rolls of 75 mm (3 in) and 100 mm (4 in). End laps must be 150 mm (6 in). Space end laps by at least 300 mm (12 in).
- .6 When the vapour barrier is installed directly on a steel deck, place a thin sheet of metal under the end laps of the vapour barrier.

3.9 INSTALLATION OF INSULATION

- .1 Adhere insulation by using specified adhesive in continuous strips spaced 14” on the field surface, 9” on the perimeter, and 6 on corners. Corners and perimeters must be installed as per FM requirements listed in the PLPDS 1-29.

NOTE TO THE CONTRACTOR: Use the following clause when boards require mechanically fastening to the substrates to lay flat if board(s) tent.

- .2 Mechanically fasten boards with screws and plates for membranes, at a rate of 14" on the field surface, 9" on the perimeter, and 6" on corners. Corners and perimeters must be installed as per FM requirements listed in the PLPDS 1-29. Screws must be driven in deck's upper flutes.

3.10 SUMP INSULATION PANEL INSTALLATION

- .1 NA

3.11 INSTALLATION OF SUPPORT PANELS

- .1 NA

3.12 INSTALLATION OF FLAME-STOP MEMBRANE

NOTE TO THE CONTRACTOR: Ensure insulation substrates and adjoining work or construction elements pose no hazards during use of torch equipment. Do not weld onto wood substrates or at locations where chimney or back draft effects could project flames onto concealed combustible materials. Consult membrane manufacturer for alternate work methods where such cases apply.

- .1 Adhere the membrane directly onto an approved substrate by removing the silicone release film. SOPRAGUARD TAPE is designed to prevent flames from penetrating into voids, cavities and openings while installing heat-welded membranes.
- .2 Unroll the flame-stop membrane onto the insulation, being careful to overlap adjacent selvages to ensure that the flame will not penetrate the insulation.

3.13 INSTALLATION OF SELF-ADHESIVE BASE SHEET ON FIELD SURFACE

- .1 Dry unroll base sheet onto substrate, taking care to align the edge of the first selvedge with drain centre (parallel to roof edge).
- .2 Remove the silicone release film to adhere the membrane to the substrate. Remove the protective film from the side lap strip.
- .3 Each selvedge will overlap the previous one along lines provided for this purpose, and will overlap by 25 mm (1 in) at the ends. Because of the nature of this system, for this type of base sheet, joints can be aligned (no offset) to facilitate the installation of the reinforcing strip.
- .4 Seal end laps with a 330-mm (13-in) 240-mm (9.45-in) wide protection strip centered on the joint.
- .5 Seal all side laps using a torch and a round-nosed trowel.
- .6 Avoid the formation of wrinkles, swellings or fishmouths.

3.14 INSTALLATION OF SELF-ADHESIVE BASE SHEET ON FLASHINGS AND PARAPETS

- .1 Apply base sheet flashing only after primer coat is dry.
- .2 Before applying membranes, always burn the plastic film from the section to be covered if there is an overlap (inside and outside corners and field surface). For sanded base sheet membranes, apply primer for self-adhesive membrane on the area to be covered at the foot of the parapets.
- .3 Cut off corners at end laps of areas to be covered by the next roll.
- .4 Each selvedge will overlap the previous one along lines provided for this purpose, and by 150 mm (6 in) at the ends.
- .5 Position the pre-cut membrane. Remove 150 mm (6 in) of the silicone release film to hold the membrane in place at the top of the parapet.
- .6 Then, gradually peel off the remaining silicone release film, pressing down on the membrane with an aluminum applicator to ensure good adhesion. Use the aluminum applicator to ensure a perfect transition between the flashing and the field surface. Smooth the entire membrane surface with a membrane roller for full adhesion.
- .7 Install a reinforcing gusset at all inside and outside corners.
- .8 Always seal overlaps at the end of the workday.
- .9 Avoid the formation of wrinkles, swellings or fishmouths.

3.15 INSTALLATION OF WELDABLE BASE SHEET ON FLASHINGS AND PARAPETS

NOTE TO THE CONTRACTOR: Ensure roofing substrates and adjoining work or construction elements pose no fire hazards during use of torch equipment. Do not torch onto wood substrates or at locations where chimney or back draft effects could project flames onto concealed combustible materials. Consult membrane manufacturer for alternate work methods where such cases apply.

- .1 Apply base sheet flashing only after primer coat is dry.
- .2 Cut off corners at end laps to be covered by the next roll.
- .3 Each selvedge will overlap along lines provided for this purpose, and by 150 mm (6 in) at the ends.
- .4 This base sheet membrane must be welded directly to the substrate, proceeding from top to bottom using a propane torch.
- .5 Avoid the formation of wrinkles, swellings or fishmouths.

3.16 INSTALLATION OF REINFORCED GUSSETS

- .1 Install reinforcing gussets at all inside and outside corners.
- .2 Heat-weld the gussets in place after installing base sheet membrane.

3.17 INSTALLATION OF WELDABLE REINFORCING MEMBRANES

- .1 Install reinforcing membranes specified according to the typical detailed instructions in the documentation of membrane manufacturer.

3.18 INSTALLATION OF THERMOFUSIBLE CAP SHEET ON FIELD SURFACE

- .1 Begin with double-selvage starter roll. If starter roll is not used, side laps covered with granules must be de-granulated by embedding granules in torch-heated bitumen over a 75-mm (3 in) width.
- .2 Starting at drain, dry unroll the membrane on the base sheet, taking care to align the edge of the first selvage with the edge of the roof.
- .3 Cut off corners at end laps at areas to be covered by the next roll.
- .4 Each selvage will overlap the previous one along lines provided for this purpose, and will overlap by 150 mm (6 in) at the ends. Space end laps a minimum of 300 mm (12 in).
- .5 Heat-weld cap sheet membrane with a torch on the base sheet to create a bleed out of 3 to 6 mm (1/8 to 1/4 in).
- .6 During installation, be careful not to overheat the membrane or its reinforcements.
- .7 Avoid the formation of wrinkles, swellings or fishmouths.
- .8 Avoid walking over finished surfaces; use rigid protective walkways as needed.

3.19 INSTALLATION OF THERMOFUSIBLE CAP SHEET ON FLASHINGS AND PARAPETS

- .1 This cap sheet must be installed in one-metre-wide strips (3.25 ft).
- .2 Each selvage will overlap the previous one laterally along lines provided for this purpose, and will overlap by 150 mm (6 in) the field surface. Membranes for flashings must be spaced at least 100 mm (4 in) with respect to the cap sheet membranes on the field surface, to avoid areas of excessive membrane thickness.
- .3 Cut off corners at end laps on areas to be covered by the next roll.
- .4 Use a chalk line to draw a straight line on the field surface, 150 mm (6 in) from flashings and parapets.

- .5 Use a torch and round-nose trowel to embed the surface granules in the layer of hot bitumen, starting from the chalk line on the field surface to the bottom edge of the flashing or parapet, as well as on the granulated vertical surfaces to be overlapped.
- .6 This cap sheet will be heat-welded directly to the base sheet membrane, proceeding from bottom to top.
- .7 Avoid the formation of wrinkles, swellings or fishmouths.
- .8 During installation, be careful not to overheat the membrane and its reinforcements.

3.20 INSTALLATION OF WALKWAYS

- .1 Install walkways in compliance with requirements previously stipulated for cap sheet installation. Apply primer to cap sheet before installing walkways.

3.21 WATERPROOFING FOR VARIOUS DETAILS

- .1 Install waterproofing membranes at various roofing details in conformance with typical details indicated in technical documentation of the manufacturer.

- END OF SECTION -

Part 1 General

1.1 GENERAL

- .1 All Drawings and all sections of the Specifications shall apply to and form an integral part of this section.

1.2 SCOPE OF WORK

- .1 Work to include all labour, Material and equipment required for installing, testing and placing in initial operation the following systems as detailed in Specifications of each section and as shown on Drawings.
 - .1 Section 21 05 10 Acceptable Materials & Equipment
 - .2 Section 21 08 10 Insulation
 - .3 Section 22 40 10 Plumbing
 - .4 Section 22 50 10 Fire Protection
 - .5 Section 23 60 10 Liquid Heat Transfer
 - .6 Section 23 80 10 Air Distribution
 - .7 Section 23 90 10 Testing, Adjusting and Balancing
 - .8 Section 25 10 10 Controls/Instrumentation
- .2 All Mechanical Work to be bid as a single complete Subcontract even though Work of various mechanical trades has been further sub-divided into each Section noted above.

1.3 REQUEST FOR INTERPRETATION PROCESS

- .1 General:
 - .1 Immediately on discovery of the need for interpretation of the Contract Documents, Contractor shall prepare and submit an RFI to the Contract Administrator in the form specified.
 - .2 Contract Administrator will return RFIs submitted to Contract Administrator by other entities controlled by Contractor with no response. The RFI will then be considered closed.
 - .3 Coordinate and submit RFIs in a prompt manner so as to avoid delays in Contractor's Work or Work of Subcontractors.
 - .4 For RFIs submitted electronically, include project name and RFI number in subject line of email.
- .2 Content of the RFI: Include a detailed, legible description of item needing information or interpretation and the following:
 - .1 Project name (including building number).
 - .2 Project number.
 - .3 Date.
 - .4 Name of Contractor.
 - .5 Name of Contract Administrator.
 - .6 RFI number, numbered sequentially. (eg: RFI-001)
 - .7 RFI subject.
 - .8 Specification Section number, title and related paragraphs, as appropriate.
 - .9 Drawing number and detail references, as appropriate.
 - .10 Field dimensions and conditions, as appropriate.

- .11 Contractor's suggested resolution. If Contractor's suggested resolution impacts the Contract Time or the Contract Price, Contractor shall state impact in the RFI.
- .12 Contractor's signature.
- .13 Attachments: Include sketches, descriptions, measurements, photos, product data, Shop Drawings, coordination Drawings, and other information necessary to fully describe items needing interpretation.
 - .1 Include dimensions, thicknesses, structural grid references, and details of affected Materials, assemblies, and attachments on attached sketches.
- .3 RFI Forms: Contractor generated form including all content indicated in this Section.
 - .1 Form and attachments shall be electronic files in Adobe Acrobat PDF format.
- .4 Contract Administrator's Action: Contract Administrator will review each RFI, determine action required, and respond. Allow 10 Working days for Contract Administrator's response for each RFI. RFIs received by Contract Administrator after 1:00 p.m. will be considered as received the following Working day.
 - .1 The following Contractor-generated RFIs will be returned without action:
 - .1 Requests for approval of submittals.
 - .2 Requests for approval of substitutions.
 - .3 Requests for approval of Contractor's means and methods.
 - .4 Requests for approval of corrective actions for deficient Work.
 - .5 Requests for coordination information already indicated in the Contract Documents.
 - .6 Requests for adjustments in the Contract Time or the Contract Sum.
 - .7 Requests for interpretation of Contract Administrator's actions on submittals.
 - .8 Incomplete RFIs or inaccurately prepared RFIs.
 - .2 Contract Administrator's action may include a request for additional information, in which case Contract Administrator's time for response will date from time of receipt of additional information.
 - .3 If Contractor believes the RFI response warrants change in the Contract Time or the Contract Sum, notify Contract Administrator in writing within 10 days of receipt of the RFI response. Failure to notify will result in the Work being included as part of the Contract.
- .5 RFI Log: Prepare, maintain, and submit a tabular log of RFIs organized by the RFI number. Submit log with progress meeting minutes. Include the following:
 - .1 Project name.
 - .2 Name and address of Contractor.
 - .3 Name and address of Contract Administrator.
 - .4 RFI number including RFIs that were returned without action or withdrawn.
 - .5 RFI description.
 - .6 Date the RFI was submitted.
 - .7 Date Contract Administrator's response was received.
- .6 On receipt of Contract Administrator action, update the RFI log and immediately distribute the RFI response to affected parties. Review response and notify Contract Administrator within 10 days if Contractor disagrees with response.

1.4 EXISTING CONDITIONS

- .1 Examine Site, existing adjacent buildings and local conditions affecting Work under this Contract. Examine Structural, Mechanical and Electrical and all other Contract Drawings to ensure Work can be performed without changes to the building as shown on plans. No allowance will be made later for necessary changes, unless notification of interferences have been brought to Contract Administrator's attention, in writing, prior to closing of Bid Opportunity in accordance with B4.

1.5 REGULATIONS

- .1 Comply with, most stringent requirements of Manitoba Building Code, National Building Code and local regulations and by-laws, with specified standards and codes and this Specification. Before any Work is proceeded with, approved layouts to be filed with and approved by proper authorities.
- .2 Provide necessary notices, obtain permits and pay all fees, in order that Work specified may be carried out. Charges and alterations required by authorized inspector of any authority having jurisdiction, to be carried out without charge or expense to The City. Pay all charges for service connections to municipal mains.
- .3 Furnish certificates confirming Work installed conforms to requirements of authorities having jurisdiction.

1.6 LIABILITY

- .1 Install Work in advance of concrete pouring or similar Work. Provide and set pipe sleeves as required.
- .2 Install concealed pipes and ducts neatly, close to building structure so furring is minimum size. Pipes, ducts and equipment installed improperly, to be removed and replaced without cost to The City.
- .3 Protect and maintain Work until building has been completed and accepted. Protect Work against damage during installation. Cover with tarpaulins if necessary. Repair all damage to floor and wall surfaces resulting from carrying out of Work, without expense to The City.
- .4 During welding or soldering ensure structure is protected against fire, shield with fire-rated sheets and galvanized iron sheets. Mount portable fire extinguishers in welding or soldering areas.
- .5 Co-ordinate Work with other sections to avoid conflict and to ensure proper installation of all equipment. Review all Contract Drawings.
- .6 On completion of Work, remove tools, surplus and waste Material and leave Work in clean, perfect condition.

1.7 GUARANTEE

- .1 Guarantee satisfactory operation of all Work and apparatus installed under this Contract. Replace, at no expense to The City, all items which fail or prove defective within a period of one year after final acceptance of complete Contract by The City, always provided such failure is not due to improper usage by The City. Make good all damage to building incurred as a result of failure or repair of mechanical Work.

- .2 No certification given, payment made, partial or entire use of equipment by The City, shall be construed as acceptance of defective Work or acceptance of improper Materials. Make good at once, without cost to the The City all such defective Work or Materials and consequence resulting therefrom, within one year of final acceptance date.
- .3 This general guarantee shall not act as a waiver for any specified guarantee and/or warranty of greater length of time noted elsewhere in these documents.

1.8 WELDING REGULATIONS

- .1 Do not weld when temp. of base metal is lower than -17 deg. C except with consent of Contract Administrator. At temp. below 0 deg. C, surface of all areas within 75mm (3") of point where weld is to be started to be heated to temp. at least warm to hand before welding is commenced. At all temperatures below +4 deg. C, operator and Work to be protected against direct effect of wind and snow.
- .2 Welding shall be performed by welder holding current welder's certificate from Provincial Department of Labour.
- .3 Comply with CSA W117.2 "Safety in Welding, Cutting, and Allied Processes".

1.9 MECHANICAL SHOP DRAWINGS

- .1 Submit for review PDF (Electronic Copy) of detailed Shop Drawings. Refer to Section 21 05 10 "Acceptable Materials & Equipment" for Shop Drawings requirements.
- .2 Check Shop Drawings for conformity to plans and Specifications before submission.
- .3 Each Drawing to bear a signed stamp including project name and Contractor's Firm name verifying Drawings have been checked prior to submission to Contract Administrator. Signature of stamp shall signify the Contractor has checked and found all dimensions to be compatible with the Contract Drawings and all capacities, quantities, sizes and other data contained in the Contract documents have been listed by the supplier on the Drawings and have been checked by the undersigned and found correct.
- .4 Clearly show division of responsibility. No item, equipment or description of Work shall be indicated to be supplied or Work to be done "By Other's or By Purchaser". Any item, equipment or description of Work shown on Shop Drawings shall form part of Contract, unless specifically noted to contrary.
- .5 Take full responsibility for securing and verifying field dimensions. In case where fabrication must proceed prior to field dimensions being available, check all Shop Drawings and approve for dimensions only. In this case guarantee that dimensions will be Worked to and ensure that other Subcontractors are aware of these dimensions and shall comply to them.
- .6 Review by Contract Administrator shall be mutually understood to refer to general design only. If errors in detailed dimensions or interference with Work are noticed, attention of Contractor will be called to such errors of interferences, but Contract Administrator's review of Drawings will not in any way relieve Contractor from responsibility for said errors or interferences, or from necessity of furnishing such Work, and Materials as may be required for completion of Work as called for in Contract documents.

1.10 MECHANICAL SUBCONTRACTORS

- .1 Upon award, successful bidder to provide names of all Subcontractors to be used in sublet Work. Also, state extent of any Work so sublet. Request and receive Contract Administrator's approval in writing, of all Subcontractors for such Work before placing Subcontractor Contract.

1.11 SCHEDULING OF WORK

- .1 Complete building to be occupied during term of this Contract. Schedule new Work so normal functions within building are not unduly interrupted. Suitable periods for shutting off mechanical services to be arranged with The City's appointed representative.
- .2 Refer to clause D2, Scope of Work, in Supplemental Conditions which is part of the front end Specifications.

1.12 DRAWINGS

- .1 Drawings are diagrammatic only and do not show all details. Information involving accurate measurements of building to be taken at Site. Make, without additional expense to The City, all necessary changes or additions to runs to accommodate structural conditions. Locations of pipes, ducts and other equipment to be altered without charge to The City, provided change is made before installation and does not necessitate additional Materials and that all such changes are ratified by Contract Administrator, recorded on Record Set of Drawings.
- .2 Drawings and Specifications to be considered as an integral part of Contract Documents. Neither Drawings nor Specifications to be used alone. Misinterpretation of requirements of plans or Specifications shall not relieve Contractor of responsibility of properly completing Work to approval of Contract Administrator.
- .3 As Work progresses and before installing piping, ductwork, fixtures and equipment interfering with interior treatment and use of building, consult Contract Administrator for comments. This applies to all levels and proper grading of piping. If Contractor fails to perform above checking and fails to inform Contract Administrator of such interference, Contractor to bear all subsequent expense to make good the installation.
- .4 Drawings indicate general location and route to be followed by pipes and ducts. Where required pipes and/or ducts are not shown on plans or only shown diagrammatically, install in such a way as to conserve head room and interfere as little as possible with free use or space through which they pass.
- .5 Spaces reserved for equipment noted as "future", to be left clear as noted on Drawings so that future connections can be made.

1.13 MATERIALS

- .1 Materials and equipment specified and acceptable manufacturers are named in this Specification for the purpose of establishing the standard of Materials and Workmanship to which Contractor shall adhere. Bid Opportunity price shall be based on the use of Materials and equipment as specified.
 - .1 Materials of same general type to be of same manufacture (e.g. all air supply units shall be of same manufacturer). Contractor to ensure that all Subcontractors provide products of same manufacturer.

- .1 Follow manufacturer's recommendations for safety, adequate access for inspection, maintenance and repairs of individual equipment installed.
 - .2 Permit equipment maintenance and disassembly with minimum disturbance to connecting piping and duct systems and without interference with building structure or other equipment.
 - .3 Provide accessible lubricating means for bearings, including permanent lubricated 'Lifetime' bearings.
- .2 Contractor may propose alternate for any specified item which Contractor considers equal in accordance with B7 to that specified. Submit with Bid Opportunity complete Specifications for proposed alternate together with amount to be added to or deducted from Bid Opportunity price for consideration by Contract Administrator. All alternate items submitted for consideration must not exceed available space limitations. All additional costs for mechanical, electrical, structural and/or architectural revisions required to incorporate Materials substituted by Contractor shall be responsibility of Contractor.
- .3 Equipment listed as 'equal in accordance with B7' in Specifications or submitted as alternate by Contractor must meet all space requirements, specified capacities and must have equipment characteristics of specified equipment as interpreted by Contract Administrator. Install equipment in strict accordance with manufacturer's published recommendations.
- .4 Equipment and Materials shown on Drawings and not specified herein, or specified herein and not shown on Drawings, shall be included in this Contract as though both shown and specified.

1.14 REMOVAL AND DISCONNECTION OF THE CITY'S EXISTING EQUIPMENT

- .1 All mechanical equipment conflicting with new equipment being installed to be removed or disconnected by Contractor shall remain property of The City. Remove ducts and piping not required in revised systems and interfering with new installation which shall become property of Contractor.
- .2 Mechanical Drawings indicate most mechanical equipment to be removed and/or disconnected. Mechanical equipment to be removed due to removal of walls of existing building, to be removed and pipes capped off by Contractor at no additional cost to The City.

1.15 ELECTRIC MOTORS, STARTERS AND WIRING

- .1 Provide electric motors for all equipment supplied in this Division. Motors to operate at 29 rps (1800 rpm), unless noted otherwise. Motor design shall comply with Canadian Electrical Code requirements. All electric motors supplied shall be capable of being serviced locally.
- .2 All three phase motors shall have a service factor of 1.15 times nominal rated horsepower of the motor.
- .3 Operating voltages: to CAN3-C235-83, motors, electric heating, control and distribution devices and equipment to operate satisfactorily at 60 Hz within normal operating limits established by above standard. Equipment to operate in extreme operating conditions established in above standard without damage to equipment.

- .4 Motors controlled by variable frequency drives (VFDs) shall comply with requirements of CSA Specification C22.2 No. 100-95, Clause 12.4 and shall be permanently marked with the following in addition to the normal marking requirements:
 - .1 Machine Application (Inverter Duty);
 - .2 Speed range over which the machine is designed to operate;
 - .3 Type of torque application for which the machine is designed (e.g. VT (variable torque), CT (constant torque), Chp (constant horsepower);
 - .4 Type(s) of inverter(s) with which the machine is intended to be used, e.g.: VSI or VVI (6-step voltage source), CSI (6-step current source), VPWM (voltage-source pulse width modulated), LCI (load commutated), cyclonverter.
- .5 Electric motors for use in hazardous locations shall have a metal nameplate marked with the following information:
 - .1 For a motor for use with variable-frequency inverter drives: The type or types of inverters, motor load characteristics, and the frequency range; for example, "PWM-Constant Torque-6 to 60 Hertz". All motor base performance values are to correspond to rated sine-wave operation. Additional markings for inverter operation may be included.
- .6 Motors 0.75 kW (1 hp) and larger shall be high efficiency motors as defined in CSA C390 or IEEE 112B Nominal Standards. Minimum efficiency (%) shall be per the following table.

Minimum efficiency (%)				
kW	3600 RPM	1800 RPM	1200 RPM	900 RPM
.75	79.0	82.4	81.1	74.4
1.11	81.0	82.8	83.8	76.8
1.50	81.7	83.8	84.4	83.8
2.24	84.6	86.1	86.4	83.6
3.73	86.4	86.9	87.2	85.4
5.60	87.4	88.4	88.2	86.2
7.46	88.4	89.4	88.6	88.6
11.19	89.3	90.1	89.0	88.0
14.92	89.7	90.9	89.8	89.8
18.65	90.0	91.1	90.9	89.6
22.38	90.6	91.5	91.1	90.3
29.84	91.0	92.0	91.6	90.1

List information on Shop Drawing submittals

- .7 Determine from electrical Drawings and Specifications, voltage characteristics applying to each individual motor. Where motor voltages are mentioned in this Specification, confirmation to be made by reference to electrical Drawings and Specifications ordering motors.
- .8 Division 26 - Electrical to provide starters for all motors, except as otherwise noted.
Division 26 - Electrical shall wire from starters to motors.

- .9 Wiring required between starters and switching apparatus such as wiring from starters to float switches, pressure switches and all control wiring to be by Division 26 - Electrical except as noted otherwise on Drawings and in Specifications. Provide proper terminal connections and lead wires at motors and other apparatus ready for connection by Division 26 - Electrical. Provide Division 26 - Electrical with accurate locations of electrical connection points and all necessary schematic and other Drawings to facilitate electric Work.
- .10 Wiring required under Section 25 10 10 to be performed by Section 25 10 10 except as noted otherwise. Refer also to Section 25 10 10 for further requirements.
 - .1 Division 26 - Electrical to perform all wiring and make final connections to all controls for roof-top HVAC units, boilers and all mechanical equipment where controls are supplied with equipment.
 - .2 Division 23 shall provide wiring diagrams indicating all power and control wiring requirements.

1.16 IDENTIFICATION OF VALVES

- .1 Provide engraved lamacoid color coded tags secured to items with non-ferrous chains or "S" hooks. Use for valves and operating controllers of all systems. Consecutively number valves in each piping system i.e. domestic water, steam, etc.
- .2 For each building, provide tag schedule, designating number, service, function, colour code, and location of each tagged item.
- .3 Provide one plastic laminated copy and secure to mechanical room wall where instructed. Place one copy in each maintenance instruction manual.
- .4 Identify controls and gauges by labels of 3mm (1/8") plastic engraving stock with white lettering on black background. Size approximately 62mm x 25mm (2-1/2" x 1") high.

1.17 HANGERS AND SUPPORTS

- .1 General
 - .1 Piping, ductwork and equipment shall be securely supported from building structure. Perforated strap or wire hangers are not permitted.
 - .2 Support components shall conform to Manufacturers Standardization Society Specification SP-38.
- .2 Installation - Horizontal
 - .1 Hangers shall adequately support piping system. Locate hangers near or at changes in piping direction and concentrated loads. Provide vertical adjustment to maintain pitch required for proper drainage. Allow for piping expansion and Contraction. Piping weight and stresses shall be supported independently of any equipment.
 - .2 Maximum spacing between pipe supports:
 - .1 Steel Pipe:
 - .1 Up to 50mm (2") diam. - 2.4m (8 ft.)
 - .2 62mm (2-1/2") and larger - 3.6m (12 ft.)
 - .2 Copper Tubing (Hard):
 - .1 Up to 25mm (1") diam. - 1.8m (6 ft.)
 - .2 32mm and larger - 2.4m (8 ft.)
- .3 Installation - Vertical Piping

- .1 Support vertical pipes at each floor by Anvil Fig. 261 riser clamps. Locate clamps immediately below coupling if possible. Support soil pipe at hub. Brace risers up to 50mm (2") size at intervals not over 2.13m (7'). Support base in approved manner.
- .4 Structural Attachments
 - .1 To Concrete:
 - .1 Place inserts in structural floors for support of piping and equipment prior to pouring of concrete. Inserts in concrete slabs shall be Anvil Fig. 285 Light Weight Concrete Insert for loads up to 182 Kg (400#) or Anvil Fig. 281 Wedge type concrete insert for loads up to 544 Kg (1200#).
 - .2 Support hangers in corrugated steel deck by 50mm (2") piece of 3mm (1/8") thick steel plate placed across top of steel deck, secured to hanger rod by washer and nut; prior to pouring of concrete topping.
 - .3 Where inserts must be placed in existing concrete use Hilti H.D.I. steel anchors as recommended by manufacturer, or if heavy weights must be supported, drill hole through slab and provide 50mm x 50mm (2" x 2") washer and nut above rough slab before floor finish is poured.
 - .2 To Steel Beams:
 - .1 Where pipe size is 50mm (2") or less, use Anvil Fig. 87 Malleable Iron C-Clamp and Retaining Clip, or equal in accordance with B7.
 - .2 Where pipe size is over 50mm (2"), use Anvil Fig. 229 Malleable Beam Clamp or Fig. 228 Forged Steel Beam Clamp.
 - .3 Miscellaneous:
 - .1 Provide suitable attachments equal in accordance with B7 in quality to above where required.
- .5 Hangers and Supports
 - .1 Steel Pipe: Up to 50mm (2") - Anvil Fig. 65 light clevis - size to suit O.D. of pipe. 62mm (2-1/2") and larger - Fig. 260 clevis - size to suit O.D. of insulation.
 - .2 Copper Tubing (Hard):
 - .1 Up to 50mm (2") - Anvil CT65 copper plated clevis - size to suit O.D. of pipe. Fig. 65 may be used if isolation is provided - see below.
 - .2 62mm (2-1/2") and larger - Fig. 260 clevis - size to suit O.D. of insulation - on uninsulated pipe provide isolation as specified below.
 - .3 Plastic and Other Types of Piping: Support as recommended by manufacturer.
 - .4 Provide fabricated steel supports as detailed on Drawings or as required to adequately support piping and equipment. Details to be approved by Contract Administrator. Supports shall be of welded construction except where adjustment is required.
 - .5 Where thermal expansion in excess of 12mm (1/2") axially is anticipated, or where indicated, use Anvil Fig. 171 Adjustable Pipe Roll or Anvil Fig. 271 Pipe Roll Stand.
 - .6 For vertical piping support, use Anvil Fig. 261 clamp. For vertical copper piping, use Fig. CT-121-C.
 - .7 Above indicates general requirements. Provide hangers and supports of equal in accordance with B7 quality to suit job requirements where not covered by the above.
 - .8 Support groups of horizontal pipes by angle iron trapeze hangers.
 - .9 Rollers and chairs shall not be installed on trapeze hangers.

- .10 Several individual hanger rods may be supported from a trapeze or individual inserts in concrete slab.
- .11 Hangers to be adjustable after pipe is in place. Parts must be of adequate strength for weight to be supported with safety factor of 5 to 1.
- .12 Hanger Rod:
 - .1 Support hangers with mild steel rod. Load on hanger not to exceed capacity indicated in following table:
 - .2 Rod Diam. Max. Safe Load
 - .1 9.5mm(3/8") 277 Kg(610 lbs.)
 - .2 13mm(1/2") 514 Kg(1130 lbs.)
 - .3 16mm(5/8") 822 Kg(1818 lbs.)
 - .4 19mm(3/4") 1232 Kg(2710 lbs.)
 - .3 Rods to have sufficient threaded length to allow for vertical adjustment after pipe is in place. Use two nuts in each rod, one above clevis or angle iron, and one below.
- .6 Isolation
 - .1 Copper piping shall be isolated from steel supports by copper plated hangers, plastic coated hangers, tinning pipe at supports, or provision of suitable lead or copper isolators. Where no pipe movement or abrasion is expected, suitable plastic electricians tape may be wrapped around pipe at hangers.
- .7 Protection Saddles
 - .1 On piping 50mm (2") and smaller, carry insulation over pipe hangers. Canvas jacket shall be neatly cut and formed to fit over hangers. On chilled and cold water piping, insert sections of insulation into space above pipe at each hanger. Seal saddle and pipe with insulation.
 - .2 On insulated steel pipe over 50mm (2") diam. use at each hanger or support, Anvil Fig. 160, 161 or 162 to suit pipe size and insulation thickness. Pack space between saddle and pipe with insulation.
 - .3 On copper piping over 50mm (2") diam. use at each hanger or support Anvil Fig. 167 protection shield. Shields shall have minimum length of 300mm (12") to spread weight.

1.18 SUPPORTS, BASES, PITS

- .1 Supply and erect all special structural Work required for installation of tanks, pumps, fans, motors and other apparatus.
- .2 Concrete pads, concrete for floating bases, curbs and pits to be supplied under structural division. Supply all anchor bolts, fasteners and foundation Drawings. Unless noted otherwise, all major pieces of equipment such as pumps, compressors, fans, etc. to be mounted on 150mm (6") concrete pad. Refer to standard details for method of forming pump bases, etc.
- .3 Mount equipment suspended above floor level but not detailed on platform bracketted from wall. Where wall thickness is inadequate to permit such brackets, carry supports to either ceiling or floor, or both as required.

1.19 FLASHING

- .1 Where pipes or ducts go through a roof or wall, they should be boxed-in and flashed as per structural division. Allow for expansion and Contraction of pipe. Flashing shall be waterproof.

1.20 IDENTIFICATION OF EQUIPMENT

- .1 Provide manufacturer's nameplate on each piece of equipment.
- .2 In addition Mechanical Subcontractor shall provide equipment I.D. tag minimum size 87mm x 32mm x 2.3mm (3-1/2" x 1-1/2" x 3/32") nominal thickness laminated phenolic plastic with black face and white centre. Engraved 6mm (1/4") high lettering. For motors and controls and for larger equipment such as chillers, tanks, 25mm (1") high lettering; for hot equipment such as boilers and convertors, provide engraved brass or bronze plates with black paint filled identification.
- .3 Identify as follows: equipment type and number (e.g. pump no. 2), service or areas or zone building served (e.g. south zone chilled water primary).
- .4 Provide manufacturers' registration plates (e.g. pressure vessel, Underwriters' Laboratories and CSA approval plates) as required by respective agency and as specified.

1.21 FLOOR PLATES AND SLEEVES

- .1 Set sleeves in concrete forms for all pipes and ducts passing through concrete walls, beams and slabs.
- .2 Pipe sleeves to extend above floor line as follows:
 - .1 Unfinished areas - 25mm (1")
 - .2 Mechanical rooms - 100mm (4")
 - .3 Caulk sleeves to provide watertight installation.
- .3 Where pipes pass through floors and walls in finished areas and where exposed to view, provide Crane #10 B.C. chrome-plated pressed floor plates.
- .4 Install galv. oversize pipe sleeves on passing through walls or partitions, for building into wall construction, by other trades.
- .5 Sleeves and holes for cold water and chilled water to be large enough to accommodate pipe insulation. Insulation on hot water lines may stop at walls or floors.
- .6 Prior to installing sleeves in concrete beams, receive final jobSite approval by the Contract Administrator.

1.22 MECHANICAL EQUIPMENT GUARDS

- .1 Meet safety requirements of Provincial Department of Labour and local authorities having jurisdiction.
- .2 Guards for drives shall have:
 - .1 No. 2.5mm (12 US std. ga.) galv. 18mm (3/4") mesh wire screen welded to steel angle frame.
 - .2 No. 1.2mm (18 US std. ga.) galv. sheet metal tops and bottoms.
 - .3 Removable sides for servicing.
- .3 For flexible couplings, provide removable, 'U' shaped, 2.5mm (12 ga.) galv. frame and 1.2mm (18 ga.) expanded mesh face.

- .4 Provide means to permit lubrication and use of test instruments with guards in place.
- .5 Install belt guards to permit movement of motors for adjusting belt tension.
- .6 Provide 18mm (3/4") mesh wire screen on inlet or outlet of exposed fan blades.
- .7 Provide 37mm (1-1/2") diameter hole on shaft centre for insertion of tachometer.

1.23 V-BELT DRIVES

- .1 Fit reinforced belts in sheave grooves matched to drive.
- .2 For 0.25 KW (1/3 hp) to 7.46 KW (10 hp) motors use standard adjustable pitch drive sheaves, having plus/minus 10% range. Use mid-position of range for specified rpm.
- .3 For over 7.46 KW (10 hp) motors, use sheave with split tapered bushing and keyway having fixed pitch unless specifically required for item concerned. Refer to Section 15600 and 15800 for fan requirements relating to V-belt, vari-pitch drives. Provide sheave of correct size as approved by Contract Administrator to suit balancing.
- .4 Use minimum drive rating of two times nameplate rating on motor. Keep overhung loads under manufacturer's requirements on all prime mover shafts.
- .5 With belt drive, provide motor slide rail adjustment plates, allowing for 150mm (6") minimum centre line adjustment.
- .6 Obtain approval to use cast iron or steel sheaves secured to shafts with removable keys.

1.24 SCREWS, BOLTS AND FASTENERS

- .1 Use standard commercial sizes and patterns with Material and finish suitable for service.
- .2 Use heavy hex heads, semi-finished unless otherwise specified. Use non-ferrous Material throughout for plumbing services. Use type 304 stainless steel for exterior areas.
- .3 Bolts used on fan equipment for access to motors, bearings, filters and the like shall be heavy-duty.
- .4 Bolts shall not project more than one diameter beyond nuts.
- .5 Washers
 - .1 Use plain-type washers on equipment, sheet metal and soft gaskets, lock-type washers where vibration occurs, and resilient washers with stainless steel.

1.25 SPECIAL TOOLS AND SPARE PARTS

- .1 Furnish the The City with spare parts as follows:
 - .1 One set of pump seals, packing for each pump.
 - .2 One casing joint gasket for each size pump.
 - .3 One glass for each gauge glass installed.
 - .4 One set of v-belts for each piece of machinery.
 - .5 One set of filters for each filter bank installed. ie. one set for both pre-filter and high efficiency filters.
- .2 Identify spare parts containers as to contents and replacement parts number.
- .3 Provide one set of all specialized tools required to service equipment as recommended by manufacturers.
- .4 Furnish one grease gun and adaptors to suit different types of grease and grease fittings.

1.26 PUMPS-GENERAL

- .1 Provide coupling guards on all pumps.
- .2 Submit certified pump curves with Shop Drawings. Pumps shall be selected such that head at design conditions does not exceed 85% of maximum possible head at design flow rate.
- .3 Manufacturer to include for checking and aligning pumps prior to start-up. Following completion of piping all base mounted pumps shall be aligned by a qualified millwright using a dial gauge. Alignment using a straightedge is not acceptable as it does not provide sufficient accuracy. The millwright shall provide a report indicating the degree of misalignment prior to carrying out the Work and the final readings when the alignment Work has been completed. Final payment will not be made until a satisfactory report has been submitted.
- .4 Piping adjacent to pump to be supported from structure so no weight is carried on pump casings. Use long sweep elbows at pump.
- .5 All pumps to have motor size large enough to not overload at runout condition. If this requires larger motor than specified, pay for larger motor starter, wiring and the like.
- .6 Provide mechanical seals on all pumps.

1.27 OPENINGS IN FIRE SEPARATIONS

- .1 Provide firestopping for all openings in fire separations for passage of pipes, ducts, etc. to maintain integrity of fire separations. Firestopping shall include all new openings and all existing openings along gridline 56/57.
- .2 Firestopping
 - .1 Firestopping to be Dow-Corning Fire Stop System.
 - .2 Material shall be Dow-Corning silicone elastomer Fire Stop penetration Seal and/or Dow-Corning liquid silicone elastomer Fire Stop Foam of density, width and depth to maintain assembly fire resistive rating.
 - .3 Components shall be ULC listed.
- .3 Installation
 - .1 Prepare all surfaces so they are clean, dry, and frost free, as per manufacturer's published recommendations.
 - .2 Use Sealant around single pipes and/or ducts.
 - .3 Use Foam for multiple pipe installation.
 - .4 Follow manufacturer's published installation instructions precisely including field quality control after installation.
 - .5 Submit to Contract Administrator, suitable document signed by manufacturer's local representative, stating:
 - .1 Div. 21 Subcontractor received sufficient installation instruction from manufacturer's representative.
 - .2 Manufacturer's representative witnessed installation procedures on Site.
 - .6 Remove firestopping assembly for random inspection by Contract Administrator and replace at no extra cost to The City.
 - .7 Issue report to Contractor, The City and Contract Administrator stating that all mechanical openings have been fire fire stopped in accordance with fire stop mfg. methods to maintain integrity of fire separation being penetrated.

1.28 TRIAL USAGE

- .1 The City reserves right to use any piece of mechanical equipment, device or Material installed under this Contract, for such reasonable lengths of time and at such times as Contract Administrator may require, to make complete and thorough test of same, before final completion and acceptance of any part of Contract. It is agreed and understood, that no claim for damage will be made for any injury or breakage to any part or parts of the above due to aforementioned tests, whether caused by weakness or inaccuracy of parts, or by defective Materials or Workmanship of any kind whatsoever. Supply all labour and equipment for such tests.

1.29 SAFETY DEVICE TESTING

- .1 Make complete inspection of all safety devices to ensure:
 - .1 That safety devices are complete and in accordance with Specifications and manufacturer's recommendations.
 - .2 That the safety devices are connected and operating according to all local regulations.
- .2 Safety devices to be inspected shall include, but not be limited to:
 - .1 Carbon monoxide and nitrogen dioxide detectors
 - .2 Freeze protection devices
- .3 On completion of inspections, supply to Contract Administrator letters and/or certificates for their record, confirming that inspections have been completed.

1.30 TEMPORARY USE OF EQUIPMENT

- .1 Permanent systems and/or equipment not to be used during construction period, without Contract Administrator's written permission.
- .2 Heating systems may be used for temporary heating within limitations specified under clause 'Temporary Heating'.
- .3 Equipment used during construction period to be thoroughly cleaned and overhauled. Replace worn or damaged parts so equipment is in perfect condition, to entire satisfaction of Contract Administrator and The City.
- .4 Provide proper care, attention and maintenance for equipment while it is being used. If, in opinion of Contract Administrator, sufficient care and maintenance is not being given to equipment and systems, Contract Administrator reserves right to forbid further use of said equipment and systems.
- .5 Temporary use of equipment shall in no way relieve Contractor of providing twelve month guarantee on all equipment so used this guarantee period to commence as of date of final acceptance of building by The City as interpreted by Contract Administrator.
- .6 All air filters shall have bi-monthly inspection. Filters shall be cleaned and/or replaced depending on filter type during period in which ventilation units are being used for temporary heat and/or commissioning of system. Contractor to be responsible for and pay all costs for air filter cleaning service. Filters to operate between pressure drops noted in filter manufacturer's catalogue.

1.31 RECORD DRAWINGS

- .1 As Work progresses, record on one (1) set of Contract Drawings, any approved changes and deviations from the original Contract and/or Working Drawings. Have these Drawings available for reference and observation at all times. At completion of Work, submit to the Contract Administrator, at the Contractor's Costs, AutoCAD Record Drawings and one hardcopy set of Record Drawings. The Contract shall not be considered complete and no final payment shall be made until these Drawings are accepted by the Contract Administrator. Provide separate Drawings for each system in order not to "crowd" Drawings.

1.32 INSTRUCTIONS TO THE CITY'S PERSONNEL

- .1 In addition to start-up supervision and instruction of The City's personnel required of individual equipment manufacturers and systems as noted, Contractor's construction supervisor to instruct The City's personnel in operation and maintenance of all equipment and systems to satisfaction of Contract Administrator.
 - .1 All instructions to The City's personnel shall be video taped by the Contractor.
 - .2 This video will remain property of the The City and will be used for the sole purpose of training and orientation of The City's maintenance staff.
 - .3 Instruction shall include visual Materials such as Drawings, diagrams, and printed handouts.
 - .4 Instructor(s) shall provide the necessary audio-visual equipment and other aids necessary to convey thorough understanding of system and/or equipment operation and maintenance.
 - .5 Provide The City with one copy of video taped session in DVD format.
- .2 Provide The City with four copies of manuals incorporating following:
 - .1 Service instructions - including lists of spare and replacement parts and names and addresses of suppliers.
 - .2 Maintenance & Operating instructions.
 - .3 Revised Shop Drawings.
- .3 Forward manuals to Contract Administrator for review. Final payment will not be made until all required manuals have been received.
- .4 Review instructions with The City's representative to ensure The City's representative has a thorough understanding of equipment and its operation.
- .5 Contractor shall submit to Contract Administrator, suitable document signed by The City's representative, stating:
 - .1 The City has received satisfactory instruction in operation and maintenance of all equipment and systems.
 - .2 Operation and maintenance manuals have been reviewed with The City.
 - .3 Specified spare parts. keys, removable handles and the like, have been turned over to The City.

1.33 PAINTING

- .1 Finish painting of mechanical equipment, piping, ductwork and the like shall be performed by a competent painting Subcontractor of Division 21 - Mechanical.
- .2 Following areas shall have equipment and Materials painted:
 - .1 Mechanical Room.

- .2 All roof top and outdoor exposed areas.
- .3 Thoroughly clean off rust and oil, all exposed iron and steel Work of every description, including hangers, pipes, ducts, etc. paint with a coat of chrome oxide phenolic base primer and a coat of 100% Alkyd base enamel of approved colour. Paint exposed galv. metal surfaces in above areas with a coat of zinc dust galvanize primer and a coat of 100% Alkyd base enamel of approved colour.
- .4 Paint exposed covering in above room and areas with two coats of 100% Alkyd base enamel of approved colour.
- .5 All roof top and outdoor exposed mechanical equipment, ductWork, piping, etc. shall have base prime coat and two finish coats of top-quality, exterior rubber-based paint.
- .6 After piping, etc. has been painted, paint neatly stencilled letters, about 25mm (1") high, designating pipe service and arrows showing direction of flow. Wording to be as later directed by Contract Administrator. Stencilling to occur at not more than fifty foot intervals. "Mystik" tape arrows and identification letters may be substituted, at discretion of Contract Administrator. Stencil all pipes at access doors also.
- .7 All colours shall be approved by Contract Administrator.

1.34 IDENTIFICATION OF PIPING

- .1 Refer to section 21 07 10, MECHANICAL PAINTING AND IDENTIFICATION SCHEDULE.

1.35 IDENTIFICATION OF DUCTWORK

- .1 Use black 50mm (2") high stencilled letters (e.g. "Cold", "Hot", "Return", "Sanitary Exhaust", "Kitchen Exhaust") with arrow indicating air flow direction.
- .2 Distance between markings 15m (50') maximum.
- .3 Identify ducts on each side of dividing walls or partitions and beside each access door.
- .4 Stencil only over final finish.
- .5 Prior to installation, review general application of identification with Contract Administrator.

1.36 CUTTING AND PATCHING

- .1 Cutting, patching and repairs to existing surfaces required as a result of the removal and/or relocation of existing equipment and piping, and/or installation of new equipment and piping in existing building(s) to be included by Div. 21 - Mechanical in Bid Opportunity price. Division 21 - Mechanical to employ and pay appropriate Subcontractor whose Work is involved, for carrying out Work described above.

1.37 SALVAGE

- .1 All usable salvaged equipment and Materials shall remain the property of the The City unless specifically noted otherwise. Such Material shall be neatly stored on Site for removal by the The City. Contractor shall remove all rejected salvage from the Site and legally dispose of it.

- .2 Mechanical Drawings indicate most mechanical equipment to be removed and/or disconnected. Mechanical equipment not indicated on Drawings as being removed or disconnected, but which has to be removed due to removal of walls of existing building, to be removed and pipes capped off by Contractor at no additional cost to The City.

1.38 CLEANING AND FLUSHING OF PIPING SYSTEMS

- .1 On completion, each piping system shall be flushed out before installation of equipment, fixtures, etc. in order to remove any foreign Material in piping.
- .2 Flush with water, unless noted otherwise in individual mechanical sections of Specifications.
- .3 All plumbing fixtures and all equipment shall be thoroughly cleaned and left in first class operating condition.

END OF SECTION

Part 1 General

1.1 GENERAL

- .1 The following Appendix of Manufacturers lists manufacturers of equipment and Materials acceptable to Contract Administrator, subject to individual clauses under the various sub-sections of Mechanical Work Specifications. See item 'Materials' under this section of Specification.
- .2 Product noted in individual Specification clauses is an item that meets Specification in all respects regarding performance, quality of Material and Workmanship, and is acceptable to Contract Administrator without qualification. Equipment proposed from other manufacturers listed as 'Approved Manufacturers' and alternates shall meet same standards.
- .3 Contractor to submit within forty-eight hours of notification from Contract Administrator, one (1) copy of fully and properly completed Appendix of Manufacturers listing thereon names of manufacturers of products which shall be used to execute Work of Contract. If list is not submitted within 48 hours, Contractor must use product named in each individual clause.
- .4 Submit Shop Drawings for all items marked with asterisk(*).
- .5 Request for equal shall be in accordance with B7.

1.2 EQUIPMENT OR MATERIAL & APPROVED MANUFACTURERS

- .1 ELECTRIC MOTORS
 - .1 G.E.; Siemens; Tamper; Reliance; Leland; Lincoln; U.S. Electric; Century; Baldor; WEG; Toshiba
- .2 INSULATION
 - .1 Pipe Insulation Manville; Owens Corning; Knauf; Pabco; Fibreglas
 - .2 External Duct Insulation Manville; Fibreglas; Knauf
- .3 VIBRATION CONTROL
 - .1 Vibration Control Products* Vibro-Acoustics; Airmaster; Vibron; Kinetics; SVC Ind.
- .4 PLUMBING
 - .1 Hangers and Supports Anvil; Crane; Myatt; Erico; Caddy
 - .2 Alignment Guides Adsco; Flexon; Fulton; Yarway
 - .3 Drainage specialties* Watts; Zurn; Wade; J.R. Smith; Mifab
(floor drains, cleanouts,etc.)
 - .4 Strainers* Spirax-Sarco; Muessco; Toyo; Crane; Colton; Watts
- .5 FIRE PROTECTION
 - .1 Automatic sprinkler equipment* Reliable; Viking; Victaulic; Tyco Fire Products (Gem, Star, Central)
- .6 LIQUID HEAT TRANSFER
 - .1 Welding fittings Anvil; Crane; Tube Turn
 - .2 Malleable iron fittings, Crane; Gourde; Anvil;

	flange, flange gaskets	International Malleable
	.1 Mechanical joints*	Victaulic; Gruvlok
.3	Pipe hangers	Anvil; Crane; Myatt
.4	Gate, globe valves*	Crane; Toyo; Kitz; Nibco
.5	Check valves (up to 2" diam.)	
	.1 Horizontal piping*	Crane; Toyo; Kitz; Nibco
	.2 Vertical piping*	Durabla; Nibco
.6	Check valves (2-1/2" diam. & up)	
	.1 Horizontal piping*	Moyes & Groves; Chek-Rite; Keystone-Prince; Victaulic; Gruvlok
	.2 Vertical piping*	Val-Matic; Durabla; Victaulic; Gruvlok
.7	Butterfly valves*	Keystone; Center Line; Nibco; Victaulic; Jenkins; Gruvlok
.8	Ball Valves*	Toyo; Kitz; Nibco; Victaulic; Newman Hattersley; Jenkins; Anvil
.9	Balancing valves (up to 2")*	Toyo; Kitz; Anvil; Newman Hattersley
.10	Balancing valves (2½" dia & up)*	Keystone; Center Line; Nibco; Victaulic; Jenkins; Gruvlok
.11	Circuit balancing valves*	Armstrong; Tour & Andersson; Gruvlok; Bell & Gossett
.12	Triple duty valves*	Armstrong; B&G; Gruvlok; Victaulic; Taco
.13	Suction guides*	Armstrong; B&G; Taco
.14	Expansion joints*	Fulton; Flexonics; Hyspan; Flex-Hose
.15	Alignment guides*	Adscot; Flexon; Fulton; Flexonics; Hyspan; Flex-Hose
.16	Air vents*	Dole; Hoffman; Maid-O-Mist; Bell & Gossett
.17	Strainers*	Spirax-Sarco; Mueller; Victaulic; Gruvlok; Colton
.18	Thermometers*	Ashcroft; H.O. Terice; Winters; Taylor; Weiss; Marshalltown
.19	Pressure gauges*	Kunkle; Winters; Ametek; Ashcroft; Terice; Weiss; Marshalltown
.20	Vertical in-line pumps*	Armstrong; B & G; Taco
.21	Flexible pipe connectors*	Flexonics; Hydro-Flex; United Flexible; Flex-Hose
.22	Chemical treatment*	GE Betz
.23	Glycol	Union Carbide; Dow
.24	Vibration control*	Vibron; Vibro-Acoustic; Airmaster
.7	AIR DISTRIBUTION	
	.1 Ducturns, damper hardware, fan connections*	Duro-Dyne
	.2 Duct Sealer	Duro-Dyne; 3M; Flexa-Duct; United; Bakelite
	.3 Filters*	A.A.F.; Camfill-Farr; Cambridge; Continental; Airguard
	.4 Diffusers, registers & grilles*	E.H. Price; Hart & Cooley; Titus; Carnes; Nailor
	.5 Acoustic duct insulation*	Manville; Fibreglas; Ultralite; Knauf
	.6 Vibration control*	Airmaster; Vibro-Acoustics; Vibron; Kinetics

- .7 Heat recovery units* Tempeff
*** HRU request for equal must be accompanied by a full shop drawing***
- .8 Motorized dampers* Tamco; Alumavent; JCI
- .8 CONTROLS/INSTRUMENTATION
 - .1 Temperature control system* Johnson Controls (Metasys)
 - .2 Gas detection sensor* Honeywell Analytics (Vulcain)
- .9 H.V.A.C. BALANCE AND TESTING
 - .1 H.V.A.C. Balance & Testing Agency
Airdronics Inc.; DFC; AHS; Air Movement

END OF SECTION

Part 1 ALL SERVICES

- .1 Paint all mechanical lines, conduit and equipment with colour code and identification markings outlined below. Use General Paint colour system specified as guide. All colours shall be accurately matched throughout. Apply minimum of two finish coats (2 mil dry thickness each coat) of premium quality General Paints Enviroguard. All surfaces shall be properly prepared and primed to ensure premium quality paint finish. On hot surfaces, use heat resistant paint rated for long term colour and adhesion at expected operating temperatures. Refer to Colour Schedules at end of this Section.
- .2 Environmental Requirements - do not apply paint finish in areas where dust is being generated. All areas shall be clean and floor swept before commencing. Do not commence Work until ambient temp. is minimum 15°C for previous 12 hours. Protect adjacent Work, finishes, equipment, etc. from paint splatter. Take necessary and reasonable precaution to protect painted surfaces from damage.
- .3 Materials - Paint Materials: Must be volatile organic compounds (VOC) compliant (contain less than 250 grams of VOC per litre - less water). Paint must have a flash point of 61°C or higher. Paint Materials for each coating formulae to be premium quality products of a single manufacturer. Paint to be a mercury free formulation and shall not contain free formaldehyde. Paint shall contain no lead, cadmium, chromium, or other toxic heavy metal derivatives. Paint shall contain no fluorocarbons, chlorinated solvents or aromatic hydrocarbons.
- .4 In all mechanical and electrical rooms and in all areas where environment is painted or finished, paint all ducts, mechanical lines and equipment, excluding prefinished surfaces or brass. In mechanical rooms paint ducts Gloss White, while in other areas colour shall be as specified by Contract Administrator or shall match environment. Paint lines and equipment with colour code and identification markings outlined below. Colour and coating Materials of all other items to be painted shall be as directed by Contract Administrator and City.
- .5 All mechanical lines shall be identified with fluid service code identification stencil and arrow indicating direction of flow. These identification markings shall be painted onto line at maximum 6 metre intervals, at inlet and outlet points, before and after barriers, beside all valves and wherever else specified.
- .6 If possible, identification markings (lettering and arrow) shall be painted on at location which is visible and obvious to averaged sized viewer standing on floor. Colours shall be Gloss Black for natural gas, Gloss White for fire quenching service, and Gloss Yellow for radioactive wastes. For all other services colour shall be Gloss Black or Gloss White, contrasting solid colour background and matching existing system.
- .7 Do not paint non-ferrous and chrome-plated surfaces, stainless steel, aluminum, plastic, glass and prefinished surfaces, unless directed otherwise by Contract Administrator.
- .8 Prepare all canvas or canvas-like surfaces with one coat (2 mil dry thickness) of General Paints Enviroguard wall primer, a premium quality latex primer-sealer, prior to application of the two finish coats of enamel. Primer and coating Materials shall be compatible and by

same manufacturer. In all finished areas, prepare, prime and paint all exposed conduit to match the colour and finish coating of adjacent surfaces (environment).

- .9 The identification letter size in relation to the outside diameter of the line shall be as outlined below. Lines with diameters less than 19mm require only a directional arrow.

<u>Outside Diameter of Line (mm)</u>	<u>Size of Letter (mm)</u>
19 to 32	13
36 to 51	19
64 to 152	32

- .10 In architecturally unfinished areas, such as crawlspaces, where mechanical lines are normally not painted, colour code lines with minimum 300mm long solid colour band at maximum 6 metre intervals, at inlet and outlet points, before and after barriers and equipment, beside all valves and on each line at every access door. Identification markings (fluid service code identification stencil and directional arrow) shall be painted onto every band such that markings are visible and obvious to a viewer.
- .11 Paint and identify ducts, mechanical lines, equipment and miscellaneous metals, to match existing.

End Of Section

Part 1 General

1.1 GENERAL

- .1 All Drawings and all sections of the Specification shall apply to and form an integral part of this section.

1.2 WORK INCLUDED

- .1 Labour, Material, plant, tools, equipment and services necessary and reasonably incidental to completion of external insulation for mechanical equipment, piping, ductwork.

1.3 RELATED WORK SPECIFIED ELSEWHERE

- .1 Section 21 05 00 Mechanical General Provisions
- .2 Section 21 05 10 Acceptable Materials & Equipment
- .3 Section 22 40 10 Plumbing
- .4 Section 22 50 10 Fire Protection
- .5 Section 23 60 10 Liquid Heat Transfer
- .6 Section 23 80 10 Air Distribution

Part 2 Products

2.1 MATERIALS

- .1 All Materials shall be equal in accordance with B7 in all respects to specified products and shall be used only in applications intended by the manufacturer. Materials not specifically intended for the purpose shall not be used. Approved Materials shall not be diluted or blended with other Materials unless specifically recommended by the manufacturer of the approved Material.
- .2 All final pipe and duct installations including insulation, covering and adhesive shall have a ULC Certified flame spread rating of not greater than 25, and a smoke developed classification of not more than 50.
- .3 All canvas shall be treated to be fire retardant in accordance with ULC standards.
- .4 Wire to be 1.2mm (18 ga.) stainless steel, dead soft annealed, type 304.
- .5 U.L.C. label or satisfactory certified report from approved testing laboratory is required to indicate that fire hazard ratings for Materials proposed for use do not exceed those specified.
- .6 Flameproofing treatments subject to deterioration due to effects of high humidity are not acceptable.

- .7 Contract Administrator reserves the right to demand test samples of components of insulation systems for fire hazard test rating.

2.2 COMPATIBILITY OF COMPONENTS

- .1 All adhesives, sealers, vapour coating, mastics, laggings and bedding compounds, shall be compatible with Materials to which they are applied. They shall not soften, corrode, or otherwise attack such Material in either wet or dry state and shall only be those recommended by manufacturer of insulation as suitable for application proposed. They shall be applied at ambient conditions acceptable to the manufacturer.

2.3 COLD INSULATION - PLUMBING

- .1 Material
 - .1 On pipes 50mm (2") diam. and under, use 12mm (1/2") Fiberglas 112 kg/m(7 lb./cu. ft.) density pipe insulation with ASJ jacket.
- .2 Location
 - .1 All domestic cold water piping.

2.4 HOT INSULATION – GLYCOL HEATING

- .1 Materials
 - .1 On piping 50mm (2") diam. and under, use 25 (1") Fibreglas 88 kg/m (5-1/2 lb./cu. ft) density pipe insulation with ASJ all service jacket and self seal lagging adhesive.
 - .2 On piping 62mm (2-1/2") diam. and larger, use 37mm (1-1/2") Fibreglas 88 kg/m (5-1/2 lb./cu. ft) density pipe insulation with ASJ all service jacket and self seal lagging adhesive.
- .2 Location
 - .1 Glycol heating piping.

2.5 INSULATION CLADDING

- .1 Cover insulation with aluminum jacket CSA HA Series - M1980.
- .2 Embossed alloy jacketting 0.4mm thick with longitudinal slip joints and 50mm end laps with factory attached protective straps with mechanical fastener.
- .3 Jackets on fittings, 0.4mm thick, die shaped components of alloy with factory attached protective liner on interior surface.
- .4 Location
 - .1 All outdoor insulated piping and ductwork.

2.6 WHITE PVC INSULATION COVER

- .1 Cover insulation and insulated fittings with white PVC fitting covers.

- .2 The fitting cover system shall consist of one-piece pre-molded high impact PVC fitting covers with fiber glass inserts and accessories, including elbows, tee/valves, end caps, mechanical line couplings, specialty fittings, jacketing, tacks, and PVC tape.
- .3 Cover shall have a flame spread rating of not more than 25 and a smoke developed classification of not more than 50.
- .4 Cover shall be resistant to and not promote growth of fungi or bacteria.
- .5 Cover shall be UV resistant for use indoors or outdoors. Paint outdoor fittings for further UV and colorfast protection.
- .6 Locations
 - .1 All new piping within building including domestic water and hydronics.

2.7 VAPOUR BARRIER FLEXIBLE DUCT INSULATION

- .1 Following duct externally insulated with Fibreglas RFFRK reinforced foil-faced vapour seal duct insulation PF335, 340 g. (3/4 lb./cu. ft.) density.
 - .1 50mm (2") Thickness
 - .1 All round supply and exhaust air ducts to/from HRUs from roof back to within building for a length of 1.8m (6'-0").

2.8 VAPOUR BARRIER RIGID INSULATION

- .1 Following ducts externally insulated with Fibreglas RFFRK reinforced foil-faced vapour seal duct insulation type FF 340 g. (4.5 lb./cu.ft.) density.
 - .1 50mm (2") Thickness
 - .1 All rectangular supply and exhaust air ducts to/from HRUs from roof back to within building for a length of 1.8m (6'-0").
 - .2 All rectangular ductwork located outdoors on roof.

Part 3 Execution

3.1 WORKMANSHIP

- .1 Work shall be performed by licensed journeymen.
- .2 Apply insulation Materials, accessories and finishes in accordance with manufacturer's recommendations.
- .3 Do not apply coverings until hydrostatic tests have been completed, surfaces are free of grease, scale, moisture, and heat tracing where required has been installed. Insulation shall be clean and dry when installed and during application of any finish.
- .4 Apply insulation and coverings to equipment and piping which will operate with hot or warm liquid vapour, while surface is hot. Provide any required temporary heat to accomplish this.

- .5 Cold surfaces to be dry and ferrous surfaces to be coated with rust penetrating protective paint before applying insulation and vapour barriers.
- .6 Vapour barriers and insulation to be complete over full length of pipe or surface, without penetration for hangers, duct or seams, and without interruption at sleeves, pipe and fittings.
- .7 Install insulation with smooth and even surfaces, with round shapes laid to true circular and concentric shape, shaped to blend with fitting insulation and adjacent covering; with full length section and tight to insulated object.
- .8 Pack solid around all pipes where they pass through sleeves in walls, floor slabs, etc. for full thickness of floor with fibreglas or rockwool. Refer to firestopping clause where piping passes through fire separations. On all services, carry full insulation thickness through walls, floors, etc. Protect insulation of exposed pipes passing through floors with 1.2mm (18 ga.) galv. iron 150mm (6") from finished floor.
- .9 On piping, gouge out insulation for proper fit where there is interference between weld bead and insulation. Bevel insulation away from studs and nuts to permit their removal without damage to insulation. Closely and neatly trim around extending parts of pipe saddles, supports, hangers and clamp guides. Seal with insulating cement.
- .10 Use pipe covering protection saddles with roll type hangers unless otherwise indicated.
- .11 Butt joints
 - .1 Place joints on top of duct wherever practical. Butt joints on side of duct for flexible duct insulation.
 - .2 Adhere and seal laps of vapour barrier cover or vapour barrier strip of 100mm (4") minimum width furnished with insulation, using vapour seal adhesives.
- .12 Sagging of duct insulation will not be acceptable.
- .13 Stagger both longitudinal and horizontal joints, on duct insulation of multilayered construction.
- .14 Duct insulation with vapour barrier shall be continuous, except at fire dampers.
- .15 Ducts acoustically lined need no external insulation, unless specifically noted otherwise.
- .16 Existing duct and pipe covering damaged or cut back during installation Work to be made good with same insulation as specified for new Work.
- .17 Protect insulation against elements during all stages of application.
- .18 Do not cover manufacturer's nameplates. Cut insulation on 45 deg. angle to nameplate edge and seal.
- .19 Covering to be uniform in diameter, smooth in finish. Place longitudinal seams so as to be invisible.

3.2 COLD INSULATION - PLUMBING

- .1 Insulate flanges, fittings and valve bodies, etc.
- .2 Fasten longitudinal laps with staples and seal with Swifts Adhesive #3218.
- .3 Butt joints wrapped with a 100mm (4") strip of ASJ. Stagger joints on multiple layers.
- .4 Refinish exposed piping with canvas and coat with Bakor 120-18 white fire retardant lagging adhesive.
- .5 All fittings shall be insulated by wrapping with 25mm (1") thick layers of 340 g. (3/4 lb.) density flexible fibreglass attached with jute twine. Surface shall be wrapped with Friction Tape and sealed with and asphaltic sealing compound. Over this to be applied a smooth coating of insulating cement. Recover fittings with ASJ vapour seal jacket and brush coat with fire retardant white lagging adhesive.

3.3 HOT INSULATION – GLYCOL HEATING

- .1 Application as per Clause "Cold Insulation- Plumbing".

3.4 INSULATION CLADDING

- .1 For aluminum jacketing installation, install in strict accordance with manufacturer's published recommendations.

3.5 WHITE PVC INSULATION COVER

- .1 Preparation
 - .1 Proto Fitting Covers shall be applied on clean, dry surfaces.
- .2 Application
 - .1 General
 - .1 The matching fiber glass insert shall either be wrapped completely around the fitting or snugly positioned inside the Proto Fitting cover for proper fit. The insert shall cover the full inner surface area of the Proto Fitting Cover. The Proto Fitting Cover shall then be applied over the fitting and insert, and the throat secured by either tack fastening, taping, sealing with a solvent type PVC adhesive, or banding.
 - .2 Hot Pipe
 - .1 Insulate as per General Instructions given above. Due to PVC softening point at approximately 150 deg. F (70.6 deg. C), care should be taken to ensure sufficient insulation thicknesses are applied. For hot piping which requires Knauf Pipe insulation over 1-1/2" (38mm) wall thickness, an extra fiber glass insert shall be applied for each additional inch of pipe insulation wall thickness. Knauf recommends the surface temperature of the pipe insulation and PVC to be no higher than 125 deg. F (52 deg. C). To complete application of Proto PVC Fittings on hot piping, the throat seam shall be riveted or tacked.

3.6 VAPOR BARRIER FLEXIBLE DUCT INSULATION

- .1 Round Ducts
 - .1 Adhere to duct surface applied in strips 150mm (6") wide, 300mm (12") o.c. Butt all edges of insulation, staple and seal all joints with tape adhered over the joint. Seal all breaks with vapor barrier type.

3.7 VAPOR BARRIER RIGID DUCT INSULATION

- .1 Insulation applied with edges tightly butted and secured by impaling on pins welded to duct. Pins to be staggered, minimum 300mm (12") o.c. in every direction. This applies to all sides. Secure insulation to pins with metal fasteners. Pins shall be long enough to bend after fasteners have been applied. Install two fasteners to all insulation on roof. Dab adhesive over pins and fasteners.
- .2 Seal all joints, edges and breaks in vapor seal jacket with vapor barrier foil of the same quality as that of duct membrane 100mm (4") wide with BF 85-15 lagging adhesive.

END OF SECTION

Part 1 General

1.1 GENERAL

- .1 All Drawings and all sections of the Specifications shall apply to and form an integral part of this section.

1.2 WORK INCLUDED

- .1 Provide labour, Material, equipment and services necessary for and incidental to the supply and installation of the systems shown on the Drawings and hereinafter specified.
- .2 Generally this shall include:
 - .1 Domestic Cold Water Supply

1.3 RELATED WORK SPECIFIED ELSEWHERE

- .1 Section 21 05 00 Mechanical General Provisions
- .2 Section 21 05 10 Acceptable Materials & Equipment
- .3 Section 21 08 10 Insulation
- .4 Section 22 50 10 Fire Protection
- .5 Section 23 60 10 Liquid Heat Transfer
- .6 Section 23 80 10 Air Distribution
- .7 Section 25 10 10 Controls/Instrumentation
- .8 Section 26 05 00 Common Work Results – For Electrical

Part 2 Products

2.1 PIPE AND FITTINGS

- .1 General
 - .1 All pipe & fittings shall be manufactured in Canada or the USA.
 - .2 Pipe and fittings shall conform to the standards listed in the applicable Building Code (latest revision).
 - .1 Flanged joints must have suitable gasket and bolts.
 - .2 Use brass nipples between copper piping and flush valves or c.p. brass goods.
 - .3 Where alternate piping Materials or jointing are specified a uniform type of pipe and fittings shall be used throughout each system.
 - .3 Domestic Cold Water Piping
 - .1 Pipe - Type 'L' third party certified hard copper tube to ASTM B.88.
 - Fittings - Wrought copper or cast brass, solder joint pressure fitting.
 - Flanges - Cast brass 1034 kPa (150 lb.) ANSI B16.24.

2.2 VALVES

- .1 General

- .1 Valve parts must be of material recommended by mfg. for service specified. Valves must be installed with stems upright or horizontal, not inverted. Valves not specifically covered herein shall be of comparable quality to those specified.
- .2 Water
 - .1 Domestic cold:
 - .1 Ball valves up to 50mm (2"): Toyo Fig. 5049A, Kitz 59, Crane 9322, MAS – B4.

2.3 EQUIPMENT

- .1 General
 - .1 Provide traps, for all equipment.
 - .2 Heating Equipment:
 - .1 Connect drain to all heating systems and equipment.

2.4 FIXTURES

- .1 Roof hydrants: Zurn Z1388, exposed, non-freeze roof hydrant, with Dura-Coated cast iron head and lift handle with lock option, bronze interior parts, galvanized steel casing, and bronze housing with 1/8" (3mm) IP drain port in housing. Complete with Dura-Coated cast iron roof support sleeve with wide anchoring flange and clamp collar. 3/4" (19mm) adapter vacuum breaker.

Part 3 Execution

3.1 GENERAL INSTALLATION

- .1 All pipe shall be cut accurately to measurements taken at Site, installed without springing or forcing. All changes in direction made with fittings.
- .2 All connections to equipment made with unions or flanges.
- .3 Remove valve working parts during installation to prevent damage from heat where brazing, soldering, or welding is used.
- .4 Comply with latest CSA Standard W117.2 "Code for Safety in Welding and Cutting".
- .5 Drain pipes dropping into slab on grade shall have sisson joint arranged to take up movement of slab.
- .6 Run all piping in accessible pipe spaces in such a way that it does not interfere with free access into pipe space.
- .7 Co-operate with Contractor and all Subcontractors to properly locate all equipment connections.
- .8 Provide a shutoff valve on supply connections at each piece of equipment.

3.2 WATER SUPPLY SYSTEM

- .1 General
 - .1 Provide complete system of water supply piping to serve all fixtures.
 - .2 Grade horizontal runs of piping to drain through risers.

- .3 Install drain valves with hose thread in mains where shown and/or necessary for complete drainage.
- .4 Install dielectric insulating unions between all pipes or apparatus constructed of dis-similar metals. Use brass nipples at flush valves, etc.

3.3 JOINTING

- .1 All joints shall be made in accordance with manufacturer's recommendations.
- .2 Fittings shall be braced where necessary to prevent joints coming apart under pressure.
- .3 Pipe, joints, couplings, gaskets, and fittings, etc, shall be in strict accordance with manufacturers published recommendations.

3.4 EXPANSION AND CONTRACTION OF PIPING

- .1 Make provision for expansion and contraction of all piping. Use swing connections where shown or necessary.
- .2 Install expansion joints where required. Provide anchors and guides as recommended by manufacturer.

3.5 CLEANING AND FLUSHING

- .1 On completion, flush out piping systems before installation of equipment, etc. in order to remove any foreign Material in piping.
- .2 Clean out all equipment and leave in first class operating condition.

3.6 TESTING

- .1 All piping systems shall be pressure tested as follows:
 - .1 Plumbing systems - in accordance with local regulations.
 - .2 Water supply piping - test with water to 690 kPa (100 psig) at the highest point of system. Maintain pressure without loss for 4 hours.
 - .3 General
 - .1 All systems and equipment will be subject to operating tests to verify that they operate properly, as directed by Contract Administrator. This will apply to pumps, heaters, compressors, and complete systems generally.
 - .2 Contract Administrator's representative shall witness tests. Give 48 hours notice in advance of all tests.

3.7 ROOF HYDRANTS

- .1 Install roof hydrant as per manufacturers standard instructions as well as the following:
 - .1 Drain port in housing shall be capped or removed.
 - .2 Provide curb or inlet wood blocking within roof around roof hydrant in addition to specified clamping collar as required to provide rigid connection to roof.
 - .3 Seal penetration water tight with sopramastic block system (detail RD-1).

END OF SECTION

Part 1 General

1.1 GENERAL

- .1 All Drawings and all sections of the Specifications shall apply to and form an integral part of this section.

1.2 WORK INCLUDED

- .1 Labour, Material, plant, tools, equipment and services necessary and reasonably incidental to completion of fire protection Work, including:
 - .1 Sprinkler System
 - .2 Modification to existing Sprinkler Systems
 - .3 Preparation of Shop Drawings, approval of same by authorities having jurisdiction, inspection, testing and approval as specified herein and as required by authorities having jurisdiction.

1.3 RELATED WORK SPECIFIED ELSEWHERE

- .1 Section 21 05 00 Mechanical General Provisions
- .2 Section 21 05 10 Acceptable Materials and Equipment
- .3 Section 21 08 10 Insulation
- .4 Section 22 40 10 Plumbing
- .5 Section 23 60 10 Liquid Heat Transfer
- .6 Section 23 80 10 Air Distribution
- .7 Section 25 10 10 Controls/Instrumentation
- .8 Section 26 05 00 Common Work Results – For Electrical

Part 2 Products

2.1 MATERIALS

- .1 General
 - .1 All pipe & fittings shall be manufactured in North America.
 - .2 All Materials shall be in accordance with requirements of the applicable NFPA fire codes including NFPA #13 - Sprinkler Systems.
 - .3 All Materials shall conform to standards listed in the current edition of applicable Building Codes.
 - .4 All equipment and components, shall be listed, labelled and approved for intended use by Underwriters Laboratories of Canada (ULC), Underwriters Laboratories

(UL), or Factory Mutual (FM), and meet with approval of the authority having jurisdiction.

.2 Pipe

- .1 Steel pipe to meet requirements of NFPA #13 - Sprinkler Systems in all respects and meets requirements of ASTM A53 - welded and seamless pipe.
- .2 All pipe in sprinkler and standpipe systems shall be schedule 40 black steel pipe and meets requirements of ASTM A53 - welded and seamless pipe.
- .3 Pipe 2" and smaller shall be joined by threaded connections or welded.
- .4 Pipe 2-1/2" and larger shall be joined by roll groove mechanical couplings or by welding.

.3 Fittings

- .1 Weld fittings up to including 1-1/2" shall be 13,790 kPa (2,000 psi) socket, 2" and larger shall be butt weld.
- .2 Grooved pipe couplings shall be Victaulic 'Zero Flex' Style 07 rigid couplings. Anvil Rigid Lock 7401 considered equal in accordance with B7.
- .3 Mechanical grooved, couplings and gaskets used on dry or preaction systems shall be listed for dry pipe service.
- .4 Threaded fittings shall be standard weight cast iron. Saddle type fittings not acceptable. All fittings to be suitable for a working pressure of 1,210 kPa (175 psi).
- .5 Pipe flanges shall be Class 150 forged steel except for welded pipe connections, flanges for pipe 64mm (2-1/2") or larger shall have grooved extension for connection to pipe using Victaulic coupling; flanges for pipe 50mm (2") and less shall be threaded. Slip on or welding neck flanges may be used on shop fabricated components. Valve companion flanges to be flat or raised face to suit valve flange. Provide suitable red rubber ring or full face gasket, machine bolts and hex nuts unless otherwise recommended by manufacturer of connecting valve or equipment.
- .6 Victaulic F.I.T. fittings Victaulic style 922 Hooker, and Victaulic Snap-Let sprinkler head connection fittings shall not be used.

.4 Valves

.1 Ball Valves

- .1 Up to including 2" - Victaulic Series 728 firelock ball valve, bronze body, chrome plated brass ball, stainless steel stem, TFE seat, wheel handle actuator with valve position indicator c/w double pole double throw supervisory switch, underwriters and FM approved. Working pressure 2,413 kPa (350 psi).

.2 Butterfly Valves

- .1 2-1/2" and larger - Iron body lug style valve with aluminum bronze disc and replaceable EPDM seat. Manual gear operator with valve position indicator. Valve rated for 1,379 kPa (200 psi) operating pressure. Anvil LC8282-3-FD with two internal SPDT monitor switches.
- .2 2-1/2" and larger - Victaulic Series 705W, ductile iron body, EPDM coated ductile iron disc, weatherproof actuator, with valve position indicator c/w double pole double throw supervisory switch, Underwriters

Listed and FM approved, working pressure 2,069 kPa (300 psi). Anvil Series 7700 Grovlok considered equal in accordance with B7.

- .3 Gate Valves
 - .1 Gate valves 4" to 6" - Iron body bronze mounted gate valves, OS & Y pattern with flanged ends, rated for 1,380 kPa operating pressure. Crane No. 10269, Underwriters and FM approved.
- .4 Check Valves
 - .1 Victaulic Series 717 Firelock check valve, ductile iron body, EPDM disc coating, ULC listed.
- .5 Sprinkler Heads
 - .1 In unfinished areas or in areas where sprinkler piping cannot be concealed sprinkler heads shall be bronze upright unless noted otherwise on Drawings. Provide bronze sidewall type where noted.
 - .2 When sprinklers are exposed to damage, fit with approved wire guards.
 - .3 Rapid response sprinkler head design shall be provided at locations required by NFPA and local Code.
- .6 Hangers and Supports
 - .1 Sprinkler system shall be in accordance with NFPA #13 and/or Section 21 05 00 Clause 'Hangers and Supports' whichever is most stringent application.

Part 3 Execution

3.1 SHOP DRAWINGS, PERMITS, FEES

- .1 Prior to installation, prepare complete set of detailed Shop Drawings in accordance with requirements of NFPA Standard #13, and inspecting authority. Information as to architectural, structural, mechanical and electrical systems shall be obtained from respective Drawings and/or from Site. Carry out any necessary flow tests without extra compensation.
- .2 Detail design shown on Shop Drawings shall conform to general piping layout and sprinkler arrangement shown on Drawings. Contract Administrators approval is required for alternative designs or revisions other than as required for co-ordination with other trades and existing Site conditions.
- .3 At completion of Work, provide two (2) sets of "As-Built" Drawings with all changes incorporated.
- .4 Submit Shop Drawings and calculations to Contract Administrator for review and to inspecting and inspection fees. Inspecting authorities for this project will be:
 - .1 Local building inspection department and/or fire department.
 - .2 The City's Insurance Underwriters.
 - .3 Provincial Fire Commissioner.
 - .4 Fire Commissioner of Canada.
 - .5 Insurer's Advisory Organization (I.A.O.).

- .5 Arrange for inspection and testing of all Work, and make any changes required to comply with regulations of inspecting authority.
- .6 Systems shall be designed in accordance with requirements of:
 - .1 The City's Insurance Underwriters ().
 - .2 National Building Code.
 - .3 Manitoba Building Code and Manitoba Fire Code
 - .4 Local building regulations
 - .5 All applicable NFPA Codes & Standards

3.2 EXAMINATION OF DRAWINGS AND CO- OPERATION

- .1 Examine all Drawings before preparing Shop Drawings. Arrange position of sprinkler heads, pipes, etc. as required to prevent interference with Work of other trades, and existing conditions.
- .2 Co-operate with all other Subcontractors and/or Subcontractors installing equipment which may affect proper installation and operation of Work and arrange sprinkler heads, etc. in proper relation to other apparatus, such as lighting fixtures, unit heaters, air inlets, air outlets etc., both new and existing.
- .3 Provide wiring diagrams, dimensions of concrete bases, dimensions of masonry openings, etc. as required by other Subcontractors and/or Subcontractors.

3.3 EXISTING CONDITIONS

- .1 Before commencement of any Work, examine Work of other trades and make immediate report to Contract Administrators of any defect or interference affecting Work or guarantee of this Work.
- .2 In case of buildings or Site conditions existing prior to tendering, examination and report must be made at least seven (7) Working days prior to closing of Bid Opportunity, otherwise existing conditions will be considered acceptable to Section 22 50 10, and no later allowance will be made for extras relating to these conditions.
- .3 Contract Administrator will arrange Site visit to allow bidders to inspect existing conditions during Bid Opportunity period. Contact at for details.

3.4 PIPING SYSTEMS

- .1 Inside of all pipe, fittings, valves and all other equipment to be left smooth, clean, and free from blisters, loose mill scale, sand and dirt.
- .2 Install unions or flanges at all equipment connections, valves, etc.
- .3 Install dielectric insulating couplings between all pipes or apparatus constructed of dissimilar metals.
- .4 Pipe bending, other than wrought iron, permitted only if seamless steel pipe is used without distortion, rippling and reduction in wall thickness. Contract Administrator reserves right to have pipe section replaced with fittings if bending is not satisfactory.

- .5 Cut all pipe accurately to measurements taken at Site, and shall be installed without springing or forcing.
- .6 Run all piping in accessible pipe spaces in such a way that it does not interfere with free access into pipe space.
- .7 All pipe concealed in walls or inaccessible spaces shall have welded joints.
- .8 Welded pipe sections shall be shop fabricated as far as possible and/or to minimize field welding required. Welding on Site is not permitted except with special approval of authorities having jurisdiction. If Site welding is required obtain written approval of authorities having jurisdiction and follow all safety precautions required by such authorities.

3.5 HOLES IN STRUCTURAL MEMBERS

- .1 If drilling of structural beams or other load bearing members is required by design or by Site conditions for passage of piping, obtain Contract Administrators approval for location and proposed drilling procedure before drilling. Drill only in locations previously approved by Contract Administrator. Where drilling required by design or existing Site conditions be responsible for carrying out same to approved procedure.
- .2 Do not cut or install piping until final drilling locations are approved by Contract Administrator. Section 22 50 10 will not be reimbursed for extra cost incurred to relocate piping previously installed on basis of unapproved drill locations.

3.6 HYDRAULIC DESIGN

- .1 Section 22 50 10 shall have option of using hydraulic design in preparing Shop Drawings for system. In some cases hydraulic design may be required by job conditions or by authority having jurisdiction. In any case, it shall be responsibility of Section 22 50 10 to carry out necessary calculations, and to submit calculations, data, and Drawings in accordance with requirements of NFPA Standard #13 and authority having jurisdiction.

3.7 TESTING

- .1 Provide all labour, Material, equipment, etc. as required to carry out testing as specified herein and as required by authorities having jurisdiction to prove satisfactory completion, performance and acceptance of all systems.
- .2 Testing shall include:
 - .1 Flow Test
 - .2 Pressure Test
 - .3 Inspectors Tests
- .3 Conduct flow tests on water systems as required by authority having jurisdiction.
- .4 Pressure Tests
 - .1 Perform pressure tests on all new or modified piping systems to requirements of NFPA #13, authority having jurisdiction, and additional requirements noted in this Specification.

- .2 All systems shall be pressure tested after final completion. If subsequent modifications are necessary; eg. relocation of sprinkler drops or similar minor revisions, pressure tests shall be repeated as directed by Contract Administrator.
- .3 Sprinkler mains and branch piping above new ceilings shall be pressure tested and all leakage repaired before installation of ceiling tiles.
- .4 Final pressure test shall be carried out after installation of sprinklers.
- .5 In addition to hydrostatic pressure tests noted above, and operational tests noted below, all pre-action sprinkler systems shall be subjected to a pneumatic pressure test. This test shall be carried out after satisfactory completion of operational tests noted below. On completion of operational tests, drain entire pre-action system including each sprinkler drop leg (pendant sprinklers). Replace all sprinkler heads and test system under 175 kPa (40 psig) air pressure for 24 hours. Test shall be considered satisfactory when observed pressure drop is less than 10 kPa (1.5 psig) over 24 hour period.
- .5 Inspectors Tests
 - .1 Inspectors tests shall be performed at all dry pipe, preaction and alarm check valve stations, and at all zone stations, flow switches, etc., and at other locations as required by authority having jurisdiction.
 - .2 Tests shall prove satisfactory operation of all flow switches and other alarm devices and all fire detectors connected to preaction system.
- .6 Documentation
 - .1 Section 22 50 10 shall properly document all testing distribute same to all authorities having jurisdiction, Contract Administrator, and The City. Testing shall be repeated as required until acceptable results obtained as determined by authority having jurisdiction and Contract Administrator.
 - .2 On completion on inspections and testing submit to Contract Administrator and authorities having jurisdiction completed signed copies of appropriate NFPA-13 Contractor's Material & Test Certificate, Forms 85-A and 85-B.
- .7 Advance Notice of Testing
 - .1 Arrange suitable times with authorities having jurisdiction, Contract Administrator and The City in advance of all testing so that all have opportunity to witness testing.
- .8 Activation
 - .1 All systems shall be left in normal active duty condition immediately following satisfactory completion of testing.
- .9 Warranty Inspection/One Year Test
 - .1 Provide complete inspection/test one year after final acceptance of systems. Annual tests required by NFPA 25 to be conducted at this inspection. Submit report to The City and Contract Administrator.

END OF SECTION

Part 1 General

1.1 GENERAL

- .1 All drawings and all sections of the Specifications shall apply to and form an integral part of this section.

1.2 WORK INCLUDED

- .1 Labour, Materials, plant, tools, equipment and services necessary for and reasonably incidental to completion of following services:
 - .1 Glycol heating systems

1.3 RELATED WORK SPECIFIED ELSEWHERE

- .1 Section 21 05 00 Mechanical General Provisions
- .2 Section 21 08 10 Insulation
- .3 Section 22 40 10 Plumbing
- .4 Section 23 80 10 Air Distribution
- .5 Section 25 10 10 Controls/Instrumentation
- .6 Section 23 90 10 Testing, Adjusting and Balancing
- .7 Section 26 05 00 Common Work Results – For Electrical

Part 2 Products

2.1 PIPE AND FITTINGS

- .1 All pipe & fittings shall be manufactured in Canada or the U.S.A.
- .2 Glycol Heating
 - .1 Pipe Diameter:
 - .1 13mm to 250mm (1/2" to 10")- Schedule 40 carbon steel, continuous weld or electric resistance weld pipe conforming to A.S.T.M. A53 Grade B.
 - .2 Fittings
 - .1 Unions to be brass to iron ground joint type. Screwed fittings on steel pipe to be best quality 1034 kPa (150 psi) black malleable iron, banded. Nipples to suit pipe type. Thred-O-Lets and Weld-O-Lets to be manufactured to ASTM A181, Grade 1.
 - .2 Butt welding fittings to be Crane manufactured to ASTM A-234. Flanges to be Anvil forged carbon slip-on welding flanges conforming to ASTM A181, Grade 1. Gaskets to be preformed non-asbestos. Site or shop cut gaskets unacceptable. Use ring gaskets on raised face flanges and full faced gaskets on flat face flanges.

2.2 VICTAULIC PIPING SYSTEMS

- .1 All pipe & fittings shall be manufactured in Canada or the U.S.A.
- .2 Section 23 60 10 may use mechanical grooved pipe coupling, fittings and butterfly valves, shall be manufactured by Victaulic, for piping systems and mechanical equipment connections (in lieu of welded, flanged, threaded methods) (and may also be used as unions, seismic joints, flexible connections, expansion compensators, vibration reducers) in systems specified.
- .3 All grooved piping system components shall be of one manufacturer
- .4 Fittings to be Victaulic; ductile iron to ASTM A-536; wrought steel ASTM A-234; or factory-fabricated from ASTM A-53 steel pipe.
- .5 Couplings, to CSA B242
 - .1 Housing: Two required; ductile iron to ASTM A536, Grade 65-45-12. (Multiple-segment couplings are not permitted.)
 - .2 Coating: Enamel
 - .3 Gasket: EPDM-HP, grade EHP, to ASTM D 2000, suitable for the temperatures for which the piping system is designed to handle.
 - .4 Bolts/Nuts: plated carbon steel to meet ASTM A449 and A183.
 - .5 Where rigid type couplings are required, housings shall be cast with offsetting, angle-pattern bolt pads to provide joint rigidity.
 - .6 Installation-Ready, for direct stab installation without field disassembly; Victaulic Style 107N (rigid) and Style 177 (flexible).
 - .7 Outlet couplings to provide an integral reducing outlet. Couplings to be equipped with electroplated carbon steel gasket neck insert.
 - .8 Reducing couplings to be equipped with special reducing gasket for pressure responsive sealing.
 - .9 Use flange adapters of materials conforming to above to connect flanged components and equipment into the grooved piping system.
- .6 Valves
 - .1 Butterfly valves 150 mm (6") and smaller to be Series 700 with latch-lock throttling handle Grade 'E' coated disc and standard trim, complete with PPS lining

2.3 VALVES

- .1 Schedule of Valves
 - .1 All valves of each type specified shall be of one manufacturer. Submit brochure of valves selected, showing make, figure numbers, Material of construction and use.
 - .2 All valves shall conform to the requirements of the Manufacturers Standardization Society (MSS).
- .2 Butterfly Valves
 - .1 Valves to be rated at 1034 kPa (150 psig) with cast iron body, aluminum bronze disc, stainless steel shaft, Buna N shaft seals, E.P.D.M. seat,

- extended neck design allowing valve operator to clear insulation, bubble-tight shut-off to 1034 kPa (150 psig).
- .2 Keystone Fig. ARI, Center Line Series 200, Anvil Series 8000 or Nibco Fig. WD-2000.
- .3 Valves 200mm (8") and smaller to have lever-lock handles with 10-position throttling plates.
- .4 Valves 250mm (10") and larger to have gear operators with position indicator.
- .5 Butterfly valves shall be considered equal in accordance with B7 to gate valves for glycol heating installations.
- .6 On flanged piping at all equipment (pumps, coils, boilers and the like), use valves conforming to requirements of above with fully tapped body lugs so that valve can be connected individually to adjacent flanges.
- .7 Keystone Fig. AR2, Centre Line Series 200 Lug Body, Anvil Series 8000 lug body or Nibco Fig. LD-2000.
- .3 Ball Valves
 - .1 Valves to have brass body, screwed ends, brass ball and stem and teflon seating seal (175 deg. C).
 - .2 Ball valves shall be considered equal to gate valves for glycol installations.
 - .3 Toyo Fig. 5044A, Kitz Fig. 58, Anvil Fig. 171N, Nibco Fig. T-FP600, Newman Hattersley Fig. 1969, Victaulic 721, 722 or Jenkins Fig. 201J.
- .4 Check Valves
 - .1 Horizontal Piping
 - .1 Sizes up to and including 50mm (2") - Crane Fig. 41TF, Toyo Fig. 236T, Anvil Fig. 3310, Kitz Fig. 22, Nibco Fig. T-413-Y, Victaulic 716 or Jenkins Fig. 4041TJ.
 - .2 Sizes 64mm (2-1/2") and above
 - .1 862 kPa wafer style with cast iron body, 316 stainless steel disc and stem, E.P.D.M. seat, Inconel-X spring and Teflon bushings, Chek-Rite Model 12-CET, Moyes & Groves Fig. W12A-I6V.
 - .2 Vertical Piping
 - .1 Sizes up to and including 50mm (2")
 - .1 862 kPa Anvil Fig. 3600 bronze body spring loaded check valve with Teflon disc.
 - .2 Size 64mm (2-1/2") and above
 - .1 862 kPa Center Line, Series 800, wafer style check valve with ductile iron EPDM lined body, aluminum bronze check valve plates and stainless steel shaft, springs and travel stops.
- .5 Drain Valves - 3/4" Toyo Fig. 5046, Kitz Fig. 68C.C. c/w brass cap and chain, Newman Hattersley Fig. 1969 c/w brass cap and chain or Jenkins Fig. 201J c/w brass cap and chain.
- .6 Circuit Balancing Valves
 - .1 13mm (1/2") to 19mm (3/4") soldered.
 - .1 Provide Armstrong Model CBV-CS solder type Circuit Balancing Valve.
 - .2 Each valve shall have metering ports incorporating EPT check valves, on both sides of the seat.
 - .3 "Y" pattern globe style, designed for either presetting with balance schedule or for proportional balancing.

- .4 All metal parts bronze copper alloy. Each valve shall provide three functions.
 - .1 precise flow measurement
 - .2 precision flow balancing
 - .3 positive shutoff with no-drip soft seat
- .5 Valves shall have one 360 degree adjustment turn of handwheel with positive memory, allowing valve to be shut off and reopened to its balance setpoint.
- .6 Ship with pre-formed insulation to meet or exceed ASTM D 1784/cLASS 14253-c, MEA #7-87, ASTM-E-84 and ASTM-E-136 with flame spread rating of 25 or less and smoke development rating of 50 or less.
- .2 13mm (1/2") to 50mm (2") Soldered
 - .1 Provide Armstrong Model CBV-S solder type CBVs or Tour & Andersson.
 - .2 Each valve shall have metering ports incorporating EPT check valves, on both sides of the seat.
 - .3 "Y" pattern equal percentage globe style, designed either for presetting with balance schedule or for proportional balancing. All metal parts bronze copper alloy.
 - .4 Each valve shall provide three functions:
 - .1 Precise flow measurement.
 - .2 Precision flow balancing.
 - .3 Positive shutoff with no-drip soft seat.
 - .5 Provide 1/4" NPT tapped drain port on each side of valve seat.
 - .6 Valves shall have four (4) full 360 degree adjustment turns of handwheel (1440 degree) with micrometer type indicator and hidden memory feature to program valve for precise, tamper-proof balanced setting. When installed, handwheel and metering ports shall not be located on bottom of valve to prevent sediment deposits. Position handwheel scale so it may be clearly read without use of mirrors or any special tools.
 - .7 Metering ports interchangeable with drain ports to allow for read-out flexibility when installed in tight piping locations.
 - .8 Ship with pre-formed insulation to meet or exceed ASTM D 1784/cLASS 14253-c, MEA #7-87, ASTM-E-84 and ASTM-E-136 with flame spread rating of 25 or less and smoke development rating of 50 or less.
- .3 13mm (1/2") to 50mm (2") threaded
 - .1 Provide Armstrong Model CBV-T threaded type CBV.
 - .2 Each valve shall have metering ports incorporating EPT check valves, on both sides of the seat.
 - .3 "Y" pattern equal percentage globe style, designed either for presetting with balance schedule or for proportional balancing. All metal parts bronze copper alloy.
 - .4 Each valve shall provide three functions:
 - .1 Precise flow measurement.
 - .2 Precision flow balancing.
 - .3 Positive shutoff with no-drip soft seat.
 - .5 Provide 1/4" NPT tapped drain port on each side of valve seat.

- .6 Valves shall have four (4) full 360 degree adjustment turns of handwheel (1440 degree) with micrometer type indicator and hidden memory feature to program valve for precise, tamper-proof balanced setting. When installed, handwheel and metering ports shall not be located on bottom of valve to prevent sediment deposits. Position handwheel scale so it may be clearly read without use of mirrors or any special tools.
- .7 Metering ports interchangeable with drain ports to allow for read-out flexibility when installed in tight piping locations.
- .8 Ship with pre-formed insulation to meet or exceed ASTM D 1784/cLASS 14253-c, MEA #7-87, ASTM-E-84 and ASTM-E-136 with flame spread rating of 25 or less and smoke development rating of 50 or less.
- .4 Size 64mm (2-1/2") to 150mm (6") diameter.
 - .1 Provide Armstrong Circuit balancing Valves or Tour & Andersson (CBV) as noted. CBVs shall be CBV-G (straight) or CBV-A (angle).
 - .2 Valve body of ductile iron with grooved ends or with Armgrip non-rotating ductile iron flange adapters.
 - .3 Valves suitable for working pressures of 150 psi.
 - .4 Valve to have metering ports with EPT check valves on both sides of seat.
 - .5 Valves to be "Y" pattern modified equal percentage globe style, designed either for presetting with balancing schedule or for proportional balancing.
 - .6 Each valve shall perform three functions:
 - .1 precise flow measurement
 - .2 precision flow balancing
 - .3 positive shutoff with no-drip soft seat.
 - .7 Valves shall have five 63.5mm (2-1/2"); 76mm (3") or six 100mm (4"); 150mm (6") full 360 degree adjustment turns of handwheel with micrometer-type indicator and hidden memory feature to program valve for precise, tamper-proof balanced setting. Do not install handwheel and metering ports on bottom of valve to prevent sediment deposits. Position handwheel scale for clear reading without use of mirrors or other special tools.
 - .8 Install valves at least five pipe diameters downstream from any fitting and at least ten pipe diameters downstream from any pump. Two pipe diameters downstream of CBV shall be free of any fitting.
 - .9 Furnish CBVs with pre-formed insulation to meet or exceed ASTM D 1784/Class 14253-C, MEA #7-87, ASTM-E-84 and ASTM-E-136 with flame spread rating of 25 or less and smoke development rating of 50 or less.
 - .10 Valves to be grooved/flanged.

2.4 EXPANSION JOINTS

- .1 On piping up to and including 64mm (2-1/2") diameter, FLEXONICS packless expansion compensators, having type 321 stainless steel bellows, suitable for traverse up to 44mm (1-3/4"), c/w guide sleeve and traverse stops. Expansion compensators up to and including 50mm (2") to have screwed ends or flanged ends; expansion compensators of 64mm (2-1/2") in size or larger to have flanged ends. Compensators to be external type 'H'.
- .2 On piping of 75mm (3") and above, Flexonics packless self-equalizing single expansion joints, with type 304 stainless steel bellows. Sizes 75mm (3") and above to be externally guided with flanged ends.
- .3 Guides to be Flexonics.
- .4 Expansion joints shall be selected on the following basis:
 - .1 Glycol heating system - 100 deg.C temp. rise.

2.5 FLEXIBLE PIPE CONNECTIONS

- .1 On "hot" liquid systems provide Hydro Flex flexible braided stainless steel connectors manufactured of 300 series stainless steel convoluted metal bellows and braid with 1034 kPa (150 lb.) forged steel flanges (PCFF) or N.P.T. male ends (PCMX). Connectors to be 454mm (18") long unless noted otherwise on drawings or schedule.
- .2 Provide Vibro-Acoustics VH spring hangers.
- .3 Location
 - .1 Suction and discharge piping to pumps
 - .2 Supply and return piping to HRU coils as shown on drawings.

2.6 AIR VENTS

- .1 Manual air vents: Dole #14 key-operated air vent rated at 1034 kPa (150 psig) with copper tube extensions or Dole #9 screwdriver operated air vent rated at 1034 kPa (150 psig).
- .2 Automatic air vents: Dole #75 automatic float air vent rated at 1034 kPa (150 psig).

2.7 THERMOMETERS

- .1 Ashcroft Series EI bi-metal dial thermometers, having stainless steel cases, rings, and stems, glass covers and adjustable pointers. Accuracy to be 1% of full span.
 - .1 Glycol heating system - plus 10 deg. C to 150 deg.C.
- .2 Thermometers located up to 1.5m (60") above finished floor to have 75mm (3") diameter dials; and located above 1.5m (60") to have 125mm (5") diameter dials. Use back or bottom inlet stems, whichever is best suited for ease of reading. Choice of stem types shall not be made until piping and equipment, etc. has been installed. Stem type to be approved by Contract Administrator.

- .3 Brass separable wells to have insulation extensions, where mounted on insulated piping or equipment, to ensure dials are clear. Minimum length of stems to be 150mm (6").

2.8 PRESSURE GAUGES

- .1 Ashcroft type 1010 quality gauges having aluminum cases, bronze geared movements, bronze bourdon tube, friction glass cover, steel slip ring, precision type pointer. Accuracy to be 1% of full scale.
- .2 Use 113mm (4-1/2") dials. Where mounted above 3m (10') from floor level, use 150mm (6") dial. Gauges to be chosen with indicating needle at 12 o'clock position for normal operating pressure. Gauges shall have dual indication (i.e. kPa, psi) with kPa prominent figure.
- .3 Provide Ashcroft Fig. DH-11 brass needle valve on gauges on glycol systems.
- .4 Provide Ashcroft Fig. 1/4-1106B pulsation dampener on pump gauges.

2.9 HEATING PUMP SYSTEM

- .1 Pumps
 - .1 Provide Series 4380 IVS Design Envelope Pumps. The design envelope shall encompass an Initial Design Point as scheduled. The design envelope shall also be capable of supplying Best Efficiency Point capacity.
 - .2 The Vertical In-Line (VIL) pump, single stage, single suction type, with pump characteristics which provide rising heads to shut off, shall be supplied NEMA Premium® efficiency Motors suitable for Inverter Duty meeting NEMA MG1, Part 31 insulation requirements and an Armstrong NEMA / UL Type-12 enclosure variable speed VFD.
 - .3 The Variable Frequency Drive shall be factory mounted and integrated with the Pump and Motor for a self-contained Compact Package. Components shall be selected to ensure optimum component matching and protection from motor overloading at any operating point within the design or operating envelope.
 - .4 Pump Construction: Pump Casing - Cast Iron with ANSI-125 flanges for working pressure to 175 psig at 150°F. Suction and discharge connections shall be flanged and the same size and shall be drilled and tapped for seal flush and gauge connections. The Casing shall be hydrostatically tested to 150% maximum working pressure.
 - .5 The casing shall be radially split to allow removal of the rotating element without disturbing the pipe connections.
 - .6 Impeller - Bronze, fully enclosed type, dynamically balanced.
 - .7 A bronze shaft sleeve, extending the full length of the mechanical seal area, shall be provided.
 - .8 Mechanical Seals - Shall be Single-spring inside type with silicon carbide faces. EPDM Elastomer with stainless steel spring and hardware shall be provided. Provide factory installed flush line with manual vent to purge

air prior to pump start-up, and shall be piped from the seal area to the pump suction connection.

.2 IVS Drives – Integrated Variable Frequency Drive (VFD)

.1 Fundamental Requirements

- .1 VFD shall be of the VVC-PWM type providing near unity displacement power factor ($\cos \phi$) without the need for external power factor correction capacitors at all loads and speeds.
- .2 VFD shall incorporate DC link chokes for the reduction of mains borne harmonic currents to reduce the DC link ripple current thereby increasing the DC link capacitors lifetime.
- .3 VFD shall be UL and C-UL Listed & CE Marked showing compliance with both the EMC Directive 89/336/EEC and the Low Voltage Directive 72/23/EEC.
- .4 RFI filters shall be incorporated within the drive to ensure it meets the emission and immunity requirements of EN61800-3 to the 1st Environment Class C1 (EN55011 unrestricted sales class B).

.2 VFD and Motor Protection

- .1 VFD and motor protection shall include: motor phase to phase fault, motor phase to ground fault, loss of supply phase, over voltage, under voltage, motor over temperature, inverter overload, over current. Over current is not allowed ensuring 4380 IVS units will not overload the motor at any point in the operating range of the unit.

.3 User Interface

- .1 VFD shall incorporate an integrated graphical user interface that shall provide running and diagnostic information and identify faults and status in clear English language. Faults shall be logged / recorded for interrogation at a later date.
- .2 It shall be possible to upload parameters from one VFD into the non-volatile memory of a computer and download the parameters into other drives requiring the same settings.
- .3 The keypad shall incorporate Hand-Off-Auto pushbuttons to enable switching between BMS and manual control.

.4 Sensorless Control Algorithm

- .1 Sensorless control software shall be embedded in the IVS unit to provide automatic speed control in variable volume systems without the need for pump mounted (internal/external) or remotely mounted differential pressure sensor. The default operating mode under Sensorless Control shall be 'quadratic pressure control' whereby head reduction with reducing flow will be according to a quadratic control curve. Control mode setting and minimum / maximum head set-points shall be user adjustable via the built-in programming interface

.5 Serial Communication

- .1 The VFD shall incorporate a USB port for direct connection to a

PC and an RS485 connection with BACnet protocol.

.6 Other Control Features

.1 The VFD shall have the following additional features:

- Sensorless override for BMS
- Manual pump control or closed loop PID control
- Programmable skip frequencies and adjustable switching frequency for noise / vibration control
- Auto alarm reset
- Motor pre-heat function
- Six programmable digital inputs (two can be configured as outputs)
- Two analogue inputs
- One programmable analogue / digital output
- Two volt-free contacts
- Warranty: 36 months from date of installation but not more than 42 months from date of manufacture.

.3 Suction Guides

- .1 Furnish and install on the suction of each pump an Armstrong Suction Guide, with Outlet Flow Stabilizing Guide Vanes, removable Stainless Steel Strainer and Fine Mesh Start-up Strainer. Supply valve with Cast Iron body with 125 psig flanged ports.
- .2 The mechanical Subcontractor shall inspect the strainer prior to activating the pump and, further, shall remove the Fine Mesh Start-up Strainer after a short running period. (24 hours maximum). Space shall be provided for removal of the Strainer and connection of a Blow-down Valve.

.4 Flo-Trex Valves

- .1 Furnish and install on the discharge side of each pump an Armstrong Model FTV Flo-Trex Combination Valve.
- .2 Each valve is to incorporate the following three functions in one body: Tight shut-off, spring-closure type silent non-slam check and effective throttling with flow measurement capability. The body shall have (2) 1/4" NPT connections on each side of the valve seat. Two connections to have brass pressure and temperature metering ports, with Nordel check valves and gasketed caps. Two other connections to be supplied with brass drain plugs. Metering ports are to be interchangeable with drain ports to allow for measurement flexibility when installed in tight locations. The valve disc shall be bronze plug & disc type with high impact engineered resin seat to ensure tight shut-off and silent check operation.
- .3 The valve stem shall be stainless steel with flat surfaces provided for adjustment with open-end wrench.
- .4 Valve body shall be Cast Iron with 125 psig flanged ports.
- .5 The valve shall be selected and installed in accordance with the manufacturer's instructions and be suitable for the pressure and temperature specified.

2.10 CHEMICAL TREATMENT

- .1 Glycol Systems Cleanout
 - .1 Provide 45 litres of GE Betz Ferroquest FQ7103 preoperational cleaner per 4,500 litres of water in system.
 - .2 Provide GE Betz Ferroquest FQ7102 as required.

2.11 ETHYLENE GLYCOL SOLUTION

- .1 Provide high grade (minimum 99.9% pure by weight) Ucartherm PM 6195 or Dowtherm SR-1 industrial inhibited ethylene glycol. Also provide two additional drums of glycol above quantity required to fill systems.
- .2 Pure glycol shall have following physical properties:
 - .1 Molecular wt = 62.07
 - .2 Specific Gravity at +20 deg.C = 1.130
 - .3 Boiling Point at 760mm Hg = 197 deg.C
 - .4 Freezing Point = -13 deg.C
 - .5 Viscosity at +20 deg.C = 20.93 centipoises
 - .6 Specific Heat at 20 deg.C = 0.561 Btu/lb./deg.F
- .3 55% aqueous solution by volume shall be made from glycol specified using distilled water, deionized water, or soft water containing less than 25 ppm each of chloride and sulfate ions and 50 ppm each of hard water ions (calcium and magnesium as calcium carbonate) with total hardness not to exceed 100 ppm. Solution shall have freezing point of -36 deg. C and viscosity of 8 centipoises at 0 deg.C. City of Winnipeg water may be used without softening. For all other locations, water analysis shall be submitted to Contract Administrator prior to use.
- .4 Glycol shall contain such inhibitors as deemed necessary by manufacturer to provide maximum corrosion protection to system. Manufacturer shall ensure that the glycol used to manufacture the heat transfer fluid is of high quality grade and is not recycled or reclaimed Material. The manufacturer of the fluid must provide written documentation stating the fluid passes ASTM D1384 standards (less than 0.5 mil penetration per year for all system metals).
- .5 Provide Contract Administrator with written report indicating methodology and type of treated water used prior to mixing solution.
- .6 After the solution has been circulated for 24 hours, a sample shall be tested by the manufacturer and a written report submitted to Contract Administrator.

2.12 HEATING COILS (GLYCOL)

- .1 Supply and install coils with .16mm (5/8") copper tubes and aluminum fins, tested to 1034 kPa (150 psi) air under water. Coils to have manual air vents. Coils shall be installed to insure proper drainage.
- .2 Coils used for glycol application shall be suitable to operate with glycol solution specified in Section 23 60 10.
- .3 Refer to Heat Recovery Unit Schedule.

Part 3 Execution

3.1 PIPE AND FITTINGS

- .1 Inside of all pipe, fittings, traps, valves and all other equipment to be smooth, clean and free from blisters, loose mill scale, sand and dirt when erected.
- .2 Install screwed unions or flanges at all equipment connections, elements, traps, valves, etc.
- .3 Pipe bending is not permitted.
- .4 Pipe and fittings up to and including 50mm (2") diam. to be screw jointed with screwed fittings. Make screw joints iron to iron, with graphite and oil filler or joint compound. Dope male threads only. All fuel oil piping shall be welded.
- .5 Pipe and fittings 63mm (2-1/2") diam. and above to be jointed by welding. Branch connections to be welded using butt welding fittings. Use slip-on welding flanges, welded to pipe on which they are fitting, at flange neck and back-welded on pipe end, at inside flange face. Valve companion flanges to be flat or raised face, matching valve flange. Use gaskets on flanged joints.
- .6 Branch connections of sizes 13mm (1/2"), 19mm (3/4") and 25mm (1") for radiation may be formed on mains of 50mm (2") diam. and above using carbon steel Thred-O-Let welding fittings.
- .7 Branch connections of sizes 31mm (1-1/4"), and larger to be formed using Weld-O-Lets. Reductions in mains to be after branches using butt weld reducing fittings. Site or shop fabricated welding fittings not permitted.
- .8 Welding to conform to Provincial Department of Labour Regulations. Welders to be licensed.
- .9 Use long radius elbows. For pipe reductions use eccentric reducing sockets.
- .10 Keep pipe connections clear for tube removal, etc.
- .11 Dielectric Couplings
 - .1 Provide where pipes of dissimilar metals are joined.
 - .2 Provide unions or flanges for pipe 50mm (2") and smaller and flanges on piping 63mm (2-1/2") and larger.
 - .3 Use Style 47 Dielectric Waterway as manufactured by Victaulic.
- .12 Branch Connections
 - .1 Type 'K' copper soft temper pipe - Silver braze joints using Handy & Harman's silver brazing alloy and flux. Fittings to Emco smooth bore silver braze fittings.

3.2 GROOVED PIPING

- .1 For mechanical grooving on site, prepare pipe in accordance with same specifications using specially designed tools.
- .2 Install in accordance with the manufacturer's latest published installation instructions.

- .3 Mechanical grooved pipe couplings, fittings, butterfly valves may be used for piping systems and mechanical equipment connections in lieu of welded and flanged methods for piping systems 2-1/2" and larger. Mechanical grooved couplings, and fittings may be used as unions, seismic joints, flexible connections, expansion compensators, and vibration reducers in systems specified.
- .4 Pipe ends shall be clean and free from indentations, projections and roll marks in the area from pipe end to (and including) groove.
- .5 Prior to coupling assembly, lightly coat lips and outer surface of gasket with a non-toxic lubricant as recommended by manufacturer. Pipes shall be gapped at time of installation to allow for expansion and contraction of system where required.
- .6 Gasket shall be manufactured by the coupling manufacturer and verified as suitable for the intended service.
- .7 Contractor shall consult with coupling manufacturer to select the appropriate locations for rigid and flexible fittings.

3.3 PIPING SYSTEMS

- .1 Glycol Piping Systems
 - .1 Grade up in flow direction or as noted so air may pass through connecting risers, etc. Minimum grading to be 1:480.
- .2 General
 - .1 Install branch riser take-offs to grade up to riser.
 - .2 Run piping parallel to walls and as unobtrusive as possible when viewed from inside or outside building.
 - .3 Where pipe change in direction is shown to take up expansion, spring piping cold.
 - .4 Blow out radiation and coils with compressed air prior to piping connections.
 - .5 Use welded piping in concealed areas and as a result inaccessible, i.e. plastered ceilings, etc. Control valves, etc. to be accessible through access doors.
 - .6 Install drain cocks on each pump and at system low points. Pipe to nearest floor drain.

3.4 TESTING OF SYSTEMS

- .1 Tests to be carried out in accordance with following time-pressure requirements and regulations and requirements of authorities have jurisdiction.
- .2 Glycol heating - test at 862 kPa (125 psig), or to pressure 1-1/2 times operating pressure, which ever is greatest, for 12 hrs.
- .3 Piping, concealed prior to completion of total service, to be tested in sections prior to concealment. Tests to be witnessed by Contract Administrator's representative. Two working days prior notice to be given Contract Administrator of such tests. Pressures to be as registered at system highest point. When sections are being tested additional pressure developed by static head of remainder of system above, to be added to specified test pressure.
- .4 Tests to be with water, unless noted otherwise, prior to insulation being applied.

- .5 System tests to be with equipment connected. Trap diaphragms to be removed and systems flushed prior test.
- .6 Make good leaks, replace defective parts, flush out defective section, re-test and adjust until system functions correctly.
- .7 Prior to The City's takeover, systems to be balanced and ready for operation, with traps, strainers, drip legs, etc. cleaned.

3.5 VALVES

- .1 Provide three valve by-passes in the following locations and where shown on drawings. By-pass valves shall be as specified for balancing valves.
 - .1 Pressure reducing valves.
 - .2 Temp. control valves on heating coils where the inlet air temperatures are 5 deg. C and below.
- .2 Provide isolating valves in the following locations and where shown on drawings.
 - .1 Suction and discharge of pumps.
 - .2 Before all temp. control valves.
 - .3 Inlet and outlet of all glycol fed equipment.
 - .1 Inlet valve shall be ahead of control valve to single coils. Provide inlet and outlet valves on all coil sections in multiple coil bank.
 - .2 Where piping detail sheets note balancing valves on leaving side of coils, additional outlet isolating valves not required, unless specifically noted on detail sheet.
- .3 Provide check valves on parallel operation pump discharges and also where noted. Install swing type check valves in a horizontal section of piping.
- .4 Provide balancing valves in following locations and where noted.
 - .1 Pump discharges.
 - .2 Outlet piping from all glycol coils.
 - .3 Valves on all glycol systems shall be gate type valves except for bypass valves which shall be globe type.
- .5 Provide chain wheel operators c/w chain for all valves where the valve operator is higher than 6'-6" above the floor. Where necessary provide shaft extensions c/w brackets and bearing to locate chain wheel operator in accessible location.
- .6 Valves installed in concealed locations, i.e. ceiling spaces, to be arranged for ease of access for servicing through access doors.
- .7 Provide a union or flange dependent on size of piping between butterfly valves and equipment which they serve to permit isolation and removal of equipment.
- .8 Butterfly valves shall be considered equal to gate valves for chilled water, condenser water, glycol and hot water heating installations.
- .9 Ball valves shall be considered equal to gate valves for low pressure condensate, hot water heating, chilled water, condenser water and glycol installations.

3.6 SUCTION GUIDES

- .1 After initial start-up of system the start-up strainer is to be removed from the unit.

3.7 EXPANSION JOINTS

- .1 Use guides on each side of expansion joints and compensators. Support from structural brackets.
- .2 When expansion joints are installed at ambient temps. higher than minimum system operating temp. they shall be precompressed prior to installation, to allow for eventual contraction of piping.

3.8 FLEXIBLE PIPE CONNECTIONS

- .1 Install as per manufacturer's recommendations.
- .2 Provide spring hangers for first three pipe support points from flexible connections.

3.9 ANCHORS

- .1 Provide where noted on horizontal piping. Fit anchors on vertical piping to ensure that water or air is not trapped. Fabricate from channels and angles to suit location; brace to building structure.

3.10 AIR VENTS

- .1 Provide manual air vents at high points of glycol heating systems.

3.11 THERMOMETERS

- .1 Stems and wells to be immersed in liquid flow. Where a separable well is mounted in pipe 37mm (1-1/2") diam. or less, enlarge pipe to 50mm (2") diam. for well length plus 75mm (3").

3.12 PRESSURE GAUGES

- .1 Use pressure gauges on pressure reducing valve stations, suctions and discharges of pumps and where noted.
- .2 Gauges, subject to vibration, to have copper tube extensions to locate away from source of vibration.

3.13 CHEMICAL TREATMENT

- .1 General
 - .1 Provide services of GE Betz Water Treatment Specialist to supply chemicals, accessories and to conduct water treatment analysis; supervise installation of equipment and initial start-up of treatment procedures. If, from analysis, other treatment is required, provide same but submit proposed treatment to Contract Administrator for approval prior to start-up of any system.

- .2 Supplier to provide training in use of test equipment, establish treatment ranges, and provide log sheets with training in their use.
 - .3 Supplier to make regular call-backs to check on procedures being followed and report each call in writing to Contract Administrator, and The Citys during first year's operation. Call-backs to be in accordance with following:
 - .1 Heating systems - at the beginning, mid-point and end of the heating season.
 - .4 Supplier to guarantee all mechanical equipment provided to be free of defects for one year from date of start-up.
 - .5 Provide operating manual indicating all phases of water conditioning program. Include detailed schematic drawings showing all special fittings, timers, controllers, etc. for each system. Four hard cover binders to be submitted to Contract Administrator for approval.
 - .6 Supplier to witness cleaning of all strainers.
 - .7 If system is used for temporary heat, clean it as outlined below prior to use for temporary heat and then clean again before takeover by The Citys. During temporary heat period chemically treat system under Supplier supervision and maintain logs on chemical balances. Chemicals required during temporary heat period are to be in addition to quantities listed below.
- .2 Glycol Systems Cleanout
- .1 Systems to be cleaned out. Pump on each system may be used to circulate cleaning solution. Balancing valves on pump discharges to be regulated to ensure against operating pumps out of their normal operating range.
 - .2 Cleaner to be introduced and circulated from 48 to 72 hours and removed from system by Contractor by dumping system.
 - .3 GE Betz to monitor system pH and add Ferroquest FQ7102 neutralizer as required, to bring pH into the 6.5-7.0 range.
 - .4 Flush each system until conductivity of water in system is back to conductivity of make-up water. If gland packed or mechanical seal pumps of permanent system are used during cleaning period, replace packing and mechanical seals with new Material.
 - .5 All strainers to be cleaned by Mechanical Subcontractor.
 - .6 System to be refilled and required amount of chemical treatment added to provide immediate protection against corrosion.
 - .7 Supplier to conduct conductivity tests before, during, and after cleaning each system, and report procedures followed and conductivity readings to Contract Administrator and Contractor in writing.
 - .8 System not to be used until cleaning procedure has been carried out and supervised by Supplier.
- .3 Sampling Connections
- .1 Provide 19mm (3/4") valved sampling connections where instructed by Supplier representative in the following systems:
 - .1 Boilers

.2 Glycol heating

3.14 GLYCOL SOLUTION

- .1 Glycol heating systems to be filled with 55% aqueous glycol solution.
- .2 Glycol supplier to report on procedure required for testing inhibitor concentration of glycol.

3.15 VIBRATION CONTROL

- .1 Supply drawings of all equipment to be isolated to isolation manufacturer. Manufacturer to submit approval drawings with isolation equipment schedule.
- .2 Manufacturer's factory-trained representative to inspect finished job and issue report to Contract Administrator indicating that all isolation equipment has been installed as per manufacturer's recommendations.

3.16 CO-ORDINATE WITH HVAC BALANCE AND TESTING AGENCY

- .1 Refer to Section 23 90 10 HVAC Balance and Testing.
- .2 Air balancing Work shall not begin until system has been completed and in full working order. Section 23 60 10 shall put all heating, ventilation, and air conditioning systems and equipment into full operation, as season would demand, and shall continue operation of same during each working day of testing and balancing. Co-ordinate Work with Section 23 90 10.
- .3 As part of this Contract, Section 23 60 10 shall make any changes in pulleys and belts, and add manual dampers for correct balance as recommended by Section 23 90 10, at no additional cost to The City.
- .4 Section 23 60 10 responsible for initial alignment and tension of all fan pulleys and belts of equipment supplied by Section 23 60 10.

END OF SECTION

Part 1 General

1.1 GENERAL

- .1 All Drawings and all sections of the Specifications shall apply to and form an integral part of this section.

1.2 WORK INCLUDED

- .1 Labour, Materials, plant, tools, equipment and services necessary and reasonably incidental to completion of ventilation Work.

1.3 RELATED WORK SPECIFIED ELSEWHERE

- .1 Section 21 05 00 Mechanical General Provisions
- .2 Section 21 08 10 Insulation
- .3 Section 22 40 10 Plumbing
- .4 Section 23 60 10 Liquid Heat Transfer
- .5 Section 25 10 10 Controls/Instrumentation
- .6 Section 23 90 10 Testing, Adjusting and Balancing
- .7 Section 26 05 00 Common Work Results – For Electrical

Part 2 Products

2.1 DUCT OPENINGS

- .1 Pack area between ducts and openings with fireproof self-supporting insulation. Seal with 25mm (1") mastic topping.

2.2 DUCT AND EQUIPMENT SUPPORTS, HANGERS AND INSERTS

- .1 Support horizontal ducts on maximum 2.4m (8'0") centres by non perforated galv. steel, rivetted strap for ductwork 900mm (36") (either dimension) or less, and minimum 25mm x 25mm x 3mm (1" x 1" x 1/8") galv. angle iron passing under ducts 925mm (37") or over (either dimension) with 9.4mm (3/8") diam. threaded rods suspending angles from structure.
- .2 Support vertical ducts at every floor with angle iron collars sized to provide proper bearing.
- .3 Use universal concrete type inserts of black malleable iron, for threaded connection with lateral adjustment, top slot for reinforcing rods and lugs for attaching to forms.

2.3 LOW PRESSURE DUCTWORK

- .1 Low Pressure Rectangular Ductwork Schedule

<u>Max. Side</u>	<u>Bracing</u>
.1 Up to 600mm (24")	None
.1 Gauge: .60mm (24 USSG)	

- | | <u>Max. Side</u> | <u>Bracing</u> |
|----|--|--|
| .2 | 635mm to 750mm
(25" to 30") | 25mm (1") x 25mm (1") x 3.2mm (1/8") angle,
1.2mm (4'0") from joint. |
| | .1 Gauge: .60mm (24 USSG) | |
| .3 | 785mm to 1000mm
(31" to 40") | 25mm (1") x 25mm (1") x 3.2mm (1/8") angle,
1.2mm (4'0") from joint. |
| | .1 Gauge: .80mm (22 USSG) | |
| .4 | 1040mm to 1.5m
(41" to 60") | 37.5mm (1-1/2") x 37.5 (1-1/2") x 3.2mm (1/8")
angle, 1.2m (4'0") from joint. |
| | .1 Gauge: .80mm (22 USSG) | |
| .5 | 1.525m to 2.25m
(61" to 90") | 37.5mm (1-1/2") x 37.5mm (1-1/2") x 3.2mm (1/8")
diagonal angles or 37.5mm (1-1/2") x 37.5mm
(1-1/2") angles 600mm (2'0") from joint. |
| | .1 Gauge: 1.0mm (20
USSG) | |
| .6 | 2.31m (91") and up
Similar to above. | |
| | .1 Gauge: 1.3mm(18
USSG) | |
| .2 | Round Ductwork Schedule | |
| | <u>Duct Diameter</u> | <u>Gauge</u> |
| .1 | Up to 508mm (20") | 0.5mm (26 USSG) |
| .2 | 533mm to 1.02m
(21" to 40") | 0.6mm (24 USSG) |
| .3 | 1.04mm to 1.52m
(41" to 60") | 0.8mm (22 USSG) |
| .3 | Ductwork to be galvanized steel unless noted otherwise. | |
| .4 | Outdoor ductwork to be two gauges heavier than directed above. | |
| .5 | Turning vanes (Ducturns) | |
| | .1 | Use duct elbows which have throat radius of 1-1/2" times the diameter. |
| | .2 | Where use of above specified item is precluded by space limitations, use duct elbows fabricated square throats and backs and fitted with Rovane turning vanes. |
| | .3 | Standard of Acceptance: S.E. Rozell & Sons Limited, Kitchener, Ontario. |

2.4 MANUAL VOLUME DAMPERS

- .1 1.2mm (16 ga.) galv. steel stiffened, blades of louvre type. Maximum of 300mm (12") wide and 1.8m (72") long, with one centre and two edge crimps. Damper hardware to be Duro-Dyne KS-145, KS-385 or KS-12 as recommended by manufacturer.

2.5 MOTORIZED DAMPERS

- .1 Supplied by Section 25 10 10 for installation by Section 23 80 10, with exception of those supplied with factory assembled heat recovery units and make-up air units.

2.6 FILTERS

- .1 General:
 - .1 Fan manufacturer to provide filter in filter sections provided with equipment.
 - .2 Filter supplier to provide all other filters.
 - .3 Provide one spare set of filter media for each filter bank.
 - .4 In some instances, filter frames are specified without filters. During cold winter periods, some filters can be relocated by The City to leaving side of preheat coils to minimize possible icing of filters.
 - .5 Refer to Equipment Schedules.

2.7 CLEANING OF H.V.A.C. SYSTEMS

- .1 If ductwork is installed carefully, and open ends are sealed whenever possible, ductwork does not need to be cleaned.

2.8 HEAT RECOVERY UNITS (TEMPEFF)

- .1 Refer to HRU Schedule.
- .2 General Description
 - .1 Configuration: Fabricate as detailed on drawings.
 - .2 Performance: As detailed in schedules.
- .3 Unit Construction
 - .1 Fabricate unit with extruded aluminum panels secured with mechanical fasteners. All access doors shall be sealed with permanently applied bulb-type gasket.
 - .1 Panels and access doors shall be constructed as a 2-inch (50-mm) nominal thick; with injected polyurethane foam insulation. R value shall be 6.5 per inch of wall thickness. The outer panel shall be constructed of G90 galvanized steel. The inner liner shall be constructed of G90 galvanized steel. Module to module assembly shall be accomplished with self adhering foam gaskets. Manufacturer shall supply test data demonstrating less than 0.2" deflection for an unsupported 48x48 panel under 30" W.C pressure. Units that cannot demonstrate this deflection are unacceptable.
 - .2 Access Doors shall be flush mounted to cabinetry, with minimum of two hinges, locking latch and full size handle assembly.
 - .3 All outdoor units will have an 18 gauge roof and gutters. The gutters will cover the entire perimeter of the unit.
- .4 Supply / Return Fans
 - .1 Provide DWDI backward incline supply & return fans. Fan assemblies including fan, motor and sheaves shall be dynamically balanced by the manufacturer on all three planes and at all bearing supports. Manufacturer must ensure maximum fan RPM is below the first critical speed.
 - .2 Bearings shall be self-aligning, grease lubricated, ball or roller bearings with extended copper lubrication lines to access side of unit. Grease fittings shall be attached to the fan base assembly near access door. If not supplied at the factory, Contractor shall mount copper lube lines in the field.
 - .3 Fan and motor shall be mounted internally on a steel base. Provide access to motor, drive, and bearings through hinged access door. Fan and motor assembly

shall be mounted on 1" deflection spring vibration type isolators inside cabinetry.

.5 Bearings And Drives

- .1 Bearings: Basic load rating computed in accordance with AFBMA - ANSI Standards, L-50 life at 200,000 hours – all DWDI fans, heavy duty pillow block type, self-aligning, grease-lubricated ball bearings.
- .2 Shafts shall be solid, hot rolled steel, ground and polished, keyed to shaft, and protectively coated with lubricating oil. Hollow shafts are not acceptable.
- .3 V-Belt drives shall be cast iron or steel sheaves, dynamically balanced, bored to fit shafts and keyed. Fixed sheaves, matched belts, and drive rated based on motor horsepower. Variable and adjustable pitch sheaves selected so required RPM is obtained with sheaves set at mid-position and rated based on motor horsepower. Contractor to furnish fixed sheaves at final RPM as determined by balancing Contractor. Standard drive service factor shall be 1.1 S.F calculated based on fan brake horsepower.

.6 Electrical

- .1 The air handler(s) shall bear an ETL listing label for the entire assembly. Units with only components bearing third party safety listing are unacceptable.
- .2 On RG sizes 1000 through 18000 all controls shall be located on the side of the unit for ease of servicing. Alternate manufacturers who supply units with controls on roof must supply a permanently installed ladder to access controls, and appropriate safety rails on roof of unit, meeting all applicable OSHA standards.
- .3 Wiring Termination: Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. All wires shall be number tagged and cross-referenced to the wiring diagram for ease of troubleshooting.
- .4 Fan motors shall be 1800 rpm, totally enclosed fan-cooled (TEFC) type. Motors shall be premium efficiency. Electrical characteristics shall be as shown in schedule.
- .5 Air handler manufacturer shall provide and mount a damper hand-off-auto (HOA) switch.
- .6 Unit is supplied with single point power connection complete with motor starters.

.7 Heating Coil Sections

- .1 Provide access to coils from connection side of unit for service and cleaning. Enclose coil headers and return bends fully within unit casing. Unit shall be provided with coil connections that extend a minimum of 5" beyond unit casing for ease of installation. Drain and vent connections shall be provided exterior to unit casing. Coil connections must be factory sealed with grommets on interior and exterior and gasket sleeve between outer wall and liner where each pipe extends through the unit casing to minimize air leakage and condensation inside panel assembly. If not factory packaged, Contractor must supply all coil connection grommets and sleeves. Coils shall be removable through side and/or top panels of unit without the need to remove and disassemble the entire section from the unit.
 - .1 Identify fin, tube & casing material type and thickness.
 - .2 Show coil weights (shipping & operating).
 - .3 State air and fluid flow amounts with its associated pressure drops.
- .2 Water Coils:

- .1 Certification - Acceptable water coils are to be certified in accordance with ARI Standard 410 and bear the ARI label. Coils exceeding the scope of the manufacturer's certification and/or the range of ARI's standard rating conditions will be considered provided the manufacturer is a current member of the ARI Air-Cooling and Air-Heating Coils certification programs and that the coils have been rated in accordance with ARI Standard 410. Manufacturer must be ISO 9002 certified.
 - .2 Headers shall consist of seamless copper tubing to assure compatibility with primary surface. Headers to have intruded tube holes to provide maximum brazing surface for tube to header joint, strength, and inherent flexibility. Header diameter should vary with fluid flow requirements.
 - .3 Fins shall have a minimum thickness of .00075" of aluminum plate construction. Fins shall have full drawn collars to provide a continuous surface cover over the entire tube for maximum heat transfer. Tubes shall be mechanically expanded into the fins to provide a continuous primary to secondary compression bond over the entire finned length for maximum heat transfer rates. Bare copper tubes shall not be visible between fins.
 - .4 Coil tubes shall be 5/8 inch (16mm) OD seamless copper, 0.020" nominal tube wall thickness, expanded into fins, brazed at joints. Soldered U-bends shall be provided to minimize the effects of erosion and premature failure having a minimum tube wall thickness of .025".
 - .5 Coil connections shall be N.P.T. threaded carbon steel with connection size to be determined by manufacturer based upon the most efficient coil circuiting. Vent and drain fittings shall be furnished on the connections, exterior to the air handler. Vent connections provided at the highest point to assure proper venting. Drain connections shall be provided at the lowest point to insure complete drainage and prevent freeze-up.
 - .6 Coil casings shall be a formed channel frame of galvanized steel. Water heating coils, 1 & 2 row only shall be furnished as uncased to allow for thermal movement and slide into a pitched track for fluid drainage.
- .8 Particulate Filters
- .1 Filter section with filter racks and guides with hinged and latching access doors on either, or both sides, for side loading and removal of filters.
 - .2 Filter media shall be UL 900 listed, Class I or Class II.
 - .3 Flat arrangement with 2", 50mm deep pleated panel filters.
- .9 Energy Recovery
- .1 Dual Core™ Energy Recovery
 - .1 Unit shall be equipped with Dual Core™ energy recovery technology. The unit shall be 90% efficient (sensible +-5%) at equal airflow in winter and up to 80% sensible in summer. It shall also provide up to 70% latent recovery. Unit shall accomplish this recovery without a defrost cycle that will reduce the effectiveness of the device. Devices employing defrost cycles that bypass the energy recovery device, or reduce the effectiveness are not acceptable. Energy recovery device shall not require frost protection in applications down to -40 degrees.
 - .2 Energy Cores shall be Generation 3, comprised of precisely corrugated high grade aluminum. Maximum allowable face velocity across heat

exchangers shall be 450 fpm. Heat exchanger face velocities exceeding 450 fpm are not acceptable.

- .3 Switchover damper section shall be comprised of multi section low leakage dampers operated by fast acting electric actuators. RG 1000-6500 shall have damper switching times of 0.75 seconds. RG 7500-18000 shall have damper switching times of 1.5 seconds. Dampers that do not switch within the specified times without objectionable noise are not acceptable. Single blade damper sections are not acceptable. Each damper shall control one of the 4 airways, upper-horizontal, lower-horizontal, forward-vertical and rear-vertical. Dampers shall be capable of orienting to close off outside air to the building without needing external shut off dampers. Dampers shall also be capable of orienting to allow 100% recirculation of air without using heat recovery device for off peak or unoccupied heating modes. Units incapable of these operations without extra ductwork are not acceptable.
- .4 Recovery cycles shall be controlled by internal programmed thermostats measuring both supply and exhaust air, and optimizing performance of both heat recovery and free cooling modes.

.10 External Dampers

- .1 External Damper Leakage: Leakage rate shall be less than two tenths of one percent leakage at 2 inches static pressure differential. Leakage rate tested in accordance with AMCA Standard 500.

.11 BMS Controls

- .1 Unit shall come with its own controls wired to a terminal strip for connection to the BMS.

.12 Installation

- .1 Install in accordance with manufacturer's Installation & Maintenance instructions.

.13 Environmental Requirements

- .1 Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

2.9 GRILLES, REGISTERS & DIFFUSERS

.1 Double Deflection Supply Grille, S-1

- .1 Furnish and install Price model 920D registers of the sizes and mounting types indicated on the plans and schedules.
- .2 Grilles shall be:
 - .1 Double Deflection
 - .2 45 degree adjustable spaced 1/2" (front) and 3/4" (back) on centre
 - .3 14 gauge steel blade and heavy duty steel support bars and frame
 - .4 Paint finish shall pass 500 hours of salt spray exposure in accordance with ASTM
 - .5 Cold rolled steel, black, integral volume control damper of opposed blade type operable from the face of the grille.

Part 3 Execution

3.1 DUCT OPENINGS

- .1 Locate only openings in walls, floors, partitions, beams, etc. required for ducts, equipment, etc. Contractor to form all openings for same, except as noted below.

3.2 DUCT AND EQUIPMENT SUPPORTS, HANGERS AND INSERTS

- .1 Design, Installation
 - .1 Supports to secure ducts and equipment, prevent vibration and provide for expansion and contraction. Design supports of strength and rigidity in a manner which will not stress the building construction. Use inserts for suspending hangers. Do not use vertical expansion shields without Contract Administrator's approval.
- .2 Concrete Inserts
 - .1 Do not weaken concrete or penetrate waterproofing membrane. Use reinforcing rods through inserts for pipe sizes over 50mm (2"), or equivalent weight. Where concrete slab is finished ceiling, inserts to be flush with surface.
- .3 Protect insulation at contact with hangers and support with approved metal shields.

3.3 CO-ORDINATION WITH H.V.A.C. BALANCE AND TESTING AGENCY

- .1 Refer to Section 23 90 10 H.V.A.C. Balance and Testing. Co-ordinate Work with Section 25 10 10.
- .2 As a part of this Contract, Section 23 80 10 shall make any changes in pulleys and belts, and add manual dampers for correct balance as recommended by 23 90 10, at no additional cost to The City.
- .3 Section 23 80 10 responsible for initial alignment and tension of all fan pulleys and belts, of equipment supplied by Section 23 80 10.

3.4 LOW PRESSURE DUCTWORK

- .1 Where duct width exceeds 450mm (18") in largest dimension, stiffen by cross breaking sheets diagonally. Beaded ducts as per SMACNA Catalogue Fig. 1.13 acceptable alternative.
- .2 Duct sizes are inside dimensions. If ducts are acoustically lined, outside duct size to be increased as required.
- .3 Provide ductturns in all elbows of ducts 1200mm (48") wide and greater, in segments of 600mm (24") maximum.
- .4 Single thickness partitions between ducts not accepted.
 - .1 All ductwork shall have seams and joints sealed watertight with Duro-Dyne S-2 duct sealer and FT-2 fibreglass duct tape. Prior to installation ductwork to be clean, dry and free of grease. Apply duct sealer with stiff brush or trowel. Wrap wet seam or joint with duct tape and apply further coat of duct sealer. Duct sealer and glassfiber to extend 25mm (1") on each side of joint or seam. On outside ductwork construct duct so that top of duct slopes 12mm (1/2") per 300mm (12") minimum to ensure that water does not collect on top.

- .2 Ductwork exposed in finished rooms do not require duct tape application, but seams and joints shall be sealed with S-2 duct sealer. Sealer must be capable of accepting finish painting.
- .3 Ductwork on roof shall have seams and joints sealed by application of TREMCO MONO black acrylic sealant applied with application gun and levelled with putty knife. Material shall be used in accordance with manufacturer's printed recommendations.
- .5 Provide openings for thermostats and controllers by Section 25 10 10.
- .6 Where ductwork conflicts with mechanical and electrical piping and it is not possible to divert ductwork or piping to stay within allowable space limitations, provide duct easements. Easements not required on pipes 100mm (4") and smaller outside dimension, unless this exceeds 20% duct area. Irregular or flat shaped piping requires duct easement. Hangers and stays in ductwork to be parallel to air flow. If easement exceeds 20% of duct area, duct to be split into two ducts with original duct area being maintained. Easements to be approved by Contract Administrator before installation.
- .7 At points within air system where air streams at different temperatures meet, install baffling for a good mix. Baffling to be by Section 23 80 10 in locations recommended by Section 25 10 10, approved by Contract Administrator, and at no additional cost to The City.
- .8 If ductwork is not adequately braced and/or supported to provide good installation, additional bracing and/or supports to be provided at no extra cost to The City. Contract Administrator to interpret.
- .9 Assemble round duct sections using beaded couplings attached with sheet metal screws.

3.5 FLEXIBLE DUCTWORK CONNECTORS

- .1 Mount on ducts with mastic seal and sheet metal screws. Formed conical connections approved by Contract Administrator, to be considered equal in accordance with B7.

3.6 DIFFUSER CONNECTIONS

- .1 Hard duct connection: provide min. 3 duct diameters section of straight vertical duct upstream of diffuser to achieve manufacturer's sound level ratings. Otherwise, provide equalizing grid in diffuser's neck.

3.7 MANUAL VOLUME DAMPERS

- .1 Install, in manner acceptable to manufacturer, where noted on Drawings.

3.8 MOTORIZED DAMPERS

- .1 Units in acoustically lined ducts are to be sized to suit clear dimensions of acoustic insulation and not of size to suit sheet metal duct. Where units are located in acoustic lined ducting, install heavy gauge metal channel and fasten to metal duct to receive damper frame. Space between channel and duct to be filled with flexible insulation.
- .2 On plenums and ducts with external insulation, Section 25 10 10 to provide channel mounting frame of same thickness as insulation. Pack channel frame with loose fibreglass insulation.

3.9 MANOMETERS

- .1 Mark on installed gauges, point at which filter should be serviced. Obtain this information from successful filter manufacturer.
- .2 Manometers are not required on roof-top filter sections.

3.10 FILTERS

- .1 During construction period, no air system to be started unless air filters function as specified. At time of building acceptance by The City, all filter banks to be in perfectly clean operating condition. There shall be no air bypass around or in filter banks.
- .2 Install all filters as per mfg. published installation data.

3.11 FAN SYSTEMS - GENERAL

- .1 Use flexible connections at inlets and outlets where ductwork and plenums connect to fans and air-handling equipment.
- .2 Fan Vibration Isolation
 - .1 Fan manufacturer to submit necessary information for proper isolation selection. This information to be incorporated in shop Drawings and shall include fan sizes, fan speeds, equipment weights, etc.
- .3 All equipment shall be installed in strict accordance with manufacturer's published data.
- .4 Protection of Fan Equipment Before Installation
 - .1 Grease shafts, sheaves, etc. to prevent corrosion. Fan bearings to be greased or oiled at time of building takeover.
- .5 Centrifugal fans located outdoors to have drain holes in casing.
- .6 Co-ordinate installation of smoke detectors with Division 26 - Electrical.

3.12 DIFFUSERS, REGISTERS AND GRILLES

- .1 Provide sponge gasket behind each outlet or inlet and adequate fastenings to prevent streaking between outlet and duct, wall or ceiling.
- .2 Shop Drawings to be accompanied by itemized list indicating unit locations by room number and unit size. Itemized list noted above shall be certified by direct representative.
- .3 Submit typical unit c/w all accessories, specified finishes, for all diffusers, grilles and registers, if requested by Contract Administrator. Materials installed on job to be fully equal in accordance with B7 to samples submitted for approval.
- .4 Exact dimensions of walls, etc. are as per architectural Drawings. Install diffusers so they fit properly in ceiling suspension system. Co-ordinate with all related Subcontractors.
- .5 Should there be any conflict in location of grilles, registers and diffusers with lights, etc. matter to be referred to Contract Administrator for directive. If requested by Contract Administrator, re-locate grilles, diffusers and registers and ductwork attached, within 1.2m (48") of locations noted on Drawings, without extra cost to The City. Refer to Drawings for additional requirements.

3.13 TESTING OF DUCTWORK

- .1 Visually and audibly check for air leaks that can be heard or felt under normal operating conditions. Repair all leaks in ductwork.
 - .1 Tests shall be performed by Section 23 90 10. Refer to Section 23 90 10.
 - .2 Section 23 80 10 shall provide all necessary temporary connections, blank-offs, tees, required for testing. Section 23 90 10 shall provide all test fans, equipment and labour required for testing.
 - .3 Section 23 80 10 shall clean all ducts before testing.
 - .4 During installation of ductwork include separate leakage air tests of each complete air riser; each completed horizontal distribution system, and after ductwork is installed and central station apparatus is erected, leakage testing of pressure side of whole system. Include testing of flexible runouts (where applicable).
 - .5 After preliminary tests, repair all leaks.
 - .6 Be responsible for any damage resulting from failure of items under test.
 - .7 Section 23 80 10 shall repair all leaks in duct system.
 - .8 Section 23 90 10 shall retest ductwork after leaks have been repaired.
 - .9 Co-ordinate Work to ensure that all ductwork is tested:
 - .1 Before ducts are insulated.
 - .2 Before ducts are concealed.

END OF SECTION

Part 1 General

1.1 GENERAL

- .1 All drawings and all sections of the specifications shall apply to and form an integral part of this section.
- .2 Testing, Adjusting and Balancing (TAB) Agency shall be an experienced, independent Contractor specializing in the testing, adjusting and balancing of HVAC systems.
- .3 TAB Agency shall be a member of the Associated Air Balance Council (AABC) and Work shall carry standard AABC Certificate of Guarantee.
- .4 Include extended service for 90 days after completion of final balancing Work, during which time Contract Administrator at his discretion may request re-check or re-setting of any systems and/or equipment listed in test report

1.2 SCOPE OF WORK

- .1 Provide complete testing, adjustment and final balancing of all building air systems.
- .2 Provide complete testing, adjustment and final balancing of liquid based building HVAC systems.
- .3 Provide complete ductwork leakage testing as specified.

1.3 RELATED WORK SPECIFIED ELSEWHERE

- .1 Section 21 05 00 Mechanical General Provisions
- .2 Section 23 60 10 Liquid Heat Transfer
- .3 Section 23 80 10 Air Distribution
- .4 Section 25 10 10 Controls/Instrumentation

Part 2 Products

2.1 BALANCING REPORTS

- .1 Provide two copies of detailed draft balancing report to Contract Administrator for review after completion of all adjustments.
- .2 Final balancing report shall incorporate all changes resulting from Contract Administrator's comments and any adjustments undertaken since the draft report was issued.
- .3 Provide four copies of final balancing report.
- .4 Provide sufficient number of copies of final balancing report to Mechanical Subcontractor for inclusion in Operating & Maintenance Manuals.

2.2 SMOKE TEST AND GRILLE ADJUSTMENT

- .1 Smoke test(s) shall be provided on the completed ventilation system. Results from the smoke test(s) shall be used to adjust supply grille deflection during commissioning.

2.3 DUCT LEAKAGE TEST REPORTS

- .1 Provide two copies of duct leakage test reports to Contract Administrator including test data for all preliminary and final tests.

Part 3 Execution

3.1 GENERAL

- .1 All instruments used shall be accurately calibrated and maintained in good working order. If requested, tests shall be conducted in the presence of Contract Administrator and/or his representative.
- .2 Schedule all Work to comply with completion date.
- .3 Work shall not begin until system has been completed and in full working order. Division 21 shall put all heating, ventilating, and air-conditioning systems and equipment into full operation, as season would demand, and shall continue operation of same during each working day of testing, adjusting and balancing.

3.2 AIR BALANCING

- .1 Coordinate with Sections 23 60 10 and 23 80 10 to ensure installation of all manual adjusting dampers and pitot tube enclosures are as indicated, as specified and as required to allow proper adjustment of air systems.
- .2 Sections 23 60 10 and 23 80 10 to provide initial alignment and tension of all fan pulleys and belts supplied by them.
- .3 Testing Procedure:
 - .1 Test, adjust and record all fan speeds, motor amperes.
 - .2 Make pitot tube traverse to main supply and obtain cfm at fan.
 - .3 Test and record static pressure for each system at fan suction and discharge.
 - .4 Adjust all supply and exhaust air ducts to proper design cfm.
 - .5 Test and adjust each diffuser, grille, and register to within 5% of design requirements. Balance as per manufacturer's recommendations.
 - .6 All outlets shall be adjusted to provide proper throw and distribution, in accordance with architectural requirements.
 - .7 Fan operating conditions tested shall confirm air delivery within 5% of manufacturer's fan curves.
 - .8 Systems shall be balanced so that fans operate at lowest possible static pressure.
 - .9 Inlet vanes shall not be used to reduce fan capacity to achieve balance condition.
 - .10 Prepare single line diagrams of duct systems indicating terminal outlets identified by number. List on data sheets all such outlets denoted by the same numbers,

including the outlet sizes, 'K' factor, location, cubic feet per minute and jet velocity. Provide this data for all supply and exhaust air systems.

- .4 As part of Work of this Contract, Sections 23 60 10 and 23 80 10 shall make any changes in the pulleys and belts, and any additional manual dampers for correct balance as recommended by Section 23 90 10, at no additional cost to The City. Section 23 90 10 shall provide final alignment and tension adjustment of fan pulleys and belts.
- .5 100% Outside Air "Blow-through" Units
 - .1 These requirements apply to all makeup air units and 100% outside air units where the fan is operating in air at ambient temperatures, i.e. heating and cooling sections are downstream of the fan.
 - .2 Balance to give design cfm at a mid-range air temperature of 0C. Calculate equivalent cfm at temperature prevailing during balancing procedure and balance to this calculated value.
 - .3 Provide charts and/or calculations in balancing report detailing the calculation of equivalent fan capacity.

3.3 GLYCOL BALANCING

- .1 Completely balance pumps and piping systems by adjustments of plug cocks, globe valves or other control devices, to obtain the flow quantities. During balancing set controls for full-flow through coils. Set automatic throttling valves in the full-open position. Close bypass port on automatic 3-way valves.
- .2 Balance fluid flow through coils, etc., in accordance with design.
- .3 For flow measuring devices, record pipe size, manufacturer and size of device, and direct reading of the differential pressure, and calculated final flow.
- .4 Balance flow through equipment and coils by means of flow measuring devices and pressure drop. Obtain curves from equipment manufacturers indicating relationship between flow and pressure drop through coils and equipment. Take readings on calibrated test gauges.
- .5 Upon completion of fluid balance, reconcile total heat transfer through all heating and cooling coils by recording entering and leaving water temperatures and entering and leaving air dry bulb and wet bulb temperatures.
- .6 Upon completion of balancing, adjust differential bypasses and 3-way valve bypasses for same pressure drop on full bypass as on full flow.
- .7 Section 23 60 10 shall supply and install water metering systems and devices. Refer to Section 23 60 10.
- .8 Equipment Data
 - .1 Provide following data on equipment:
 - .1 Glycol Coils
 - .1 Equipment information
 - .2 Air and fluid flow rates

- .3 Air and fluid temperatures entering and leaving
 - .2 Pumps
 - .1 Equipment information
 - .2 Fluid flow and head:
 - .1 at operating capacity
 - .2 at no flow
 - .3 at full flow.
 - .3 Motor bhp and Amperage at above ratings and motor speed.
 - .4 Marked up pump curves on all pumps.
 - .2 Equipment lists shall also include all information noted in schedules.
- .9 After entire installation has been completed, make required adjustments to balance valves, air vents, automatic controls, pumps until performance requirements are met. Make these adjustments with equipment operating. During such periods of adjustment prior to date of acceptance of mechanical systems, operate equipment. After date of acceptance of mechanical systems, The City's maintenance personnel will operate equipment.
- .10 During the first year of operation Section 23 90 10 shall repeat these adjustments for each of immediately following three seasons of the year.
- .11 Division 21 Subcontractors to install red valve tags onto all balancing valves, as specified under Section 21 05 00, subsection "Identification of Valves". Section 23 90 10 to add following information onto each balancing valve tag; valve final setting position, date of final adjustment, TAB Agency name and name of individual who made final adjustment.

3.4 SYSTEM CHECK

- .1 Provide spot checks of systems if called upon by Contract Administrator. If capacities, fan speeds, ratings, etc. do not agree with submitted balance report, rebalance system or systems in question, until satisfactory results are received.

3.5 LEAK TESTING OF AIR DUCTS

- .1 General:
 - .1 Tests shall be performed by Section 23 90 10.
 - .2 Section 23 80 10 shall provide all necessary temporary connections, blank-offs, tees, required for testing. Section 23 90 10 shall provide all test fans, equipment and labour required for testing.
 - .3 Section 23 80 10 shall clean all ducts before testing.
 - .4 During installation of ductwork include separate leakage air tests of each complete air riser; each completed horizontal distribution system, and after ductwork is installed and central station apparatus is erected, leakage testing of flexible runouts (where applicable).
 - .5 Perform preliminary tests and repair all leaks before notifying Contract Administrator of final tests.
 - .6 Maintain log book of all tests showing dates, personnel, observers' initials.
 - .7 Be responsible for any damage resulting from failure of items under test.
 - .8 Section 23 80 10 shall repair all leaks in duct systems.

- .9 Section 23 90 10 shall retest ductwork after leaks have been repaired.
- .10 Coordinate the Work as required with Sections 23 80 10, Mechanical Subcontractor and Contractor to ensure that all ductwork is tested:
 - .1 Before ducts are insulated.
 - .2 Before ducts are concealed.
- .11 Issue report to Contract Administrator after witnessing final tests.
- .2 Low Pressure Ductwork Test: (below 50mm water gauge operating pressure)
 - .1 Visual and audible check for leaks that can be heard or felt under normal operating conditions.
- .3 Leakage Testing of Other Systems:
 - .1 Make tests prior to insulation of system being tested using suitable test equipment, including 'U' tube, orifice, tubing and cocks, arrange to indicate amount of air leakage.
 - .2 Make leakage test with pressure maintained for minimum of 5 minutes at level of 150% of average operating pressure of duct section under test, obtained by operation of air supply fan, or if fan cannot be operated, by use of test blower. Inspect and check joints for leakage, record and submit results.
 - .3 Allowable leakage at test pressure: 5% of design maximum flow rate of duct section under test.

END OF SECTION

Part 1 General

1.1 RELATED DOCUMENTS

- .1 All Work of this Division shall be coordinated and provided by the single Building Management System (BMS) Contractor.
- .2 The Work of this Division shall be scheduled, coordinated, and interfaced with the associated Work of other trades. Reference the Division 21 Sections for details.
- .3 The Work of this Division shall be as required by the Specifications, Point Schedules and Drawings.
- .4 If the BMS Contractor believes there are conflicts or missing information in the project documents, the Contractor shall promptly request clarification and instruction from the design team.

1.2 DEFINITIONS

- .1 Analog: A continuously variable system or value not having discrete levels. Typically exists within a defined range of limiting values.
- .2 Binary: A two-state system where an "ON" condition is represented by one discrete signal level and an "OFF" condition is represented by a second discrete signal level.
- .3 Building Management System (BMS): The total integrated system of fully operational and functional elements, including equipment, software, programming, and associated materials, to be provided by this Division BMS Contractor and to be interfaced to the associated Work of other related trades.
- .4 BMS Contractor: The single Contractor to provide the Work of this Division. This Contractor shall be the primary manufacturer, installer, commissioner and ongoing service provider for the BMS Work.
- .5 Control Sequence: An BMS pre-programmed arrangement of software algorithms, logical computation, target values and limits as required to attain the defined operational control objectives.
- .6 Direct Digital Control: The digital algorithms and pre-defined arrangements included in the BMS software to provide direct closed-loop control for the designated equipment and controlled variables. Inclusive of Proportional, Derivative and Integral control algorithms together with target values, limits, logical functions, arithmetic functions, constant values, timing considerations and the like.
- .7 BMS Network: The total digital on-line real-time interconnected configuration of BMS digital processing units, workstations, panels, sub-panels, controllers, devices and associated elements individually known as network nodes. May exist as one or more fully interfaced and integrated sub-networks, LAN, WAN or the like.
- .8 Node: A digitally programmable entity existing on the BMS network.

- .9 BMS Integration: The complete functional and operational interconnection and interfacing of all BMS Work elements and nodes in compliance with all applicable codes, standards and ordinances so as to provide a single coherent BMS as required by this Division.
- .10 Provide: The term “Provide” and its derivatives when used in this Division shall mean to furnish, install in place, connect, calibrate, test, commission, warrant, document and supply the associated required services ready for operation.
- .11 PC: IBM-compatible Personal Computer from a recognized major manufacturer
- .12 Furnish: The term “Furnish” and its derivatives when used in this Division shall mean supply at the BMS Contractor’s cost to the designated third party trade contractor for installation. BMS Contractor shall connect furnished items to the BMS, calibrate, test, commission, warrant and document.
- .13 Wiring: The term “Wiring” and its derivatives when used in this Division shall mean provide the BMS wiring and terminations.
- .14 Install: The term “Install” and its derivatives when used in this Division shall mean receive at the jobsite and mount.
- .15 Protocol: The term “protocol” and its derivatives when used in this Division shall mean a defined set of rules and standards governing the on-line exchange of data between BMS network nodes.
- .16 Software: The term “software” and its derivatives when used in this Division shall mean all of programmed digital processor software, preprogrammed firmware and project specific digital process programming and database entries and definitions as generally understood in the BMS industry for real-time, on-line, integrated BMS configurations.
- .17 The use of words in the singular in these Division documents shall not be considered as limiting when other indications in these documents denote that more than one such item is being referenced.
- .18 Headings, paragraph numbers, titles, shading, bolding, underscores, clouds and other symbolic interpretation aids included in the Division documents are for general information only and are to assist in the reading and interpretation of these Documents.
- .19 The following abbreviations and acronyms may be used in describing the Work of this Division:
 - ADC - Analog to Digital Converter
 - AI - Analog Input
 - AN - Application Node
 - ANSI - American National Standards Institute
 - AO - Analog Output
 - ASCII - American Standard Code for Information Interchange
 - ASHRAE - American Society of Heating, Refrigeration and Air Conditioning Engineers
 - AWG - American Wire Gauge
 - CCMS - Central Control & Monitoring System
 - CPU - Central Processing Unit

CRT	-	Cathode Ray Tube
DAC	-	Digital to Analog Converter
DDC	-	Direct Digital Control
DI	-	Digital Input
DO	-	Digital Output
EEPROM	-	Electronically Erasable Programmable Read Only Memory
EMI	-	Electromagnetic Interference
FAS	-	Fire Alarm Detection and Annunciation System
GUI	-	Graphical User Interface
HOA	-	Hand-Off-Auto
ID	-	Identification
IEEE	-	Institute of Electrical and Electronics Engineers
I/O	-	Input/Output
LAN	-	Local Area Network
LCD	-	Liquid Crystal Display
LED	-	Light Emitting Diode
MCC	-	Motor Control Center
NC	-	Normally Closed
NIC	-	Not In Contract
NO	-	Normally Open
OWS	-	Operator Workstation
OAT	-	Outdoor Air Temperature
PC	-	Personal Computer
RAM	-	Random Access Memory
RF	-	Radio Frequency
RFI	-	Radio Frequency Interference
RH	-	Relative Humidity
ROM	-	Read Only Memory
RTD	-	Resistance Temperature Device
SPDT	-	Single Pole Double Throw
SPST	-	Single Pole Single Throw
XVGA	-	Extended Video Graphics Adapter
TBA	-	To Be Advised
TCP/IP	-	Transmission Control Protocol/Internet Protocol
TTD	-	Thermistor Temperature Device
UPS	-	Uninterruptible Power Supply
VAC	-	Volts, Alternating Current
VDC	-	Volts, Direct Current
WAN	-	Wide Area Network

1.3 BMS DESCRIPTION

- .1 The City of Winnipeg has an existing central monitoring system in place. Where DDC points are identified as centrally monitored points, the Controls Contractor shall provide and install required hardware and software to interface to the The City's Johnson Controls Metasys EA servers and workstations. These are located at the Central Control Offices, 510 Main Street, Winnipeg, Manitoba (ie City Hall).

- .2 Controls Contractor to supply all drawings/graphics/sequence of operations in both a hard and soft copy. Drawings and graphics to be able to be read and modified by City of Winnipeg Staff. User interface graphics to be completed using Graphic Generation Tool software. Graphics must use City of Winnipeg graphic templates. Contractor to supply As-Built drawings in an editable format, able to be easily edited by City of Winnipeg Staff. Contractor shall use metric units; imperial units will not be accepted.
- .3 The use of either N2Open or BACnet to be determined based on type of building where the Work is being performed. The new Work is to be tied into the existing controls. The Contractor should contact City of Winnipeg technical staff to determine the best protocol to use based on existing equipment.
- .4 The existing facility consists of multiple NAE's. At a minimum, one new NAE shall be provided for the new system.
- .5 No LON protocols are to be accepted.
- .6 The Building Management System (BMS) shall be a complete system designed for use with the enterprise IT systems. This functionality shall extend into the equipment rooms. Devices residing on the automation network located in equipment rooms and similar shall be fully IT compatible devices that mount and communicate directly on the IT infrastructure in the facility. Contractor shall be responsible for coordination with the The City's IT staff to ensure that the FMS will perform in the The City's environment without disruption to any of the other activities taking place on that LAN.
- .7 All points of user interface shall be on standard PCs that do not require the purchase of any special software from the BMS manufacturer for use as a building operations terminal. The primary point of interface on these PCs will be a standard Web Browser.
- .8 Where necessary and as dictated elsewhere in these Specifications, Servers shall be used for the purpose of providing a location for extensive archiving of system configuration data, and historical data such as trend data and operator transactions. All data stored will be through the use of a standard data base platform: Microsoft Data Engine (MSDE) or Microsoft SQL Server as dictated elsewhere in this specification.
- .9 The Work of the single BMS Contractor shall be as defined individually and collectively in all Sections of this Division specifications together with the associated Point Sheets and Drawings and the associated interfacing Work as referenced in the related documents.
- .10 The BMS Work shall consist of the provision of all labor, materials, tools, equipment, software, software licenses, software configurations and database entries, interfaces, wiring, tubing, installation, labeling, engineering, calibration, documentation, samples, submittals, testing, commissioning, training services, permits and licenses, transportation, shipping, handling, administration, supervision, management, insurance, temporary protection, cleaning, cutting and patching, warranties, services, and items, even though these may not be specifically mentioned in these Division documents which are required for the complete, fully functional and commissioned BMS.
- .11 Provide a complete, neat and workmanlike installation. Use only manufacturer employees who are skilled, experienced, trained, and familiar with the specific equipment, software, standards and configurations to be provided for this Project.

- .12 Manage and coordinate the BMS Work in a timely manner in consideration of the Project schedules. Coordinate with the associated Work of other trades so as to not impede or delay the Work of associated trades.
- .13 The BMS as provided shall incorporate, at minimum, the following integrated features, functions and services:
 - .1 Operator information, alarm management and control functions.
 - .2 Enterprise-level information and control access.
 - .3 Information management including monitoring, transmission, archiving, retrieval, and reporting functions.
 - .4 Diagnostic monitoring and reporting of BMS functions.
 - .5 Offsite monitoring and management access.
 - .6 Energy management
 - .7 Standard applications for terminal HVAC systems.
 - .8 Indoor Air Quality monitoring and control

1.4 QUALITY ASSURANCE

- .1 General
 - .1 The Building Management System Contractor shall be the primary manufacturer-owned branch office that is regularly engaged in the engineering, programming, installation and service of total integrated Building Management Systems.
 - .2 The BMS Contractor shall be a recognized national manufacturer, installer and service provider of BMS.
 - .3 If a franchised dealer is to be considered via addendum, the dealer must provide a letter written by a minimum Vice President of Operations for the specific automatic temperature control manufacturer with the following verbiage; “should the Franchise Dealer fail to provide a complete and operational system (as judged by the The City/Contract Administrator), the Manufacturer will complete the project to the Contract Administrators satisfaction at no additional cost to the City”. This letter must be provided to the Contract Administrator along with the other supporting documentation at the time of request for equal in accordance with B7.
 - .4 The BMS Contractor shall have a branch facility within a 100-mile radius of the job site supplying complete maintenance and support services on a 24 hour, 7-day-a-week basis.
 - .5 The Building Management System architecture shall consist of the products of a manufacturer regularly engaged in the production of Building Management Systems, and shall be the manufacturer’s latest standard of design at the time of bid.
- .2 Workplace Safety And Hazardous Materials
 - .1 Provide a safety program in compliance with the Contract Documents.
 - .2 The FMS Contractor shall have a corporately certified comprehensive Safety Certification Manual and a designated Safety Supervisor for the Project.
 - .3 The Contractor and its employees and subtrades comply with federal, state and local safety regulations.

- .4 The Contractor shall ensure that all Subcontractors and employees have written safety programs in place that covers their scope of Work, and that their employees receive the training required by the OSHA have jurisdiction for at least each topic listed in the Safety Certification Manual.
- .5 Hazards created by the Contractor or its Subcontractors shall be eliminated before any further Work proceeds.
- .6 Hazards observed but not created by the Contractor or its Subcontractors shall be reported to either the Contractor or the City within the same day. The Contractor shall be required to avoid the hazard area until the hazard has been eliminated.
- .7 The Contractor shall sign and date a safety certification form prior to any Work being performed, stating that the Contractors' company is in full compliance with the Project safety requirements.
- .8 The Contractor's safety program shall include written policy and arrangements for the handling, storage and management of all hazardous materials to be used in the Work in compliance with the requirements of the AHJ at the Project site.
- .9 The Contractor's employees and Subcontractor's staff shall have received training as applicable in the use of hazardous materials and shall govern their actions accordingly.
- .3 Quality Management Program
 - .1 Designate a competent and experienced employee to provide BMS Project Management. The designated Project Manager shall be empowered to make technical, scheduling and related decisions on behalf of the BMS Contractor. At minimum, the Project Manager shall:
 - .1 Manage the scheduling of the Work to ensure that adequate materials, labor and other resources are available as needed.
 - .2 Manage the financial aspects of the BMS Contract.
 - .3 Coordinate as necessary with other trades.
 - .4 Be responsible for the Work and actions of the BMS workforce on site.

1.5 REFERENCES

- .1 All Work shall conform to the following Codes and Standards, as applicable:
 - .1 National Fire Protection Association (NFPA) Standards.
 - .2 National Electric Code (NEC) and applicable local Electric Code.
 - .3 Underwriters Laboratories (UL) listing and labels.
 - .4 UL 916 Energy Management
 - .5 NFPA 70 - National Electrical Code.
 - .6 NFPA 90A - Standard For The Installation Of Air Conditioning And Ventilating Systems.
 - .7 Factory Mutual (FM).
 - .8 American National Standards Institute (ANSI).
 - .9 National Electric Manufacturer's Association (NEMA).
 - .10 American Society of Mechanical Engineers (ASME).
 - .11 American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE)
 - .12 Air Movement and Control Association (AMCA).

- .13 Institute of Electrical and Electronic Engineers (IEEE).
- .14 American Standard Code for Information Interchange (ASCII).
- .15 Electronics Industries Association (EIA).
- .16 Occupational Safety and Health Administration (OSHA).
- .17 American Society for Testing and Materials (ASTM).
- .18 Federal Communications Commission (FCC) including Part 15, Radio Frequency Devices.
- .19 Americans Disability Act (ADA)
- .20 ANSI/ASHRAE Standard 195-2004 (BACnet)
- .2 In the case of conflicts or discrepancies, the more stringent regulation shall apply.
- .3 All Work shall meet the approval of the Authorities Having Jurisdiction at the project site.

1.6 WORK BY OTHERS

- .1 Section 22 40 10 and Section 23 60 10 to distribute and mount all pipe connected equipment including valves, , flow switches etc. in their respective locations, as supervised by Section 25 10 10.
- .2 Section 23 80 10 to distribute and mount all motorized dampers, etc. in their respective locations, as supervised by Section 25 10 10.
- .3 Section 23 80 10 shall provide additional galv. iron baffles as required at all mixed air plenums to ensure good air mix so controllers can function properly. Section 25 10 10 shall assist Section 23 80 10 in establishing locations of such baffles.
- .4 Division 26 - Electrical to supply and install all conduit, wire and connections from the distribution panels to line side of magnetic starters and thermal overload switches, and from load side of starters and switches to motors.
- .5 Division 26 - Electrical to supply and install conduit, wire and connection for line voltage control devices on single phase equipment such as:
 - .1 Mechanical wiring required but not specified in this section of the specifications.
 - .2 All safety controls must be wired in series with both "HAND" and "AUTO" starter switch positions to ensure against damage to equipment and/or system.
 - .3 Power source wiring to Section 25 10 10 systems panels and other devices or groups of devices requiring 120 volt power source.
 - .4 All control wiring for boilers in accordance with wiring diagrams supplied by boiler manufacturer.
 - .5 All control wiring for remote supervisory panels supplied with gas-fired units.

1.7 ELECTRICAL WIRING PERFORMED BY SECTION 25 10 10

- .1 Supply and installation of all conduit, wire, electric relays, connections and other devices required for control circuit wiring for systems as specified in Section 25 10 10, whether line or low voltage, shall be responsibility of Section 25 10 10, except as noted above.

- .2 Section 25 10 10 shall either use own electricians, retain and pay for services of successful Division 26, or use an Electrical Subcontractor acceptable to Contract Administrator to supply and install all conduit and wiring for systems as specified in this Section.
- .3 Factory trained servicemen in employ of manufacturer, shall make final wiring connections on all components, mount and electrically connect all controls.
- .4 Electrical wiring shall be installed in conformance with CSA, ULC, Manitoba Building Code, National Building Code of Canada and standards set in Division 26 of this specification.
- .5 Ensure that adequate conduit is installed during initial phases of construction, to accommodate total systems requirements.
- .6 Wire all safety controls in series with both 'Hand' and 'Auto' starter positions to ensure that systems are properly protected.
- .7 Section 25 10 10 shall provide all other conduit and wiring required for Section 25 10 10 systems operation, including tie-ins from Section 25 10 10 supplied relays to motor starting circuits.
- .8 As a minimum, provide separate, dedicated conduit system for each of following. Conduit to be minimum 19mm EMT.
 - .1 C.C.M.S. transmission wiring.
 - .2 All other wiring connected to an electronic control system including sensor and control wiring associated with DDC panels, DGP's, Card Access Panels, etc., which are connected to the C.C.M.S. system or are capable of being connected at some future date.
 - .3 Sensor and control wiring for stand-alone electric control systems. Conduit identification labels shall state "CCMS" for 1., and 2., 3. above, and "CONTROL WIRING" for above.
- .9 If approved by system manufacturer, cable up to 30 Volts may be installed in extra-low voltage communication cable tray.
- .10 Refer to Division 26 for conduit and cable identification requirements.
- .11 Section 25 10 10 shall provide detailed wiring diagrams for remote supervisory panels supplied with rooftop equipment, connections between Section 25 10 10 supplied equipment.
- .12 Supply and installation of all equipment interlocks required to meet the sequence of operations.

1.8 SUBMITTALS

- .1 Shop Drawings, Product Data, and Samples
 - .1 The BMS Contractor shall submit a list of all shop drawings with submittals dates within 30 days of contract award.
 - .2 Submittals shall be in defined packages. Each package shall be complete and shall only reference itself and previously submitted packages. The packages shall be as approved by the Contract Administrator for Contract compliance.
 - .3 Allow 15 working days for the review of each package by the Contract Administrator in the scheduling of the total BMS Work.

- .4 Equipment and systems requiring approval of local authorities must comply with such regulations and be approved. Filing shall be at the expense of the BMS Contractor where filing is necessary. Provide a copy of all related correspondence and permits to the City.
- .5 Prepare an index of all submittals and shop drawings for the installation. Index shall include a shop drawing identification number, Contract Documents reference and item description.
- .6 The BMS Contractor shall correct any errors or omissions noted in the first review.
- .7 Prior to commissioning, submit as-built information and drawings for each of the above items, for use by The City during commissioning.
- .8 At a minimum, submit the following:
 - .1 BMS network architecture diagrams including all nodes and interconnections.
 - .2 Systems schematics, sequences and flow diagrams.
 - .3 Points schedule for each point in the BMS, including: Point Type, Object Name, Expanded ID, Display Units, Controller type, and Address.
 - .4 Samples of Graphic Display screen types and associated menus.
 - .5 Detailed Bill of Material list for each system or application, identifying quantities, part numbers, descriptions, and optional features.
 - .6 Control Damper Schedule including a separate line for each damper provided under this section and a column for each of the damper attributes, including: Code Number, Fail Position, Damper Type, Damper Operator, Duct Size, Damper Size, Mounting, and Actuator Type.
 - .7 Control Valve Schedules including a separate line for each valve provided under this section and a column for each of the valve attributes: Code Number, Configuration, Fail Position, Pipe Size, Valve Size, Body Configuration, Close off Pressure, Capacity, Valve CV, Design Pressure, and Actuator Type.
 - .8 Details of all BMS interfaces and connections to the Work of other trades.
 - .9 Product data sheets or marked catalog pages including part number, photo and description for all products including software.

1.9 RECORD DOCUMENTATION

- .1 Operation and Maintenance Manuals
 - .1 Three (3) copies of the Operation and Maintenance Manuals shall be provided to the City's Representative upon completion of the project. The entire Operation and Maintenance Manual shall be furnished on Compact Disc media, and include the following for the BMS provided:
 - .1 Table of contents.
 - .2 As-built system record drawings. Computer Aided Drawings (CAD) record drawings shall represent the as-built condition of the system and incorporate all information supplied with the approved submittal.
 - .3 Manufacturers product data sheets or catalog pages for all products including software.
 - .4 System Operator's manuals.

- .5 Archive copy of all site-specific databases and sequences.
- .6 BMS network diagrams.
- .7 Interfaces to all third-party products and Work by other trades.
- .2 The Operation and Maintenance Manual CD shall be self-contained, and include all necessary software required to access the product data sheets. A logically organized table of contents shall provide dynamic links to view and print all product data sheets. Viewer software shall provide the ability to display, zoom, and search all documents.
- .2 On-Line documentation: After completion of all tests and adjustments the Contractor shall provide a copy of all as-built information and product data to be installed on a customer designated computer workstation or server

1.10 WARRANTY

- .1 Standard Material and Labor Warranty:
 - .1 Provide a one-year labor and material warranty on the BMS.
 - .2 If within twelve (12) months from the date of acceptance of product, upon written notice from the City, it is found to be defective in operation, workmanship or materials, it shall be replaced, repaired or adjusted at the option of the BMS Contractor at the cost of the BMS Contractor.
 - .3 Maintain an adequate supply of materials within Winnipeg such that replacement of key parts and labor support, including programming. Warranty Work shall be done during BMS Contractor's normal business hours.

Part 2 Products

2.1 GENERAL DESCRIPTION

- .1 The Building Management System (BMS) shall use an open architecture and fully support a multi-vendor environment. To accomplish this effectively, the BMS shall support open communication protocol standards and integrate a wide variety of third-party devices and applications. The system shall be designed for use on the Internet, or intranets using off the shelf, industry standard technology compatible with other City provided networks.
- .2 The Building Management System shall consist of the following:
 - .1 Standalone Network Automation Engine(s)
 - .2 Field Equipment Controller(s)
 - .3 Input/Output Module(s)
 - .4 Local Display Device(s)
 - .5 Portable Operator's Terminal(s)
 - .6 Distributed User Interface(s)
 - .7 Network processing, data storage and communications equipment
 - .8 Other components required for a complete and working BMS

- .3 The system shall be modular in nature, and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, controllers and operator devices, while re-using existing controls equipment.
- .4 System architectural design shall eliminate dependence upon any single device for alarm reporting and control execution. The failure of any single component or network connection shall not interrupt the execution of control strategies at other operational devices.
- .5 Acceptable Manufacturers

.1 **Basis of Design:** Johnson Controls Metasys

2.2 IDENTIFICATION OF EQUIPMENT - GENERAL

- .1 Use engraved black and white laminated plastic, 25mm x 62mm (1") x (2-1/2"), at all thermostats, thermometers, panels, etc., supplied so as to clearly indicate service of particular device. Manual switches, unless they come with standard nameplates, and thermostats, thermometers, switches, etc., installed on local panels to be similarly labelled. All controllers, relays, etc. mounted inside local panels may have tape labels.
- .2 Excluding damper assemblies, provide lamacoid identification plates fastened with rivets or self-tapping screws at all equipment supplied by Section 25 10 10 so as to clearly indicate service of particular device. All manual switches, unless they come with standard nameplates, shall be similarly labelled.
- .3 Equipment installed on surfaces of local panels shall be similarly labelled. Equipment mounted inside local panels, must have permanent plate labels with self-tapping screws. Tape labels are not acceptable.
- .4 Identification plates, by Section 25 10 10, to be white background with minimum 5mm high black letters, unless specified otherwise. Electrical systems identification to be as per Division 26.
- .5 Information on lamacoid identification plates to be consistent with 'as-built' control Drawings.
- .6 Prior to lamacoid fabrication, submit copies of control Drawings and complete list of proposed wording for each lamacoid, for approval by Contract Administrator and City. Include copy of approved lamacoid list in each Maintenance/Operating Manual.

2.3 INSTRUMENT CABINETS

- .1 Provide at each system or groups of systems, cabinet type metal control panel with all instruments mounted inside locking cover. All panels shall have same key. Temperature indication and control point adjustments and gauges labelled as to function with lamacoid nametags fixed to panel face with self-tapping screws. All electrical equipment mounted in cabinet to be pre-wired to labelled terminal strips.

2.4 IDENTIFICATION OF EQUIPMENT CONTROLLED BY C.C.M.S.

- .1 Provide adhesive back tags for all pieces of equipment controlled by the C.C.M.S.
- .2 Tags shall be white background with red letters, 100mm wide x 70mm high, with rounded corners, and shall read as follows:

"WARNING

- THIS EQUIPMENT IS UNDER CENTRAL CONTROL AND MAY START OR STOP WITHOUT WARNING
 - Leave starters in 'AUTO' position.
 - Phone CCMS Office to inform monitoring room if equipment is being shutdown.
 - Ensure disconnect is locked off prior to working on equipment."
- .3 Tags shall be of 3M Material, similar to that used for renewal tags on automobile licence plates, as available from Aristo-Print Limited, Winnipeg.
- .4 Submit one sample tag for approval prior to installation.
- .5 An example label is included at end of this section for information purposes.

2.5 BMS ARCHITECTURE

- .1 Automation Network
- .1 The automation network shall be based on a PC industry standard of Ethernet TCP/IP. Where used, LAN controller cards shall be standard "off the shelf" products available through normal PC vendor channels.
 - .2 The BMS shall network multiple user interface clients, automation engines, system controllers and application-specific controllers. Provide application and data server(s) as required for systems operation.
 - .3 The automation network shall be capable of operating at a communication speed of 100 Mbps, with full peer-to-peer network communication.
 - .4 Network Automation Engines (NAE) shall reside on the automation network.
 - .5 The automation network will be compatible with other enterprise-wide networks. Where indicated, the automation network shall be connected to the enterprise network and share resources with it by way of standard networking devices and practices.
- .2 Control Network
- .1 Network Automation Engines shall provide supervisory control over the control network and shall support all three (3) of the following communication protocols:
 - .1 BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135, Clause 9.
 - .2 The Johnson Controls N2 Field Bus.
 - .2 Control networks shall provide either "Peer-to-Peer," Master-Slave, or Supervised Token Passing communications, and shall operate at a minimum communication speed of 9600 baud.
 - .3 DDC Controllers shall reside on the control network.
 - .4 Control network communication protocol shall be BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135.
 - .5 A BACnet Protocol Implementation Conformance Statement shall be provided for each controller device (master or slave) that will communicate on the BACnet MS/TP Bus.
 - .6 The Conformance Statements shall be submitted 10 day prior to bidding.

- .3 Integration
 - .1 Hardwired
 - .1 Analog and digital signal values shall be passed from one system to another via hardwired connections.
 - .2 There will be one separate physical point on each system for each point to be integrated between the systems.
 - .2 Direct Protocol (Integrator Panel)
 - .1 The BMS system shall include appropriate hardware equipment and software to allow bi-directional data communications between the BMS system and 3rd party manufacturers' control panels. The BMS shall receive, react to, and return information from multiple building systems, including but not limited to the boilers and variable frequency drives.
 - .2 All data required by the application shall be mapped into the Automation Engine's database, and shall be transparent to the operator.
 - .3 Point inputs and outputs from the third-party controllers shall have real-time interoperability with BMS software features such as: Control Software, Energy Management, Custom Process Programming, Alarm Management, Historical Data and Trend Analysis, Totalization, and Local Area Network Communications.
 - .3 BACnet Protocol Integration - BACnet
 - .1 The neutral protocol used between systems will be BACnet over Ethernet and comply with the ASHRAE BACnet standard 135-2003.
 - .2 A complete Protocol Implementation Conformance Statement (PICS) shall be provided for all BACnet system devices.
 - .3 The ability to command, share point object data, change of state (COS) data and schedules between the host and BACnet systems shall be provided.

2.6 USER INTERFACE

- .1 Dedicated Web Based User Interface
 - .1 The control system shall be compatible with the existing central monitoring system; refer to BMS description.
 - .2 No outside PC's can reside on the City of Winnipeg network.
- .2 User Interface Application Components
 - .1 Operator Interface
 - .1 An integrated browser based client application shall be used as the user operator interface program.
 - .2 All Inputs, Outputs, Setpoints, and all other parameters as defined within Part 3, shown on the design drawings, or required as part of the system software, shall be displayed for operator viewing and modification from the operator interface software.
 - .3 The user interface software shall provide help menus and instructions for each operation and/or application.

- .4 All controller software operating parameters shall be displayed for the operator to view/modify from the user interface. These include: setpoints, alarm limits, time delays, PID tuning constants, run-times, point statistics, schedules, and so forth.
- .5 The Operator Interface shall incorporate comprehensive support for functions including, but not necessarily limited to, the following:
 - .1 User access for selective information retrieval and control command execution
 - .2 Monitoring and reporting
 - .3 Alarm, non-normal, and return to normal condition annunciation
 - .4 Selective operator override and other control actions
 - .5 Information archiving, manipulation, formatting, display and reporting
 - .6 FMS internal performance supervision and diagnostics
 - .7 On-line access to user HELP menus
 - .8 On-line access to current FMS as-built records and documentation
 - .9 Means for the controlled re-programming, re-configuration of FMS operation and for the manipulation of FMS database information in compliance with the prevailing codes, approvals and regulations for individual FMS applications.
- .6 The operation of the control system shall be independent of the user interface, which shall be used for operator communications only. Systems that rely on an operator workstation to provide supervisory control over controller execution of the sequences of operations or system communications shall not be acceptable.
- .2 Navigation Trees
 - .1 The system will have the capability to display multiple navigation trees that will aid the operator in navigating throughout all systems and points connected. At minimum provide a tree that identifies all systems on the networks.
 - .2 Provide the ability for the operator to add custom trees. The operator will be able to define any logical grouping of systems or points and arrange them on the tree in any order. It shall be possible to nest groups within other groups. Provide at minimum 5 levels of nesting.
 - .3 The navigation trees shall be “dockable” to other displays in the user interface such as graphics. This means that the trees will appear as part of the display, but can be detached and then minimized to the Windows task bar or closed altogether. A simple keystroke will reattach the navigation to the primary display of the user interface.
- .3 Alarms
 - .1 Alarms shall be routed directly from Network Automation Engines to PCs and servers. It shall be possible for specific alarms from specific points to be routed to specific PCs and servers. The alarm management portion of the user interface shall, at the minimum, provide the following functions:
 - .1 Log date and time of alarm occurrence.

- .2 Generate a “Pop-Up” window, with audible alarm, informing a user that an alarm has been received.
- .3 Allow a user, with the appropriate security level, to acknowledge, temporarily silence, or discard an alarm.
- .4 Provide an audit trail on hard drive for alarms by recording user acknowledgment, deletion, or disabling of an alarm. The audit trail shall include the name of the user, the alarm, the action taken on the alarm, and a time/date stamp.
- .5 Provide the ability to direct alarms to an e-mail address or alphanumeric pager. This must be provided in addition to the pop up window described above. Systems that use e-mail and pagers as the exclusive means of annunciating alarms are not acceptable.
- .6 Any attribute of any object in the system may be designated to report an alarm.
- .2 The FMS shall annunciate diagnostic alarms indicating system failures and non-normal operating conditions
- .3 The FMS shall annunciate application alarms at minimum, as required by Part 3.
- .4 Reports and Summaries
 - .1 Reports and Summaries shall be generated and directed to the user interface displays, with subsequent assignment to printers, or disk. As a minimum, the system shall provide the following reports:
 - .1 All points in the BMS
 - .2 All points in each BMS application
 - .3 All points in a specific controller
 - .4 All points in a user-defined group of points
 - .5 All points currently in alarm
 - .6 All points locked out
 - .7 All BMS schedules
 - .8 All user defined and adjustable variables, schedules, interlocks and the like.
 - .2 Summaries and Reports shall be accessible via standard UI functions and not dependent upon custom programming or user defined HTML pages.
 - .3 Selection of a single menu item, tool bar item, or tool bar button shall print any displayed report or summary on the system printer for use as a building management and diagnostics tool.
 - .4 The system shall allow for the creation of custom reports and queries via a standard web services XML interface and commercial off-the-shelf software such as Microsoft Access, Microsoft Excel, or Crystal Reports.
- .5 Schedules
 - .1 A graphical display for time-of-day scheduling and override scheduling of building operations shall be provided. At a minimum, the following functions shall be provided:
 - .1 Weekly schedules
 - .2 Exception Schedules

- .3 Monthly calendars.
 - .2 Weekly schedules shall be provided for each group of equipment with a specific time use schedule.
 - .3 It shall be possible to define one or more exception schedules for each schedule including references to calendars
 - .4 Monthly calendars shall be provided that allow for simplified scheduling of holidays and special days for a minimum of five years in advance. Holidays and special days shall be user-selected with the pointing device or keyboard, and shall automatically reschedule equipment operation as previously defined on the exception schedules.
 - .5 Changes to schedules made from the User Interface shall directly modify the Network Automation Engine schedule database.
 - .6 Schedules and Calendars shall comply with ASHRAE SP135/2003 BACnet Standard.
 - .7 Selection of a single menu item or tool bar button shall print any displayed schedule on the system printer for use as a building management and diagnostics tool.
- .6 Password
- .1 Multiple-level password access protection shall be provided to allow the user/manager to user interface control, display, and database manipulation capabilities deemed appropriate for each user, based on an assigned password.
 - .2 Each user shall have the following: a user name (24 characters minimum), a password (12 characters minimum), and access levels.
 - .3 The system shall allow each user to change his or her password at will.
 - .4 When entering or editing passwords, the system shall not echo the actual characters for display on the monitor.
 - .5 A minimum of five levels of access shall be supported individually or in any combination as follows:
 - .1 Level 1 = View Data
 - .2 Level 2 = Command
 - .3 Level 3 = Operator Overrides
 - .4 Level 4 = Database Modification
 - .5 Level 5 = Database Configuration
 - .6 Level 6 = All privileges, including Password Add/Modify
 - .6 A minimum of 100 unique passwords shall be supported.
 - .7 Operators shall be able to perform only those commands available for their respective passwords. Display of menu selections shall be limited to only those items defined for the access level of the password used to log-on.
 - .8 The system shall automatically generate a report of log-on/log-off and system activity for each user. Any action that results in a change in the operation or configuration of the control system shall be recorded, including: modification of point values, schedules or history collection parameters, and all changes to the alarm management system, including the acknowledgment and deletion of alarms.

- .7 Screen Manager - The User Interface shall be provided with screen management capabilities that allow the user to activate, close, and simultaneously manipulate a minimum of 4 active display windows plus a network or user defined navigation tree.
- .8 Dynamic Color Graphics
 - .1 The graphics application program shall be supplied as an integral part of the User Interface. Browser or Workstation applications that rely only upon HTML pages shall not be acceptable.
 - .2 The graphics applications shall include a create/edit function and a runtime function. The system architecture shall support an unlimited number of graphics documents (graphic definition files) to be generated and executed.

The graphics shall be able to display and provide animation based on real-time data that is acquired, derived, or entered.
 - .3 Graphics runtime functions – A maximum of 16 graphic applications shall be able to execute at any one time on a user interface or workstation with 4 visible to the user. Each graphic application shall be capable of the following functions:
 - .1 All graphics shall be fully scalable
 - .2 The graphics shall support a maintained aspect ratio.
 - .3 Multiple fonts shall be supported.
 - .4 Unique background shall be assignable on a per graphic basis.
 - .5 The color of all animations and values on displays shall indicate if the status of the object attribute.
 - .4 Operation from graphics – It shall be possible to change values (setpoints) and states in system controlled equipment by using drop-down windows accessible via the pointing device
 - .5 Graphic editing tool – A graphic editing tool shall be provided that allows for the creation and editing of graphic files. The graphic editor shall be capable of performing/defining all animations, and defining all runtime binding.
 - .1 The graphic editing tool shall in general provide for the creation and positioning of point objects by dragging from tool bars or drop-downs and positioning where required.
 - .2 In addition, the graphic editing tool shall be able to add additional content to any graphic by importing backgrounds in the SVG, BMP or JPG file formats.
 - .6 Aliasing – Many graphic displays representing part of a building and various building components are exact duplicates, with the exception that the various variables are bound to different field values. Consequently, it shall be possible to bind the value of a graphic display to aliases, as opposed to the physical field tags.
- .9 Historical trending and data collection
 - .1 Each Automation Engine shall store trend and point history data for all analog and digital inputs and outputs, as follows:
 - .1 Any point, physical or calculated, may be designated for trending. Three methods of collection shall be allowed:

- .1 Defined time interval
 - .2 Upon a change of value
 - .2 Each Automation Engine shall have the capability to store multiple samples for each physical point and software variable based upon available memory, including an individual sample time/date stamp. Points may be assigned to multiple history trends with different collection parameters.
 - .2 Trend and change of value data shall be stored within the engine and uploaded to a dedicated trend database or exported in a selectable data format via a provided data export utility. Uploads to a dedicated database shall occur based upon one of the following: user-defined interval, manual command, or when the trend buffers are full. Exports shall be as requested by the user or on a time scheduled basis.
 - .3 The system shall provide a configurable data storage subsystem for the collection of historical data. Data can be stored in either Microsoft Access or SQL database format.
- .10 Trend data viewing and analysis
- .1 Provide a trend viewing utility that shall have access to all database points.
 - .2 It shall be possible to retrieve any historical database point for use in displays and reports by specifying the point name and associated trend name.
 - .3 The trend viewing utility shall have the capability to define trend study displays to include multiple trends
 - .4 Displays shall be able to be single or stacked graphs with on-line selectable display characteristics, such as ranging, color, and plot style.
 - .5 Display magnitude and units shall both be selectable by the operator at any time without reconfiguring the processing or collection of data. This is a zoom capability.
 - .6 Display magnitude shall automatically be scaled to show full graphic resolution of the data being displayed.
 - .7 Trend studies shall be capable of calculating and displaying calculated variables including highest value, lowest value and time based accumulation.
- .3 Portable Operator Terminal
- .1 The control system shall provide full access to systems configuration and definition via the Browser Based user interface. Providing a portable operator terminal for programming purposes is not acceptable.

2.7 NETWORK AUTOMATION ENGINES (NAE)

- .1 Network Automation Engine (NAE)
 - .1 The Network Automation Engine (NAE) shall be a fully user-programmable, supervisory controller. The NAE shall monitor the network of distributed

application-specific controllers, provide global strategy and direction, and communicate on a peer-to-peer basis with other Network Automation Engines.

- .2 Automation network – The NAE shall reside on the automation network and shall support a subnet of system controllers.
- .3 User Interface – Each NAE shall have the ability to deliver a web based User Interface (UI) as previously described. All computers connected physically or virtually to the automation network shall have access to the web based UI.
 - .1 The web based UI software shall be imbedded in the NAE. Systems that require a local copy of the system database on the user's personal computer are not acceptable.
 - .2 The NAE shall support up four (4) concurrent users.
 - .3 The web based user shall have the capability to access all system data through one NAE.
 - .4 Remote users connected to the network through an Internet Service Provider (ISP) or telephone dial up shall also have total system access through one NAE.
 - .5 Systems that require the user to address more than one NAE to access all system information are not acceptable.
 - .6 The NAE shall have the capability of generating web based UI graphics. The graphics capability shall be imbedded in the NAE.
 - .7 Systems that support UI Graphics from a central database or require the graphics to reside on the user's personal computer are not acceptable.
 - .8 The web based UI shall support the following functions using a standard version of Microsoft Internet Explorer:
 - .1 Configuration
 - .2 Commissioning
 - .3 Data Archiving
 - .4 Monitoring
 - .5 Commanding
 - .6 System Diagnostics
 - .9 Systems that require workstation software or modified web browsers are not acceptable.
 - .10 The NAE shall allow temporary use of portable devices without interrupting the normal operation of permanently connected modems.
- .4 Processor – The NAE shall be microprocessor-based with a minimum word size of 32 bits. The NAE shall be a multi-tasking, multi-user, and real-time digital control processor. Standard operating systems shall be employed. NAE size and capability shall be sufficient to fully meet the requirements of this Specification.
- .5 Memory – Each NAE shall have sufficient memory to support its own operating system, databases, and control programs, and to provide supervisory control for all control level devices.
- .6 Hardware Real Time Clock – The NAE shall include an integrated, hardware-based, real-time clock.
- .7 The NAE shall include troubleshooting LED indicators to identify the following conditions:
 - .1 Power - On/Off

- .2 Ethernet Traffic – Ethernet Traffic/No Ethernet Traffic
- .3 Ethernet Connection Speed – 10 Mbps/100 Mbps
- .4 FC Bus – Normal Communications/No Field Communications
- .5 Peer Communication – Data Traffic Between NAE Devices
- .6 Run – NAE Running/NAE In Startup/NAE Shutting Down/Software Not Running
- .7 Bat Fault – Battery Defective, Data Protection Battery Not Installed
- .8 Fault – General Fault
- .9 Modem RX – NAE Modem Receiving Data
- .10 Modem TX – NAE Modem Transmitting Data
- .8 Communications Ports – The NAE shall provide the following ports for operation of operator Input/Output (I/O) devices, such as industry-standard computers, modems, and portable operator's terminals.
 - .1 Up to two (2) USB port
 - .2 Up to two (2) URS-232 serial data communication port
 - .3 Up to two (2) RS-485 port
 - .4 One (1) Ethernet port
- .9 Diagnostics – The NAE shall continuously perform self-diagnostics, communication diagnosis, and diagnosis of all panel components. The Network Automation Engine shall provide both local and remote annunciation of any detected component failures, low battery conditions, or repeated failures to establish communication.
- .10 Power Failure – In the event of the loss of normal power, The NAE shall continue to operate for a user adjustable period of up to 10 minutes after which there shall be an orderly shutdown of all programs to prevent the loss of database or operating system software.
 - .1 During a loss of normal power, the control sequences shall go to the normal system shutdown conditions. All critical configuration data shall be saved into Flash memory.
 - .2 Upon restoration of normal power and after a minimum off-time delay, the controller shall automatically resume full operation without manual intervention through a normal soft-start sequence.
- .11 Certification – The NAE shall be listed by Underwriters Laboratories (UL).
- .12 Controller network – The NAE shall support the following communication protocols on the controller network:
 - .1 The NAE shall support BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135, Clause 9 on the controller network.
 - .1 A BACnet Protocol Implementation Conformance Statement shall be provided for each controller device (master or slave) that will communicate on the BACnet MS/TP Bus.
 - .2 The Conformance Statements shall be submitted 10 day prior to bidding.
 - .3 The NAE shall support a minimum of 100 control devices.
 - .2 The NAE shall support the Johnson Controls N2 Field Bus.
 - .1 The NAE shall support a minimum of 100 N2 control devices.

- .2 The Bus shall conform to Electronic Industry Alliance (EIA) Standard RS-485.
- .3 The Bus shall employ a master/slave protocol where the NAE is the master.
- .4 The Bus shall employ a four (4) level priority system for polling frequency.
- .5 The Bus shall be optically isolated from the NAE.
- .6 The Bus shall support the Metasys Integrator System.

2.8 DDC SYSTEM CONTROLLERS

- .1 Field Equipment Controller (**FEC**)
 - .1 The Field Equipment Controller (FEC) shall be a fully user-programmable, digital controller that communicates via BACnet MS/TP protocol.
 - .2 The FEC shall employ a finite state control engine to eliminate unnecessary conflicts between control functions at crossover points in their operational sequences. Suppliers using non-state based DDC shall provide separate control strategy diagrams for all controlled functions in their submittals.
 - .3 Controllers shall be factory programmed with a continuous adaptive tuning algorithm that senses changes in the physical environment and continually adjusts loop tuning parameters appropriately. Controllers that require manual tuning of loops or perform automatic tuning on command only shall not be acceptable.
 - .4 The FEC shall be assembled in a plenum-rated plastic housing with flammability rated to UL94-5VB.
 - .5 The FEC shall include a removable base to allow pre-wiring without the controller.
 - .6 The FEC shall include troubleshooting LED indicators to identify the following conditions:
 - .1 Power On
 - .2 Power Off
 - .3 Download or Startup in progress, not ready for normal operation
 - .4 No Faults
 - .5 Device Fault
 - .6 Field Controller Bus - Normal Data Transmission
 - .7 Field Controller Bus - No Data Transmission
 - .8 Field Controller Bus - No Communication
 - .9 Sensor-Actuator Bus - Normal Data Transmission
 - .10 Sensor-Actuator Bus - No Data Transmission
 - .11 Sensor-Actuator Bus - No Communication
 - .7 The FEC shall accommodate the direct wiring of analog and binary I/O field points.
 - .8 The FEC shall support the following types of inputs and outputs:
 - .1 Universal Inputs - shall be configured to monitor any of the following:
 - .1 Analog Input, Voltage Mode
 - .2 Analog Input, Current Mode

- .3 Analog Input, Resistive Mode
 - .4 Binary Input, Dry Contact Maintained Mode
 - .5 Binary Input, Pulse Counter Mode
 - .2 Binary Inputs - shall be configured to monitor either of the following:
 - .1 Dry Contact Maintained Mode
 - .2 Pulse Counter Mode
 - .3 Analog Outputs - shall be configured to output either of the following
 - .1 Analog Output, Voltage Mode
 - .2 Analog Output, current Mode
 - .4 Binary Outputs - shall output the following:
 - .1 24 VAC Triac
 - .5 Configurable Outputs - shall be capable of the following:
 - .1 Analog Output, Voltage Mode
 - .2 Binary Output Mode
- .9 The FEC shall have the ability to reside on a Field Controller Bus (FC Bus).
 - .1 The FC Bus shall be a Master-Slave/Token-Passing (MS/TP) Bus supporting BACnet Standard protocol SSPC-135, Clause 9.
 - .2 The FC Bus shall support communications between the FECs and the NAE.
 - .3 The FC Bus shall also support Input/Output Module (IOM) communications with the FEC and with the NAE.
 - .4 The FC Bus shall support a minimum of 100 IOMs and FEC in any combination.
 - .5 The FC Bus shall operate at a maximum distance of 15,000 Ft. between the FEC and the furthest connected device.
- .10 The FEC shall have the ability to monitor and control a network of sensors and actuators over a Sensor-Actuator Bus (SA Bus).
 - .1 The SA Bus shall be a Master-Slave/Token-Passing (MS/TP) Bus supporting BACnet Standard protocol SSPC-135, Clause 9.
 - .2 The SA Bus shall support a minimum of 10 devices per trunk.
 - .3 The SA Bus shall operate at a maximum distance of 1,200 Ft. between the FEC and the furthest connected device.
- .11 The FEC shall have the capability to execute complex control sequences involving direct wired I/O points as well as input and output devices communicating over the FC Bus or the SA Bus.
- .12 The FEC shall support, but not be limited to, the following:
 - .1 Hot water central plant applications
 - .2 Built-up air handling units for special applications
 - .3 Terminal units
 - .4 Special programs as required for systems control

2.9 FIELD DEVICES

- .1 Input/Output Module (**IOM**)

- .1 The Input/Output Module (IOM) provides additional inputs and outputs for use in the FEC.
 - .2 The IOM shall communicate with the FEC over either the FC Bus or the SA Bus using BACnet Standard protocol SSPC-135, Clause 9.
 - .3 The IOM shall be assembled in a plenum-rated plastic housing with flammability rated to UL94-5VB.
 - .4 The IOM shall have a minimum of 4 points to a maximum of 17 points.
 - .5 The IOM shall support the following types of inputs and outputs:
 - .1 Universal Inputs - shall be configured to monitor any of the following:
 - .1 Analog Input, Voltage Mode
 - .2 Analog Input, Current Mode
 - .3 Analog Input, Resistive Mode
 - .4 Binary Input, Dry Contact Maintained Mode
 - .5 Binary Input, Pulse Counter Mode
 - .2 Binary Inputs - shall be configured to monitor either of the following:
 - .1 Dry Contact Maintained Mode
 - .2 Pulse Counter Mode
 - .3 Analog Outputs - shall be configured to output either of the following:
 - .1 Analog Output, Voltage Mode
 - .2 Analog Output, current Mode
 - .4 Binary Outputs - shall output the following:
 - .1 24 VAC Triac
 - .2 Configurable Outputs - shall be capable of the following:
 - .3 Analog Output, Voltage Mode
 - .4 Binary Output Mode
 - .6 The IOM shall include troubleshooting LED indicators to identify the following conditions:
 - .1 Power On
 - .2 Power Off
 - .3 Download or Startup in progress, not ready for normal operation
 - .4 No Faults
 - .5 Device Fault
 - .6 Normal Data Transmission
 - .7 No Data Transmission
 - .8 No Communication
- .2 Networked Thermostat (**TEC**)
 - .1 The Networked Thermostats shall be capable of controlling all necessary functions.
 - .2 The Networked Thermostat shall communicate over the Field Controller Bus using BACnet Standard protocol SSPC-135, Clause 9.
 - .1 The Networked Thermostat shall support remote read/write and parameter adjustment from the web based User Interfaceable through a Network Automation Engine.

- .3 The Networked Thermostat shall include an intuitive User Interface providing plain text messages.
 - .1 Two line, 8 character backlit display
 - .2 LED indicators for Fan and Heat status
 - .3 Five (5) User Interface Keys
 - .1 Mode
 - .2 Fan
 - .3 Override
 - .4 Degrees C/F
 - .5 Up/Down
 - .4 The display shall continuously scroll through the following parameters:
 - .1 Room Temperature
 - .2 System Mode
 - .3 Schedule Status – Occupied/Unoccupied/Override
 - .4 Applicable Alarms
 - .4 The Networked Thermostats shall provide the flexibility to support the following inputs:
 - .1 Integral Indoor Air Temperature Sensor
 - .2 Duct Mount Air Temperature Sensor
 - .3 Remote Indoor Air Temperature Sensor with Occupancy Override and LED Indicator.
 - .4 Two configurable binary inputs
 - .5 The Networked Thermostats shall provide the flexibility to support the following outputs:
 - .1 Three Speed Fan Control
 - .2 On/Off Control
 - .3 Floating Control
 - .4 Proportional (0 to 10V) Control
 - .6 The Networked Thermostat shall provide a minimum of six (6) levels of keypad lockout.
 - .7 The Networked Thermostat shall provide the flexibility to adjust the following parameters:
 - .1 Adjustable Temporary Occupancy from 0 to 24 hours
 - .2 Adjustable heating deadband from 2° F to 5° F
 - .3 Adjustable heating cycles per hour from 4 to 8
 - .8 The Networked Thermostat shall employ nonvolatile electrically erasable programmable read-only memory (EEPROM) for all adjustable parameters.
- .3 Network Sensors (NS)
- .1 The Network Sensors (NS) shall have the ability to monitor the following variables as required by the systems sequence of operations:
 - .1 Zone Temperature
 - .2 Zone humidity
 - .3 Zone setpoint

- .2 The NS shall transmit the zone information back to the controller on the Sensor-Actuator Bus (SA Bus) using BACnet Standard protocol SSPC-135, Clause 9.
- .3 The Network Sensors shall include the following items:
 - .1 A backlit Liquid Crystal Display (LCD) to indicate the Temperature, Humidity and Setpoint.
 - .2 An LED to indicate the status of the Override feature.
 - .3 A button to toggle the temperature display between Fahrenheit and Celsius.
 - .4 A button to initiate a timed override command
- .4 The NS shall be available with either screw terminals or phone jack.
- .5 The NS shall be available in either surface mount or wall mount styles.

2.10 INPUT DEVICES

- .1 General Requirements
 - .1 Installation, testing, and calibration of all sensors, transmitters, and other input devices shall be provided to meet the system requirements.
- .2 Temperature Sensors
 - .1 General Requirements:
 - .1 Sensors and transmitters shall be provided, as outlined in the input/output summary and sequence of operations.
 - .2 The temperature sensor shall be of the resistance type, and shall be either two-wire 1000 ohm nickel RTD, or two-wire 1000 ohm platinum RTD.
 - .3 The following point types (and the accuracy of each) are required, and their associated accuracy values include errors associated with the sensor, lead wire, and A to D conversion:

Point Type	Accuracy
Room Temp	$\pm .5^{\circ}\text{F.}$
Duct Temperature	$\pm .5^{\circ}\text{F.}$
All Others	$\pm .75^{\circ}\text{F.}$

- .2 Room Temperature Sensors
 - .1 Room sensors shall be constructed for either surface or wall box mounting.
 - .2 Room sensors shall have the following options when specified:
 - .1 Setpoint reset slide switch providing a ± 3 degree (adjustable) range.
 - .2 Individual heating setpoint slide switches.
 - .3 A momentary override request push button for activation of after-hours operation.
 - .4 Analog thermometer.
- .3 Room Temperature Sensors with Integral Display
 - .1 Room sensors shall be constructed for either surface or wall box mounting.

- .2 Room sensors shall have an integral LCD display and four button keypad with the following capabilities:
 - .1 Display room and outside air temperatures.
 - .2 Display and adjust room comfort setpoint.
 - .3 Display and adjust fan operation status.
 - .4 Timed override request push button with LED status for activation of after-hours operation.
 - .5 Display controller mode.
 - .6 Password selectable adjustment of setpoint and override modes.
- .4 Thermo wells
 - .1 When thermo wells are required, the sensor and well shall be supplied as a complete assembly, including wellhead and Greenfield fitting.
 - .2 Thermo wells shall be pressure rated and constructed in accordance with the system working pressure.
 - .3 Thermo wells and sensors shall be mounted in a threadolet or 1/2" NPT saddle and allow easy access to the sensor for repair or replacement.
 - .4 Thermo wells shall be constructed of 316 stainless steel.
- .5 Outside Air Sensors
 - .1 Outside air sensors shall be designed to withstand the environmental conditions to which they will be exposed. They shall also be provided with a solar shield.
 - .2 Sensors exposed to wind velocity pressures shall be shielded by a perforated plate that surrounds the sensor element.
 - .3 Temperature transmitters shall be of NEMA 3R construction and rated for ambient temperatures.
- .6 Duct Mount Sensors
 - .1 Duct mount sensors shall mount in an electrical box through a hole in the duct, and be positioned so as to be easily accessible for repair or replacement.
 - .2 Duct sensors shall be insertion type and constructed as a complete assembly, including lock nut and mounting plate.
 - .3 For outdoor air duct applications, a weatherproof mounting box with weatherproof cover and gasket shall be used.
- .7 Averaging Sensors
 - .1 For ductwork greater in any dimension than 48 inches and/or where air temperature stratification exists, an averaging sensor with multiple sensing points shall be used.
 - .2 For plenum applications, such as mixed air temperature measurements, a string of sensors mounted across the plenum shall be used to account for stratification and/or air turbulence. The averaging string shall have a minimum of 4 sensing points per 12-foot long segment.
 - .3 Capillary supports at the sides of the duct shall be provided to support the sensing string.
- .8 Acceptable Manufacturers: Johnson Controls, Setra.
- .3 CO and NO₂ Gas Detectors

- .1 Honeywell E³Point gas detector, wall mounted, 8.1"x5.9"x2.7" size, 24Vac nominal power, BACnet communications, model E3SMSCO for CO monitoring and model E3SMSNO2 for NO2 monitoring.
- .2 Transmitter will be powered by the control panels power output rated at 17-27 Vac or by an external power supply rated at 17-27 Vac or 24-38 Vdc.
- .3 The gas transmitter will incorporate an electrochemical cell for toxic gas monitoring. Unit sensing cell must compensate for variations in relative humidity and temperature to maintain high levels of accuracy. For local activation of fans or louvers (or other equipment) an optional DPDT relay 5A, 30 Vdc or 250 Vac (resistive load) will be activated at programmable set points (and programmable time delays) through the control panel. Transmitter will also have the capability of sending an analog 4-20mA signal to the BMS/DDC.
- .4 Transmitter will be capable of operating within relative humidity ranges of 5-90% and temperature ranges of 32F to 100F (0C to 40C). Transmitter must also have optional capacity of operating at lower temperature range.
- .5 Unit will be manufactured to UL 1244 label and CSA 22.2. Transmitter must be manufactured within an ISO 9002 production environment.
- .6 Transmitter unit to be installed to the following parameters:

GASES	SENSOR LOCATION	RADIUS OF COVERAGE
Carbon Monoxide (CO)	3-5 ft above the floor	50 feet
Nitrogen Dioxide (NO ₂)	1-3 ft below the ceiling	50 feet

- .7 Acceptable manufacturers: Honeywell

.4 Status and Safety Switches

.1 General Requirements

- .1 Switches shall be provided to monitor equipment status, safety conditions, and generate alarms at the BMS when a failure or abnormal condition occurs. Safety switches shall be provided with two sets of contacts and shall be interlock wired to shut down respective equipment.

.2 Current Sensing Switches

- .1 The current sensing switch shall be self-powered with solid-state circuitry and a dry contact output. It shall consist of a current transformer, a solid state current sensing circuit, adjustable trip point, solid state switch, SPDT relay, and an LED indicating the on or off status. A conductor of the load shall be passed through the window of the device. It shall accept over-current up to twice its trip point range.
- .2 Current sensing switches shall be used for run status for fans, pumps, and other miscellaneous motor loads.
- .3 Current sensing switches shall be calibrated to show a positive run status only when the motor is operating under load. A motor running with a broken belt or coupling shall indicate a negative run status.
- .4 Acceptable manufacturers: Veris Industries

- .3 Air Filter Status Switches
 - .1 Differential pressure switches used to monitor air filter status shall be of the automatic reset type with SPDT contacts rated for 2 amps at 120VAC.
 - .2 A complete installation kit shall be provided, including: static pressure tops, tubing, fittings, and air filters.
 - .3 Provide appropriate scale range and differential adjustment for intended service.
 - .4 Acceptable manufacturers: Johnson Controls, Cleveland Controls
- .4 Air Flow Switches
 - .1 Differential pressure flow switches shall be bellows actuated mercury switches or snap acting micro-switches with appropriate scale range and differential adjustment for intended service.
 - .2 Acceptable manufacturers: Johnson Controls, Cleveland Controls
- .5 Water Flow Switches
 - .1 Water flow switches shall be equal in accordance with B7 to the Johnson Controls P74.
- .6 Low Temperature Limit Switches
 - .1 The low temperature limit switch shall be of the manual reset type with Double Pole/Single Throw snap acting contacts rated for 16 amps at 120VAC.
 - .2 The sensing element shall be a minimum of 15 feet in length and shall react to the coldest 18-inch section. Element shall be mounted horizontally across duct in accordance with manufacturers recommended installation procedures.
 - .3 For large duct areas where the sensing element does not provide full coverage of the air stream, additional switches shall be provided as required to provide full protection of the air stream.
 - .4 The low temperature limit switch shall be equal in accordance with B7 to Johnson Controls A70.

2.11 OUTPUT DEVICES

- .1 Actuators
 - .1 General Requirements
 - .1 Damper and valve actuators shall be electronic.
 - .2 Electronic Damper Actuators
 - .1 Electronic damper actuators shall be direct shaft mount.
 - .2 Modulating and two-position actuators shall be provided as required by the sequence of operations. Damper sections shall be sized Based on actuator manufacturer's recommendations for face velocity, differential pressure and damper type. The actuator mounting arrangement and spring return feature shall permit normally open or normally closed positions of the dampers, as required. All actuators (except terminal units) shall be furnished with mechanical spring return unless otherwise specified in the sequences of operations. All actuators shall have external adjustable stops

to limit the travel in either direction, and a gear release to allow manual positioning.

.3 Modulating actuators shall accept 24 VAC or VDC power supply, consume no more than 15 VA, and be UL listed. The control signal shall be 2-10 VDC or 4-20 mA, and the actuator shall provide a clamp position feedback signal of 2-10 VDC. The feedback signal shall be independent of the input signal and may be used to parallel other actuators and provide true position indication. The feedback signal of one damper actuator for each separately controlled damper shall be wired back to a terminal strip in the control panel for trouble-shooting purposes.

.4 Two-position or open/closed actuators shall accept 24 or 120 VAC power supply and be UL listed. Isolation, smoke, exhaust fan, and other dampers, as specified in the sequence of operations, shall be furnished with adjustable end switches to indicate open/closed position or be hard wired to start/stop associated fan. Two-position actuators, as specified in sequences of operations as "quick acting," shall move full stroke within 20 seconds. All smoke damper actuators shall be quick acting.

.5 Acceptable manufacturers: Johnson Controls, Mamac.

.3 Electronic Valve Actuators

.1 Electronic valve actuators shall be manufactured by the valve manufacturer.

.2 Each actuator shall have current limiting circuitry incorporated in its design to prevent damage to the actuator.

.3 Modulating and two-position actuators shall be provided as required by the sequence of operations. Actuators shall provide the minimum torque required for proper valve close-off against the system pressure for the required application. The valve actuator shall be sized Based on valve manufacturer's recommendations for flow and pressure differential. All actuators shall fail in the last position unless specified with mechanical spring return in the sequence of operations. The spring return feature shall permit normally open or normally closed positions of the valves, as required. All direct shaft mount rotational actuators shall have external adjustable stops to limit the travel in either direction.

.4 Modulating Actuators shall accept 24 VAC or VDC and 120 VAC power supply and be UL listed. The control signal shall be 2-10 VDC or 4-20 mA and the actuator shall provide a clamp position feedback signal of 2-10 VDC. The feedback signal shall be independent of the input signal, and may be used to parallel other actuators and provide true position indication. The feedback signal of each valve actuator (except terminal valves) shall be wired back to a terminal strip in the control panel for trouble-shooting purposes.

.5 Two-position or open/closed actuators shall accept 24 or 120 VAC power supply and be UL listed. Butterfly isolation and other valves, as specified in the sequence of operations, shall be furnished with adjustable end switches to indicate open/closed position or be hard wired to start/stop the associated pump.

.6 Acceptable manufacturers: Johnson Controls

.2 Control Dampers

- .1 The BMS Contractor shall furnish all automatic dampers. All automatic dampers shall be sized for the application by the BMS Contractor or as specifically indicated on the Drawings.
- .2 Provide all control dampers of type and sizes indicated. All outside and exhaust control dampers to be opposed blade low leakage moduflo dampers. Frames to be heavy ga. galv. steel formed for extra strength with mounting holes for flange and enclosed duct mounting. Dampers available in 50mm (2") size increments from 203mm (8") horizontal and vertical to 1219mm (48"). Requirements over 1219mm (48") to be standard modules with interconnecting hardware. 1.6mm (16 ga.) damper blades, galv. steel, roll formed for high velocity performance. Blades of 203mm (8") width maximum; blade seals and spring loaded stainless side seals. Dampers and seals suitable for temperature ranges of -40 deg.C to 100 deg.C. Leakage shall not exceed 1% with approach velocity of 7.62M/s (1500fpm) when damper is closed against 100mm (4") W.G.
- .3 Control Relays
 - .1 Control Pilot Relays
 - .1 Control pilot relays shall be of a modular plug-in design with retaining springs or clips.
 - .2 Mounting Bases shall be snap-mount.
 - .3 DPDT, 3PDT, or 4PDT relays shall be provided, as appropriate for application.
 - .4 Contacts shall be rated for 10 amps at 120VAC.
 - .5 Relays shall have an integral indicator light and check button.
 - .6 Acceptable manufacturers: Finder, Omron
- .4 Control Valves
 - .1 All automatic control valves shall be fully proportioning and provide near linear heat transfer control. The valves shall be quiet in operation and fail-safe open, closed, or in their last position. All valves shall operate in sequence with another valve when required by the sequence of operations. All control valves shall be sized by the control manufacturer, and shall be guaranteed to meet the loads, as specified. All control valves shall be suitable for the system flow conditions and close against the differential pressures involved. Body pressure rating and connection type (sweat, screwed, or flanged) shall conform to the pipe schedule elsewhere in this Specification.
 - .2 Ball valves shall be used for hot glycol applications except those described hereinafter.
 - .3 Butterfly valves shall be acceptable for modulating large flow applications greater than modulating plug valves, and for all two-position, open/close applications. In-line and/or three-way butterfly valves shall be heavy-duty pattern with a body rating comparable to the pipe rating, replaceable lining suitable for temperature of system, and a stainless steel vane. Valves for modulating service shall be sized and travel limited to 50 degrees of full open. Valves for isolation service shall be the same as the pipe. Valves in the closed position shall be bubble-tight.
 - .4 Acceptable manufacturers: Johnson Controls
- .5 Electronic Signal Isolation Transducers

- .1 A signal isolation transducer shall be provided whenever an analog output signal from the BMS is to be connected to an external control system as an input (such as a boiler control panel), or is to receive as an input signal from a remote system.
- .2 The signal isolation transducer shall provide ground plane isolation between systems.
- .3 Signals shall provide optical isolation between systems.
- .4 Acceptable manufacturers: Advanced Control Technologies
- .6 External Manual Override Stations
 - .1 External manual override stations shall provide the following:
 - .1 An integral HAND/OFF/AUTO switch shall override the controlled device pilot relay.
 - .2 A status input to the Facility Management System shall indicate whenever the switch is not in the automatic position.
 - .3 A Status LED shall illuminate whenever the output is ON.
 - .4 An Override LED shall illuminate whenever the HOA switch is in either the HAND or OFF position.
 - .5 Contacts shall be rated for a minimum of 1 amp at 24 VAC.

2.12 MISCELLANEOUS DEVICES

- .1 Local Control Panels
 - .1 All control panels shall be factory constructed, incorporating the BMS manufacturer's standard designs and layouts. All control panels shall be UL inspected and listed as an assembly and carry a UL 508 label listing compliance. Control panels shall be fully enclosed, with perforated sub-panel, hinged door, and slotted flush latch (minimum standard of acceptance is a NEMA 4 enclosure suitable for the facility environment).
 - .2 In general, the control panels shall consist of the DDC controller(s), display module as specified and indicated on the plans, and I/O devices—such as relays, transducers, and so forth—that are not required to be located external to the control panel due to function. Where specified the display module shall be flush mounted in the panel face unless otherwise noted.
 - .3 All I/O connections on the DDC controller shall be provide via removable or fixed screw terminals.
 - .4 Low and line voltage wiring shall be segregated. All provided terminal strips and wiring shall be UL listed, 300-volt service and provide adequate clearance for field wiring.
 - .5 All wiring shall be neatly installed in plastic trays or tie-wrapped.
 - .6 A convenience 120 VAC duplex receptacle shall be provided in each enclosure, fused on/off power switch, and required transformers.
- .2 Power Supplies
 - .1 DC power supplies shall be sized for the connected device load. Total rated load shall not exceed 75% of the rated capacity of the power supply.
 - .2 Input: 120 VAC +10%, 60Hz.
 - .3 Output: 24 VDC.

- .4 Line Regulation: +0.05% for 10% line change.
- .5 Load Regulation: +0.05% for 50% load change.
- .6 Ripple and Noise: 1 mV rms, 5 mV peak to peak.
- .7 An appropriately sized fuse and fuse block shall be provided and located next to the power supply.
- .8 A power disconnect switch shall be provided next to the power supply.
- .3 Thermostats
 - .1 Electric space thermostats of the heavy-duty type shall be provided. All these items shall be provided with concealed adjustment. Thermostats shall be provided in enclosures to protect against the ingress of water (dripping, hosedown and splashing) and ingress of solid foreign objects (falling dirt, circulating dust/lint/fibers, settling airborne dust/lint/fibers). Finish of enclosures shall match and be manufacturer's standard finish.

Part 3 Performance / Execution

3.1 BMS SPECIFIC REQUIREMENTS

- .1 Graphic Displays
 - .1 Provide advanced color graphic system flow diagram display for each system with all points as indicated on the point list. All terminal unit graphic displays shall be from a standard design library.
 - .2 User shall access the various system schematics via a graphical penetration scheme and/or menu selection. .
- .2 Custom Reports:
 - .1 Provide custom reports as specified by the City of Winnipeg:
- .3 Actuation / Control Type
 - .1 Primary Equipment
 - .1 Controls shall be provided by equipment manufacturer as specified herein.
 - .2 All damper and valve actuation shall be electric.
 - .2 Air Handling Equipment
 - .1 All air handlers shall be controlled with a HVAC-DDC Controller
 - .2 All damper and valve actuation shall be electric.

3.2 INSTALLATION PRACTICES

- .1 BMS Wiring
 - .1 All conduit, wiring, accessories and wiring connections required for the installation of the Building Management System, as herein specified, shall be provided by the BMS Contractor unless specifically shown on the Electrical Drawings under Division 26 Electrical. All wiring shall comply with the requirements of applicable portions of Division 26 and all local and national electric codes, unless specified otherwise in this section.

- .2 All BMS wiring materials and installation methods shall comply with BMS manufacturer recommendations.
- .3 The sizing, type and provision of cable, conduit, cable trays, and raceways shall be the design responsibility of the BMS Contractor. If complications arise, however, due to the incorrect selection of cable, cable trays, raceways and/or conduit by the BMS Contractor, the Contractor shall be responsible for all costs incurred in replacing the selected components.
- .4 Class 2 Wiring
 - .1 All Class 2 (24VAC or less) wiring shall be installed in conduit unless otherwise specified.
 - .2 Conduit is not required for Class 2 wiring in concealed accessible locations. Class 2 wiring not installed in conduit shall be supported every 5' from the building structure utilizing metal hangers designed for this application. Wiring shall be installed parallel to the building structural lines. All wiring shall be installed in accordance with local code requirements.
- .5 Class 2 signal wiring and 24VAC power can be run in the same conduit. Power wiring 120VAC and greater cannot share the same conduit with Class 2 signal wiring.
- .6 Provide for complete grounding of all applicable signal and communications cables, panels and equipment so as to ensure system integrity of operation. Ground cabling and conduit at the panel terminations. Avoid grounding loops.
- .2 BMS Line Voltage Power Source
 - .1 120-volt AC circuits used for the Building Management System shall be taken from panel boards and circuit breakers provided by Division 26.
 - .2 Circuits used for the BMS shall be dedicated to the BMS and shall not be used for any other purposes.
 - .3 DDC terminal unit controllers may use AC power from motor power circuits.
- .3 BMS Raceway
 - .1 All wiring shall be installed in conduit or raceway except as noted elsewhere in this specification. Minimum control wiring conduit size 1/2".
 - .2 Where it is not possible to conceal raceways in finished locations, surface raceway (Wiremold) may be used as approved by the Contract Administrator.
 - .3 All conduits and raceways shall be installed level, plumb, at right angles to the building lines and shall follow the contours of the surface to which they are attached.
 - .4 Flexible Metal Conduit shall be used for vibration isolation and shall be limited to 3 feet in length when terminating to vibrating equipment. Flexible Metal Conduit may be used within partition walls. Flexible Metal Conduit shall be UL listed.
- .4 Penetrations
 - .1 Provide fire stopping for all penetrations used by dedicated BMS conduits and raceways.
 - .2 All openings in fire proofed or fire stopped components shall be closed by using approved fire resistive sealant.

- .3 All wiring passing through penetrations, including walls shall be in conduit or enclosed raceway.
- .4 Penetrations of floor slabs shall be by core drilling. All penetrations shall be plumb, true, and square.
- .5 BMS Identification Standards
 - .1 Node Identification. All nodes shall be identified by a permanent label fastened to the enclosure. Labels shall be suitable for the node location.
Cable types specified in Item A shall be color coded for easy identification and troubleshooting.
- .6 BMS Panel Installation
 - .1 The BMS panels and cabinets shall be located as indicated at an elevation of not less than 2 feet from the bottom edge of the panel to the finished floor. Each cabinet shall be anchored per the manufacturer's recommendations.
 - .2 The BMS Contractor shall be responsible for coordinating panel locations with other trades and Electrical and Mechanical Subcontractors.
- .7 Input Devices
 - .1 All Input devices shall be installed per the manufacturer recommendation
 - .2 Locate components of the BMS in accessible local control panels wherever possible.
- .8 HVAC Input Devices – General
 - .1 All Input devices shall be installed per the manufacturer recommendation
 - .2 Locate components of the BMS in accessible local control panels wherever possible.
 - .3 The Mechanical Subcontractor shall install all in-line devices such as temperature wells, pressure taps, airflow stations, etc.
 - .4 Input Flow Measuring Devices shall be installed in strict compliance with ASME guidelines affecting non-standard approach conditions.
 - .5 Outside Air Sensors
 - .1 Sensors shall be mounted on the North wall to minimize solar radiant heat impact or located in a continuous intake flow adequate to monitor outside air conditions accurately.
 - .2 Sensors shall be installed with a rain proof, perforated cover.
 - .6 Water Differential Pressure Sensors
 - .1 Differential pressure transmitters used for flow measurement shall be sized to the flow-sensing device.
 - .2 Differential pressure transmitters shall be supplied with tee fittings and shut-off valves in the high and low sensing pick-up lines.
 - .3 The transmitters shall be installed in an accessible location wherever possible.
 - .7 Medium to High Differential Water Pressure Applications (Over 21" w.c.):
 - .1 Air bleed units, bypass valves and compression fittings shall be provided.
 - .8 Space Sensors:
 - .1 Shall be mounted per ADA requirements.

- .2 Provide lockable tamper-proof covers in public areas and/or where indicated on the plans.
- .9 Low Temperature Limit Switches:
 - .1 Install on the discharge side of the first water or steam coil in the air stream.
 - .2 Mount element horizontally across duct in a serpentine pattern insuring each square foot of coil is protected by 1 foot of sensor.
 - .3 For large duct areas where the sensing element does not provide full coverage of the air stream, provide additional switches as required to provide full protection of the air stream.
- .10 Air Differential Pressure Status Switches:
 - .1 Install with static pressure tips, tubing, fittings, and air filter.
- .11 Water Differential Pressure Status Switches:
 - .1 Install with shut off valves for isolation.
- .9 HVAC Output Devices
 - .1 All output devices shall be installed per the manufacturers recommendation. The Mechanical Subcontractor shall install all in-line devices such as control valves, dampers, airflow stations, pressure wells, etc.
 - .2 Actuators: All control actuators shall be sized capable of closing against the maximum system shut-off pressure. The actuator shall modulate in a smooth fashion through the entire stroke.
 - .3 Control Dampers: Shall be opposed blade for modulating control of airflow. Parallel blade dampers shall be installed for two position applications.
 - .4 Control Valves: Shall be sized for proper flow control with equal percentage valve plugs. The maximum pressure drop for water applications shall be 5 PSI. The maximum pressure drop for steam applications shall be 7 PSI.
 - .5 Electronic Signal Isolation Transducers: Whenever an analog output signal from the Building Management System is to be connected to an external control system as an input (such as a boiler control panel), or is to receive as an input a signal from a remote system, provide a signal isolation transducer. Signal isolation transducer shall provide ground plane isolation between systems. Signals shall provide optical isolation between systems

3.3 TRAINING

- .1 The BMS Contractor shall provide the following training services:
 - .1 One day of on-site orientation by a system technician who is fully knowledgeable of the specific installation details of the project. This orientation shall, at a minimum, consist of a review of the project as-built drawings, the BMS software layout and naming conventions, and a walk through of the facility to identify panel and device locations.

3.4 COMMISSIONING

- .1 Fully commission all aspects of the Building Management System Work.
- .2 Acceptance Check Sheet

- .1 Prepare a check sheet that includes all points for all functions of the BMS as indicated on the point list included in this specification.
 - .2 Submit the check sheet to the Contract Administrator for approval
 - .3 The Contract Administrator will use the check sheet as the basis for acceptance with the BMS Contractor.
- .3 Promptly rectify all listed deficiencies and submit to the Contract Administrator that this has been done.

3.5 SEQUENCES

- .1 Space Pressure Differential
 - .1 Provide Magnahelic gauges (3 in Storage Track 1-12) to measure space differential pressure.
 - .2 Provide the pressure registered from each gauge as a DDC point in the BMS.
- .2 Gas Detection
 - .1 Gas detection system shall be configured in as a single zone in Storage Track 1-12
 - .2 System shall operate as follows:
 - .1 Storage Track 1-12
 - .1 HRU's shall operate continuously.
 - .2 The highest reading shall form the basis of reading.
 - .3 Send notification to the BMS when CO level exceeds 12 ppm or NOx level exceeds 0.2 ppm.
 - .4 Local sounder and alarm to the BMS when CO level exceeds 25 ppm and NOx level exceeds 2 ppm.
 - .5 Send fire alarm supervisory alarm signal if CO level is sustained at 200 ppm for five minutes
 - .2 BACnet Gas Detection Network Panel will provide the DDC with all relevant information including alarms.
- .3 Service Bay Ventilation Equipment Sequences
 - .1 Modify the existing sequence so that existing fan EF-2 runs continuously and EF-1d will be off unless one or more of EF-8/45/22/53/60 fails rather than EF-2 and EF-1d being dependant on EF-8/45/22/53/60.
- .4 Heat Recovery Units, HRU-5/6
 - .1 HRU will come with own control components (ie actuators) wired to a terminal strip with two relays (run unit enable signal and free cooling mode to switch dampers every 3 hours).
 - .2 HRU will operate continuously. Heating control valve shall modulate to maintain a space temperature of 70°F (adjustable).
 - .3 Associated motorized dampers in supply and exhaust ductwork at roofline shall remain open during normal operation and shall close if HRU fails or is shutdown.
 - .4 Provide the following DDC points

- .1 Supply Fan Status and Command
- .2 Exhaust Fan Status and Command
- .3 Supply Motorized Damper Position
- .4 Exhaust Motorized Damper Position
- .5 Supply Air Temperature
- .6 Exhaust Air Temperature
- .7 Pre Heat Air Temperature (ie Temperature before Heating Coil)
- .8 Supply Air Low Limit Status (ie Freeze Stat)
- .9 Free Cooling Command
- .10 Filter differential sensor
- .11 Heating Control Valve Position

.5 Secondary Heating Pumps

- .1 Secondary heating pumps will come with BACnet protocol equipped package controller.
- .2 The secondary pumps shall operate as duty/standby in the event of a pump failure to provide 100% redundancy. Alternate lead/lag pump status based on a weekly schedule.
- .3 Interlock pumps with boilers such that when boilers are enabled, pumps shall enable.
- .4 The secondary pumps shall be controlled by the IVS Sensorless programming (in lieu of a remote field installed pressure sensor) to maintain flow through the secondary loop.
- .5 BACnet controller will provide the BAS with all relevant information including alarms.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 This Section covers items common to Sections of Division 26. This section supplements requirements of Division 1.
- .2 All Drawings and all sections of the Specifications shall apply to and form an integral part of this section.
- .3 Carefully examine all plans and Specifications pertaining to this Contract and become familiar with all details. Visit the Site and determine all factors affecting this section of the Work and include all costs for same in Bid Opportunity.

1.2 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CSA C22.1, Canadian Electrical Code, Part 1, Safety Standard for Electrical Installations.
- .2 The electrical installation shall comply with the requirements of the Electrical Supply Authority, the latest edition of the Canadian Electrical Code, with all Provincial and Municipal Laws, Rules and Ordinances, and to the satisfaction of those persons having jurisdiction over same.
- .3 Notify the Contract Administrator of any discrepancies or conflicts with any regulation seven (7) Working days before Bid Opportunity Bid Opportunity closes. Failing such notification, meet all such requirements without change to the Contract price.
- .4 In no instance shall the standard established by these Specifications and Drawings be reduced by any of the codes, rules or ordinances.
- .5 Health Canada / Workplace Hazardous Materials Information System (WHMIS)

1.3 REQUEST FOR INTERPRETATION PROCESS

- .1 General:
 - .1 Immediately on discovery of the need for interpretation of the Contract Documents, Contractor shall prepare and submit an RFI to the Contract Administrator in the form specified.
 - .2 Contract Administrator will return RFIs submitted to Contract Administrator by other entities controlled by Contractor with no response. The RFI will then be considered closed.
 - .3 Coordinate and submit RFIs in a prompt manner so as to avoid delays in Contractor's Work or Work of Subcontractors.
 - .4 For RFIs submitted electronically, include project name and RFI number in subject line of email.
- .2 Content of the RFI: Include a detailed, legible description of item needing information or interpretation and the following:

- .1 Project name (including building number).
 - .2 Project number.
 - .3 Date.
 - .4 Name of Contractor.
 - .5 Name of Contract Administrator.
 - .6 RFI number, numbered sequentially. (eg: RFI-001)
 - .7 RFI subject.
 - .8 Specification Section number, title and related paragraphs, as appropriate.
 - .9 Drawing number and detail references, as appropriate.
 - .10 Field dimensions and conditions, as appropriate.
 - .11 Contractor's suggested resolution. If Contractor's suggested resolution impacts the Contract Time or the Contract Price, Contractor shall state impact in the RFI.
 - .12 Contractor's signature.
 - .13 Attachments: Include sketches, descriptions, measurements, photos, product data, Shop Drawings, coordination Drawings, and other information necessary to fully describe items needing interpretation.
 - .1 Include dimensions, thicknesses, structural grid references, and details of affected Materials, assemblies, and attachments on attached sketches.
- .3 RFI Forms: Contractor generated form including all content indicated in this Section.
- .1 Form and attachments shall be electronic files in Adobe Acrobat PDF format.
- .4 Contract Administrator's Action: Contract Administrator will review each RFI, determine action required, and respond. Allow 10 Working days for Contract Administrator's response for each RFI. RFIs received by Contract Administrator after 1:00 p.m. will be considered as received the following Working day.
- .1 The following Contractor-generated RFIs will be returned without action:
 - .1 Requests for approval of submittals.
 - .2 Requests for approval of substitutions.
 - .3 Requests for approval of Contractor's means and methods.
 - .4 Requests for approval of corrective actions for deficient Work.
 - .5 Requests for coordination information already indicated in the Contract Documents.
 - .6 Requests for adjustments in the Contract Time or the Contract Sum.
 - .7 Requests for interpretation of Contract Administrator's actions on submittals.
 - .8 Incomplete RFIs or inaccurately prepared RFIs.
 - .2 Contract Administrator's action may include a request for additional information, in which case Contract Administrator's time for response will date from time of receipt of additional information.
 - .3 If Contractor believes the RFI response warrants change in the Contract Time or the Contract Sum, notify Contract Administrator in writing within 10 days of receipt of the RFI response. Failure to notify will result in the Work being included as part of the Contract.

- .5 RFI Log: Prepare, maintain, and submit a tabular log of RFIs organized by the RFI number. Submit log with progress meeting minutes. Include the following:
 - .1 Project name.
 - .2 Name and address of Contractor.
 - .3 Name and address of Contract Administrator.
 - .4 RFI number including RFIs that were returned without action or withdrawn.
 - .5 RFI description.
 - .6 Date the RFI was submitted.
 - .7 Date Contract Administrator's response was received.
- .6 On receipt of Contract Administrator action, update the RFI log and immediately distribute the RFI response to affected parties. Review response and notify Contract Administrator within 10 days if Contractor disagrees with response.

1.4 COORDINATION

- .1 The Contractor is responsible for installing a complete, fully functional and fully operational system, and is responsible for reviewing all other trades' Drawings to ensure all electrical requirements are included in the Bid Opportunity price. Inform the Contract Administrator of any discrepancies during the Bid Opportunity process. Any discrepancies not identified, shall be incorporated by the Contractor at no cost during construction.
- .2 The Contractor is responsible for coordination with all other trades and Contractors on Site.
- .3 Through the Contractor, coordination shall include regular meetings, exchange of Shop Drawings and other technical information. Compile Working combined systems Drawings, where parts of the installation are complex or require input of several trades. Ensure the Contractor is in attendance and is aware of all coordination. Obtain and exchange schedules with all other trades and Contractors to ensure Work which impacts another trade or Contract is completed in sufficient time.
- .4 All Work is to be properly phased to enhance coordination. Where it is evident that Work outside of phase has inhibited the Work of another Contractor, the Contract Administrator shall reserve the right to instruct the Contractor to remove said Work at the cost of the Contractor.

1.5 SUSTAINABLE DESIGN PROCEDURES

- .1 The City has established, with the design team, the target for sustainable goals for the project. The Contractor, its Subcontractors and suppliers will be required to participate in the process to realize The City's sustainable goals.
- .2 Refer to Front End Specifications.

1.6 DESIGN REQUIREMENTS

- .1 Operating voltages: to CAN3-C235.
- .2 Motors, electric heating, control and distribution devices and equipment to operate satisfactorily at 60 Hz within normal operating limits established by above standard.

- .3 Equipment to operate in extreme operating conditions established in above standard without damage to equipment.

1.7 SUBMITTALS

- .1 Submit Shop Drawings, produce detailed data and samples in accordance with previous sections, as specified herein, and to Contract Administrator's satisfaction.
- .2 Shop Drawings submitted electronically (e.g. by email) shall comply with the following:
 - .1 Shop Drawings larger than 11 x 17 shall include a hard copy delivered separately by messenger the same day as the email copies.
 - .2 All necessary transmittals shall be included with the email submission.
 - .3 Emailed Shop Drawings shall comply in all respects with this section of the Specifications.
- .3 Indicate details of construction, dimensions, capacities, weights and electrical performance characteristics of equipment or Material.
- .4 Where applicable, include actual wiring, single line and schematic diagrams. Include all technical data and full details of each component.
- .5 Include wiring Drawings or diagrams showing interconnection with Work of other sections.
- .6 Shop Drawings must reflect actual equipment being provided. Generic Shop Drawings are not acceptable and will be returned for re-submittal without Contract Administrator's review.
- .7 Shop Drawings of all equipment must be submitted to the Contract Administrator for review in sufficient time to enable him to retain them for at least ten (10) Working days.
- .8 Each applicable device to be highlighted or identified with an arrow.
- .9 Each applicable device to be tagged (e.g. light fixture type, motor tag, etc.).
- .10 Bind each system separately eg. Power distribution, Fire Alarm, etc. One common binder from one supplier will not be acceptable.
- .11 Shop Drawing submission shall include a photocopy of all applicable Specification sections showing a complete compliance/ non-compliance listing. Refer to spec. detail sheet "Shop Drawing Compliance List Sample" for example.
- .12 Division 26 shall check all Shop Drawings and make necessary changes, or cause the supplier to make necessary changes, prior to submission to the Contract Administrator. Shop Drawings will be reviewed by the Contract Administrator and if re-submission is required, Division 26 shall ensure that the supplier's Drawings have been changed to comply before returning them to the Contract Administrator for review again.
- .13 Review of the Shop Drawings by the Contract Administrator shall not relieve the Contractor from responsibility for errors and omissions therein.

- .14 Each Drawing submission to bear the following signed stamp, and shall include name of project, equipment supplier, and clause number equipment is specified under.

CONTRACTORS CERTIFICATION

This Drawing has been reviewed by
(firm name) .

All dimensions have been checked and found compatible with the Contract Drawings and all capacities, quantities, sizes, and other data contained in the Contract documents have been listed by the supplier on this Drawing and have been checked by the undersigned and found correct.

Date Per:

- .15 Clearly show division of responsibility. No item, equipment or description of Work shall be indicated to be supplied or Work to be done "By Others" or "By Purchaser". Any item, equipment or description of Work shown on Shop Drawings shall form part of Contract, unless specifically noted to the contrary.
- .16 Provide field dimensions required by electrical suppliers and Subcontractors. In cases where fabrication is required prior to field dimensions being available, check all related Drawings and obtain clarification from Contract Administrator if necessary.
- .17 Main distribution and utility metering Shop Drawings must be approved by local utility prior to submission to Contract Administrator.
- .18 Incomplete submissions will be returned for updating and re-submittal without Contract Administrator's review.
- .19 Product Data: submit WHMIS MSDS in accordance with Division 1.
- .20 Quality Control: in accordance with Division 1.
- .1 Provide CSA certified equipment and Material.
- .2 Where CSA certified equipment and Material is not available, submit such equipment and Material to authority having jurisdiction for special approval before delivery to Site.
- .3 Submit test results of installed electrical systems and instrumentation.
- .4 Permits and fees: in accordance with General Conditions of Contract.
- .5 Submit, upon completion of Work, load balance report.
- .6 Submit certificate of acceptance from authority having jurisdiction upon completion of Work.
- .7 Other requirements as listed in Specification.
- .21 Manufacturer's Field Reports: submit manufacturer's written reports, within 3 days of review, verifying compliance of Work and electrical system and instrumentation testing, as described in other sections.

1.8 QUALITY ASSURANCE

- .1 Quality Assurance: in accordance with Front End Specifications.

- .2 Qualifications: electrical Work to be carried out by qualified, licensed electricians or apprentices in accordance with authorities having jurisdiction and as per the conditions of Provincial or Territorial Act respecting manpower vocational training and qualification.

1.9 DELIVERY, STORAGE AND HANDLING

- .1 Material Delivery Schedule: provide Contract Administrator with schedule within 2 weeks after award of Contract.
- .2 Construction/Demolition Waste Management and Disposal: separate waste Materials for reuse and recycling in accordance with Front End Specifications.

1.10 SYSTEM STARTUP

- .1 Upon completion of the project, demonstrate the operation, care and maintenance of all system equipment and components in the presence of The City, or his representative, and the Contract Administrator. Obtain signed certification from The City that such equipment was shown to be fully operational and that all necessary operating instructions have been provided.
- .2 Arrange and pay for services of manufacturer's factory service engineer to supervise start-up of installation, check, adjust, balance and calibrate components and instruct operating personnel.
- .3 Provide these services for such period, and for as many visits as necessary to put equipment in operation, and ensure that operating personnel are conversant with aspects of its care and operation.

1.11 DRAWINGS

- .1 Drawings are intended to communicate the general design intent. They are not to be interpreted as a description of means and methods of construction. The Contractor is responsible for reviewing the Drawings and Specifications of this and all other trades on the project to ensure that they deliver a fully coordinated, complete and fully operational system. Any component or service not described, but reasonably obvious as required for completion shall be included by the Contractor at no cost.
- .2 Carefully examine all Drawings and Specifications relating to all Work, and all electrical Work indicated thereon shall be considered as a part of the Work by this section unless indicated otherwise. Prior to the date of the last addendum report at once to the Contract Administrator, any defect, discrepancy, omission or interference affecting the Work of this section, or the guarantee of same.
- .3 Install all equipment as shown or as specified and in accordance with manufacturer's approved Shop Drawings.
- .4 The Drawings accompanying these Specifications are intended to show the general arrangement and extent of the Work to be carried out, but the exact location and arrangement of all parts shall be determined as the Work progresses. The location of equipment, outlets, etc., as given on the Drawings are approximately correct, but it shall be understood that they are subject to such modifications as may be found necessary or desirable at the time of installation to meet any structural or architectural requirements.

Such changes shall be implemented as directed by the Contract Administrator, without additional charge.

- .5 Electrical Drawings do not show all structural and other details. Architectural and structural conditions shall govern, and this Section shall make without charge, changes or additions to accommodate these conditions.
- .6 Where Drawings indicate the general location and route to be followed by conduit, cable, etc., these locations must be governed by job conditions. Where the required conduit, cable, and boxes are not shown on Drawings or only shown diagrammatically, they shall be installed to conserve maximum head room and interfere as little as possible with free use of space through which they pass. Maximum clearance above floor shall be maintained under all suspended conduit and equipment, unless otherwise shown on the Drawings, or approved by the Contract Administrator.
- .7 Submit a complete set of Drawings for the proposed installation to the Inspection Department having jurisdiction and receive written approval before installation or fabrication of any equipment. No extra compensation will be allowed for any changes or rearrangement of any electrical apparatus or Materials necessary due to failure to receive this approval.
- .8 Provide the Electric Utility with three copies of a Drawing showing the main distribution and the proposed method of metering for approval prior to the manufacture of equipment.

1.12 OPERATION AND MAINTENANCE DATA

- .1 Provide operation and maintenance data for incorporation into operation and maintenance manuals specified.
- .2 Provide one copy of Operation and Maintenance manuals to Contract Administrator for review. Operation and Maintenance manuals will be reviewed by the Contract Administrator and if re-submission is required, ensure that the manuals have been changed to comply before returning them to the Contract Administrator for review again.
- .3 Include in operations and maintenance data:
 - .1 Details of design elements, construction features, component function and maintenance requirements, to permit effective start-up, operation, maintenance, repair, modification, extension, and expansion of any portion or feature of the electrical installation.
 - .2 Technical data, product data, supplemented by bulletins, component illustrations, exploded views, technical descriptions of items, and parts lists. Advertising or sales literature alone is not acceptable.
 - .3 Wiring and schematic diagrams and performance curves.
 - .4 Names and addresses of local suppliers.
 - .5 Copy of reviewed Shop Drawings.
- .4 Provide four (4) complete, hard-backed, D-ring loose leaf Maintenance Manuals. These shall consist of typewritten or printed instructions for operating and maintaining all systems and equipment provided under this section of the Specification. Manuals shall also contain Shop Drawings, wiring diagrams, test results and manufacturer's brochures on

all equipment, together with typed index tab sheets. Manuals shall also contain a DVD with PDF files of the contents of the manuals.

- .5 As Work progresses, record on one (1) set of Contract Drawings, installed conduit layout as well as any approved changes and deviations from the original Contract and/or Working Drawings, including outlets, equipment and panel locations. Have these Drawings available for reference and observation at all times. At completion of Work, submit to the Contract Administrator, at the Contractor's Costs, AutoCAD Record Drawings and one hardcopy set of Record Drawings. The Contract shall not be considered complete and no final payment shall be made until these Drawings are accepted by the Contract Administrator. Provide separate Drawings for each system in order not to "crowd" Drawings.

1.13 EXAMINATION OF DOCUMENTS AND SITE

- .1 Carefully examine all plans and Specifications pertaining to this Contract and become familiar with all details. Visit the Site and determine all factors affecting this section of the Work; include all costs for same in Bid Opportunity.

Part 2 Products

2.1 SUSTAINABLE REQUIREMENTS

- .1 Materials and products in accordance with Front End Specifications.

2.2 MATERIALS AND EQUIPMENT

- .1 Provide Materials and equipment in accordance with Front End Specifications.
- .2 Equipment and Material to be CSA certified. Electrical equipment consisting of individual certified components must also have a CSA certification for the entire assembly. Where there is no alternative to supplying equipment which is certified, obtain special approval from local Electrical Inspection Department or authority having jurisdiction.
- .3 Factory assemble control panels and component assemblies.
- .4 Submit for Contract Administrator's approval, a duplicate list of makes and types of all equipment and Materials for this project, prior to placing of orders for same. This shall be done within fourteen (14) days of the award of the project Contract to the Contractor in order to avoid delays in delivery and completion.
- .5 Any Material or equipment ordered or installed without the Contract Administrator's prior approval shall, if so directed by the Contract Administrator, be removed and replaced with approved Material or equipment without a change in the Contract price.

2.3 ELECTRIC MOTORS, EQUIPMENT AND CONTROLS

- .1 Verify installation and co-ordination responsibilities related to motors, equipment and controls, as indicated.

- .2 Supplier and installer responsibility is indicated in Motor Schedule, or electrical Drawings, or in this Specification and related mechanical responsibility is indicated in Mechanical Equipment Schedule or mechanical Drawings and Specifications.
- .3 Refer to other Sections of this Specification and to Drawings for responsibilities for control wiring and conduit.
- .4 Coordinate with other trades. Identify any discrepancies during Bid Opportunity.

2.4 WARNING SIGNS

- .1 Warning Signs: in accordance with requirements of authority having jurisdiction and Contract Administrator.
- .2 Decal signs, minimum size 175 x 250 mm.
- .3 Provide "Danger High Voltage" labelling on main electrical room door.

2.5 WIRING TERMINATIONS

- .1 Ensure lugs, terminals, screws used for termination of wiring are suitable for type of conductors used.

2.6 EQUIPMENT IDENTIFICATION

- .1 Identify electrical equipment with nameplates and labels as follows, and as indicated in other Specification sections:
 - .1 Nameplates: lamicoid 3mm thick plastic engraving sheet, black face with white core (black with white letters) lettering accurately aligned and engraved into core mechanically attached with self tapping screws.
 - .2 Nameplates for equipment fed from emergency power or from emergency UPS power (increase nameplate size as required to suit wording) shall be red with white letters (red with white letters).
 - .3 Sizes as follows:

NAMEPLATE SIZES			
Size 1	10 x 50 mm	1 line	3 mm high letters
Size 2	12 x 70 mm	1 line	5 mm high letters
Size 3	12 x 70 mm	2 lines	3 mm high letters
Size 4	20 x 90 mm	1 line	8 mm high letters
Size 5	20 x 90 mm	2 lines	5 mm high letters
Size 6	25 x 100 mm	1 line	12 mm high letters
Size 7	25 x 100 mm	2 lines	6 mm high letters
- .2 Labels: embossed plastic labels with 6mm high letters unless specified otherwise.
- .3 Wording on nameplates and labels to be approved by Contract Administrator prior to manufacture.
- .4 Allow for minimum of twenty-five (25) letters per nameplate and label.
- .5 Nameplates for terminal cabinets, pullboxes and junction boxes to indicate system and/or voltage characteristics.

- .6 Disconnects, starters and contactors: indicate equipment being controlled and voltage.
- .7 Transformers: indicate capacity, primary and secondary voltages.
- .8 Room names and numbers used shall be actual room names and numbers that will be used on the project. Co-ordinate and confirm with trades involved.
- .9 Co-ordinate names of equipment and systems with Mechanical section to ensure that identical names are used.
- .10 Nameplates for control devices: indicate equipment controlled.
- .11 Adjacent to each breaker in CDP type panelboards, provide and mount lamacoid nameplates identifying the respective load and location.
- .12 To match existing where applicable.
- .13 All convenience receptacles shall have a lamacoid size 1 plate on which the panel and circuit number from which it is fed, is indicated. The identification shall be mechanically secured to the coverplate on the appropriate outlet. Pressure indented adhesive strip nameplates are not acceptable and shall not be used.

2.7 WIRING IDENTIFICATION

- .1 Identify wiring with permanent indelible identifying markings on both ends of phase conductors of feeders (coloured plastic tapes) and branch circuit wiring (numbered wire markers). Conductor marker identification shall correspond with panel or terminal board directory information.
- .2 Maintain phase sequence and colour coding throughout.
- .3 Colour coding: to CSA C22.1.
- .4 Use colour coded wires in communication cables, matched throughout system. Colour coding used shall be documented by individual systems in Maintenance Manuals.
- .5 Insulated grounding conductors shall have a green finish and shall be used only as a grounding conductor.

2.8 CONDUIT AND CABLE IDENTIFICATION

- .1 Colour code conduits, boxes and metallic sheathed cable.
- .2 Colour coding to match existing where applicable.
- .3 Confirm colour coding with City and Contract Administrator prior to start of Work.
- .4 Code with plastic tape or paint at points where conduit or cable enters wall, ceiling, or floor, and at 15m intervals.
- .5 Colours: 25mm wide prime colour and 20mm wide auxiliary colour.

Prime

Auxiliary

Up to 250V (normal power)	yellow	
Up to 600V (normal power)	yellow	green
Fire alarm	red	
Other security systems	red	yellow
Control	blue	

- .6 Other conduit systems as directed on Site; all conduit systems shall be identified.
- .7 Colour outlet box covers to colour designated and show circuit numbers in black felt marker on inside of covers.

2.9 FINISHES

- .1 Shop finish metal enclosure surfaces by application of rust resistant primer inside and outside, and at least two coats of finish enamel.
 - .1 Paint outdoor electrical equipment "equipment green".
 - .2 Paint indoor switchgear and distribution enclosures light gray.

2.10 WORKMANSHIP AND MATERIALS

- .1 The installation shall consist of Material and equipment specified unless as provided herein. Electrical equipment provided under this Contract shall be built in accordance with EEMAC standards and shall be C.S.A. certified and/or locally approved. All equipment supplied under this Contract shall be new and the best of its respective kind and of uniform pattern throughout.
- .2 Any Material or equipment ordered or installed without the Contract Administrator's prior approval shall, if so directed by the Contract Administrator, be removed and replaced with approved Material or equipment without a change to the Contract.
- .3 Replace inferior Work if so ordered by Contract Administrator without a change to the Contract.
- .4 Retain same foreman or superintendent on the job until completed, unless otherwise directed by the Contract Administrator.
- .5 All tradesmen shall carry all tools on their person at all times. Any tool not in use shall be under lock and key in an area authorized by the building supervisor.

2.11 REQUEST FOR EQUAL

- .1 Refer to clause B7 for substitute requirements.

2.12 WIRING TERMINATIONS

- .1 Lugs, terminals, screws used for termination of wiring to be suitable for either copper or aluminum conductors.

2.13 SPARE PARTS

- .1 The Contractor shall submit 15 days after Bid Opportunity a list of spare parts that the Contractor considers essential/important/useful to the operation of the systems described

herein. This list shall be in addition to any spares/consumables called for in the Contract Documents and those which are required up to practical completion and hand over.

- .2 Each spare part listed shall include the manufacturer's/ supplier's price including all mark-ups, delivery and packaging. The prices shall remain valid for 12 months following handover of the project.
- .3 These spare parts may or may not be ordered during the Contract period. The Contractor shall only include these items in the Contract sum if specifically instructed to do so.
- .4 Any spare parts listed shall be completely interchangeable with those specified in the Contract Documents and included in the Works.
- .5 Any spares ordered shall be delivered to the specified client's representative complete with all documents/instructions.

2.14 HOUSEKEEPING PADS

- .1 All floor mounted electrical equipment shall be mounted on concrete housekeeping pads.
- .2 Pad mounted equipment with doors that open to the bottom of the enclosure shall have horizontal struts installed between the enclosure bottom and the concrete pad to prevent the door from dragging on the concrete.
- .3 All housekeeping pads for electrical equipment to be installed by sub-trade hired and paid by Electrical Subcontractor, unless noted otherwise.
- .4 Where housekeeping pads for electrical equipment are required to be installed by Contractor, notify Contractor and provide required pad sizes.
- .5 Housekeeping pad shall be 4" (100mm) high, rebar 10M @ 12" (300mm) o/c, each way top, unless noted otherwise.
- .6 Housekeeping pad shall extend 4" (100mm) on each side of equipment.
- .7 Chamfer top edge and corners.

Part 3 Execution

3.1 INSTALLATION

- .1 Do complete installation in accordance with CSA C22.1 except where specified otherwise.

3.2 NAMEPLATES AND LABELS

- .1 Ensure manufacturer's nameplates, CSA labels and identification nameplates are visible and legible after equipment is installed.

3.3 CONDUIT AND CABLE INSTALLATION

- .1 Arrange for holes through exterior wall and roof to be flashed and made weatherproof.

3.4 LOCATION OF OUTLETS

- .1 Locate outlets in accordance with Section 26 05 32 - Outlet Boxes, Conduit Boxes and Fittings.
- .2 Do not install outlets back-to-back in wall; allow minimum 150mm horizontal clearance between boxes.
- .3 Change location of outlets at no extra cost or credit, providing distance does not exceed 3000mm, and information is given before installation.
- .4 Coordinate receptacle locations in mechanical rooms with Mechanical Subcontractor prior to install.
- .5 Locate disconnect devices in mechanical rooms on latch side of centre line of equipment unless specified or indicated otherwise.
- .6 If mounting height of equipment is not specified or indicated, verify before proceeding with installation.
- .7 Install electrical equipment at following heights unless indicated otherwise.
 - .1 Local switches, timers, etc: 1200mm.
 - .2 Wall receptacles:
 - .1 General: 400mm.
 - .2 Above top of continuous baseboard heater: 200mm.
 - .3 In mechanical rooms: 915mm.
 - .3 Panelboards, annunciators etc.: 2000mm to top.
 - .4 Thermostats: 1200mm.
 - .5 Speed controls: 1200mm.
 - .6 Manual starters: 1200mm.
 - .7 Emergency power off buttons: 1200mm.

3.5 FIELD QUALITY CONTROL

- .1 Verification of protective device coordination.
 - .1 A certified testing agency normally engaged in field service equipment testing shall be engaged and shall test all the circuit breaker settings for coordination verification as follows (to include new and existing breakers that require adjustment of settings):
 - .1 Test programmable/adjustable circuit breakers after programming/adjusting (where applicable).
 - .2 Verification of coordination testing shall consist of:
 - .1 Testing of all circuit breaker solid state relays with the breaker manufacturer's test kit to verify at least 3 points on each time-current characteristic. One point shall be tested at the breakpoint of the characteristic at the high end and another point shall be tested at the breakpoint of the characteristic at the low end. The other points shall be tested along the straight line of the characteristic.

- .2 Ductor (contact resistance) testing and meggar (insulation) testing of all breakers including moulded case breakers in CDP type panels, other breakers with solid state trips, high voltage breakers, etc.
 - .3 The report shall be bound in a 3-ring loose leaf binder, similar to the Short Circuit and Time-Coordination Study, with title sheet, table of contents, purpose, test criteria, test equipment used, summary and test data. The test data shall list all devices in table form with both the actual tested values and the required values listed. All test values shall fall within +/- 10% of the required values. Necessary corrective action shall be taken to correct any problems and then re-tested until the equipment passes all required tests. Compare test results to the time current coordination study and confirm that the curves as actually tested provide the required coordination. After all tests and analysis has been completed successfully, the summary in the final report shall clearly state that all equipment has successfully passed all tests and is in good operating condition. The test report shall be certified by the testing agency and shall be signed and sealed by a Professional Engineer responsible for the testing. A minimum of 6 copies shall be submitted.
 - .4 The breaker co-ordination test report shall be included in the Operating and Maintenance Manuals.
 - .2 Load Balance:
 - .1 Measure phase current to panelboards with normal loads operating at time of acceptance.
 - .2 Adjust branch circuit connections as required to obtain best balance of current between phases and record changes.
 - .3 Measure phase voltages at loads and adjust transformer taps to within 2% of rated voltage of equipment.
 - .4 Provide upon completion of Work, load balance report as directed in PART 1 - Submittals: phase and neutral currents on panelboards, dry-core transformers and motor control centres, operating under normal load, as well as hour and date on which each load was measured, and voltage at time of test.
 - .3 Conduct following tests:
 - .1 Circuits originating from branch distribution panels.
 - .2 Motors, heaters and associated control equipment including sequenced operation of systems where applicable.
 - .3 All other electrical systems.
 - .4 Insulation resistance testing:
 - .1 Conductors rated 1000V and less:
 - .1 Megger circuits, feeders and equipment up to 350V with a 500V instrument.
 - .2 Megger 350V - 600V circuits, feeders and equipment with a 1000V instrument.
 - .2 Conductor rated above 1000V:
 - .1 All cables rated above 1000V shall be tested with "Very Low Frequency" test method.

- .4 Furnish manufacturer's certificate or letter confirming that entire installation as it pertains to each system has been installed to manufacturer's instructions.
- .5 All circuits shall be tested to ensure that the circuit numbers are correct and that the proper neutral conductors have been provided and installed.
- .6 Carry out tests in presence of Contract Administrator and City.
- .7 Advise Contract Administrator of dates and times for all testing with sufficient advance notice to allow Contract Administrator to make arrangements to attend.
- .8 Provide instruments, meters, equipment and personnel required to conduct tests during and at conclusion of project.
- .9 Insert test results and supplier's certifications in Maintenance Manuals.
- .10 Manufacturer's Field Services:
 - .1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports as described in PART 1 - SUBMITTALS.
 - .2 Provide manufacturer's field services consisting of product use recommendations and periodic Site visits for observation of product installation in accordance with manufacturer's instructions.
 - .3 Schedule Site visits, to review Work, as directed in PART 1 - QUALITY ASSURANCE.
- .11 Verification requirements in accordance with Front End Specifications for Sustainable Requirements.
- .12 Clean and touch up surfaces of shop-painted equipment scratched or marred during shipment or installation, to match original paint.
- .13 Clean and prime exposed non-galvanized hangers, racks and fastenings to prevent rusting.

3.6 PERMITS, FEES AND INSPECTION

- .1 Submit to Electrical Inspection Department and Supply Authority necessary number of Drawings and Specifications for examination and approval prior to commencement of Work.
- .2 Pay all associated fees for inspection of the Work by authorities having jurisdiction.
- .3 Notify Contract Administrator of changes required by Electrical Inspection Department prior to making changes.
- .4 Furnish Certificates of Acceptance from authorities having jurisdiction on completion of Work to Contract Administrator. Copies to be included in Maintenance Manuals.

3.7 RESPONSIBILITY

- .1 Be responsible for any damage caused the City, or their Contractors due to improperly carrying out this Work.

- .2 Install all components of this Work promptly and where applicable, in advance of concrete pouring, or similar construction. Provide and set in the proper sequence of construction, all sleeves, hangers, inserts, etc. and arrange for all necessary openings, where required to accommodate the electrical installation.
- .3 Work shall be arranged in co-operation with other divisions of this Specification in such a manner that it doesn't interfere with the progress of the project. In areas where ducts or pipes must be installed along with conduit or cable, co-operate with other divisions so that the finished job will represent the most efficient use of the space.
- .4 In no case proceed with any Work in uncertainty. Obtain, from the Contract Administrator, any clarification necessary and thoroughly understand all portions of the Work to be performed.

3.8 CLEANLINESS AND CLEANING

- .1 This division shall maintain a clean tidy job Site. All boxes, crates, and construction debris due to this portion of the Work shall be neatly piled outside the construction area and shall be removed at least weekly during the construction period. All construction areas shall be kept clear of debris.
- .2 Before the project will be accepted by the City, all panelboards, switches, receptacles, cover plates, and other electrical equipment shall be clean and free of dust, plaster, paint, etc. Any equipment which is scratched or damaged shall be refinished or replaced if so designated by the Contract Administrator.

3.9 MODIFICATIONS

- .1 Locations of all convenience receptacles, outlets, switches, etc. are subject to modification by the Contract Administrator, who reserves the right to move these up to 3000 mm from the position shown, without change to the Contract price, provided notice is given before the related Work has commenced.

3.10 GUARANTEE

- .1 Guarantee the satisfactory operation of all Work and equipment supplied and installed as a part of this section of the Specifications.
- .2 Replace forthwith, at no additional Material or labour cost, any part which may fail, or prove defective within a period of twelve (12) calendar months after the final acceptance of the complete installation, provided that such failure is not due to improper usage, or ordinary wear and tear.
- .3 No certificate given, payment made, partial or entire use of the equipment by the City or his representative shall be construed as acceptance of defective Workmanship or Materials.
- .4 This general guarantee shall not act as a waiver of any specified guarantee or special equipment guarantees covering a greater length of time.

3.11 CUTTING AND PATCHING

- .1 Cutting, patching and repairs to existing surfaces required as a result of the removal and/or relocation of existing equipment and piping, and/or installation of new equipment and piping in existing building(s) to be included by Electrical Subcontractor in Bid Opportunity price. Electrical Subcontractor to employ and pay appropriate sub-trade whose Work is involved, for carrying out Work described above.
- .2 Electrical Subcontractor shall mark all openings required for conduits, cables, ducts, and the like.
- .3 Description:
 - .1 Perform all cutting and patching required for installing electrical systems.
 - .2 Electrical Subcontractor shall retain services of General Sub-trades to carry out actual Work involved in cutting wall openings, floor openings and the like, and in patching up after installation has been completed.
 - .3 Cutting to be 'neat' sizes. Patch all edges such as cover plates, etc. Hide cut edges.
 - .4 Electrical Subcontractor to perform all cutting only of existing surfaces as required as a result of the removal and/or relocation of existing equipment and conduit and/or installation of new equipment and conduit in the existing building to be included by the Div. 26 in the Bid Opportunity price.
 - .5 If, in the opinion of Contract Administrator, cutting of holes has been improperly performed (i.e. too large for conduits or cables) Electrical Subcontractor to do all patching as per original Specifications and all costs will be borne by him.

3.12 FIREPROOFING

- .1 Where cables or conduits pass through floors, block or concrete walls and fire rated walls, seal openings with 3 M Brand Fire Barrier Products, to maintain fire rating.
- .2 Seal all holes resulting from removal of cables, conduits and equipment.
- .3 Fireproofing of electrical cables, conduits, trays, etc. passing through fire barriers shall conform to local codes and inspection authorities.
- .4 Refer to following table for 3M brand products.

Penetrating Item	3M Brand Fire Barrier Product Options	Range of Applications			Concrete Walls and Assemblies		Gypsum Wall Assemblies	
		Penetrating Items	Annular Space	Maximum Opening Size	F Ratings (Hrs)	T Ratings (Hrs)	F Ratings (Hrs)	T Ratings (Hrs)
1. Plastic Pipe/Conduit & Cast-in Coupling	FS-195+ Wrap Strip, CP 25WB+ Caulk or MP Moldable Putty+	PVC: 8 in. Nominal Diameter 4 Wraps/Application	0.2 in.	9 in. Diameter	2	2	2	1-1/2
		PVC: 4 in. Nominal Diameter 3 Wraps/Application	0.75 in.	6 in. Diameter	3	2	2	2
		ABS: 4 in. Nominal Diameter 3 Wraps/Application	0.75 in.	6 in. Diameter	2	2	1-1/2	1-1/2
	PSS 7904 Penetration Sealing System with CP 25 WB+ Caulk	PVC: 4 in. Nominal Diameter	3.0 in.	10 in. Diameter	3	1/2	--	--
		ABS: 4 in. Nominal Diameter	3.0 in.	10 in. Diameter	3 (in wall) 1 (in floor)	3 (in wall) 0 (in floor)	--	--

		PB: 2 in. Nominal Diameter	3.0 in.	8 in. Diameter	1/2	--	--	--
2. Metal Pipe and Conduit	CP 25WB+ Caulk	1 in. Depth of Caulk; 20 in. Diameter	2.5 in.	22.5 in. Diameter	3	0	2	0
	FS-195+ Wrap Strip, CP 25WB+ Caulk or MP Moldable Putty+	4 in. Nominal Metal Pipe	1.75 in.	8 in. Diameter	2	0	2	2
	CS-195+ Composite Sheet with FS-195+ Wrap Strip and CP 25WB+ Caulk or MP Moldable Putty+	4 in. Nominal Metal Pipe (Multiple Pipes)	45.0 in.*	30 x 50 in.	4 (both sides) 3 (one side)	3/4 0	--	--
	PSS 7902 Penetration Sealing System CP 25 WB+ Caulk or MP Moldable Putty+	10 in. Nominal Diameter Pipe and 8x16 in Rectangular Cover Plate if fill is less than 10%	9.0 in.	10 x 20 in.	3	0	--	--
	CP 25WB+ Caulk	1/2 in. Diameter Depth of CP-25WB 12 in. Nominal Diameter Pipe	1.2 in.	14 in. Diameter	3	0	--	--
	FD 150 FireDam Caulk	2 in. Depth of FireDam 150 Chaulk 6 in. Nominal Diameter Pipe	2.0 in.	8-1/4 in. Diameter	3	0	--	--
	MP Moldable Putty+	1 in. Depth of Putty; 10 in. Nominal Diameter Pipe	0.75 in.*	12-1/4 in. Diameter	2 (1/2 in. Depth) 3 (1 in. Depth)	0	--	--
3. Insulated Electrical and Communications Cable	CP 25WB+ Caulk	1 in. Depth of Caulk; 43% of Area Filled, 350 MCM Cable and 100 Pair Telephone Cable	0.75 in.	6 in. Diameter	3	0	2	1-1/2
		1 in. Depth of Caulk; 37% of Area Filled, 3/0 350MCM Cable and 100 Pair Telephone Cable	0.75 in.					
		2-12 in. Depth of Caulk; 59% of Area Filled, 7C/12 AWG Cable, 100 Pair Telephone Cable	0.75 in.					
	FS-195+ Wrap Strip with CP 25WB+ Caulk or MP Moldable Putty+	4 in. Depth of Caulk with FS-195 Wrap; 59% Area Filled, 350 MCM Cable	0.75 in.	6 in. Diameter	2	0	--	--
	CS-195+ Composite Sheet with FS-195+ Wrap Strip and CP 25WB+ Caulk or MP Moldable Putty+	Multiconductor 12 AWG Cable, 100 Pair PVC Telephone Cable, Cable Bundle 3 in. Diameter	47.0 in.*	30 x 50 in.	4	1	--	--
	PSS 7904 Penetration Sealing System with CP 25 WB+ Caulk	350 MCM Cable; 30% of Area Filled. Cover Plate required if Fill is less than 10%	11.0 in.	8 x 16 in.	3	1/2	--	--
	MP Moldable Putty+	Telephone Cable; 100 Pair, 40% or Area Filled	0.75 in.	6-1/4 in. Diameter	2	0	--	--
4. Cable Tray	CS-195+ Composite Sheet with CP 25WB+ Caulk	Nominal Size Cable Tray 4 x 24 in.; 39% Area Filled in Tray; Cable Size: 300 MCM 4 in. Depth of Chaulk	14.64 in.	12 x 24 in.	3	0	--	--
	PSS 7904-R Penetration Sealing System with CP 25 WB+ Caulk	Nominal Size Cable Tray 4 x 18 in.; 52% Area Filled in Tray; 25 Pair No. 22 AWG Telephone Cable	9.0 in.	10 x 20 in.	3	3/4	--	--
5. Blank Openings and Construction Joints and Expansion Trenches	CP 25WB+ Caulk	1/2 to 1 in. Depth	--	Joint Width	3	3	--	--
		2 in. Depth Cover Plate required when joint width exceeds 2 in.	--	4 in. Diameter Opening 4 in. Joint Width	3	2	--	--
	MP Moldable Putty+	1 in. Depth	--	1 in. Joint Width	2	2	--	--
	PSS 7904 Penetration Sealing System with CP 25 WB+ Caulk	4 in. Depth of Kit. Cover Plate Required.	--	8 x 16 in.	3	1	--	--

* Distance Measured from the outer edge of the pentrant to the furthest edge of the opening

3.13

SCHEDULING OF WORK

- .1 Existing building will remain in use during construction. Arrange Work so that interruption of services is kept to a minimum. Obtain permission from City prior to cutting into electrical services.

- .2 Contractor to maintain continuous and adequate all existing electrical systems and other services during entire duration of this Contract.

3.14 DEMOLITION OF EXISTING ELECTRICAL

- .1 Remove all unnecessary existing electrical equipment, wiring, fixtures, in those portions of the existing building which are being remodelled or demolished. All devices/fixtures, etc. are not necessarily shown on the plans. The City shall select from the Materials and/or equipment remaining that which he wishes to retain, and the remainder shall be removed from the Site. Any electrical equipment in remodelled sections or in structures removed or altered, adjacent to new Work, necessary for the operation of existing building, shall be relocated as necessary. All existing equipment re-used shall be made good and guaranteed. Power interruptions to be kept to a minimum and shall be at a time suitable to the building occupant. Refer to Front End Specifications for description of demolition/phasing.
- .2 Drawings do not show all electrical requiring removal to accommodate renovations such as receptacles, switches, lights, starters, motors, components, heaters, etc. Division 26 shall visit Site, refer structural, mechanical and electrical Drawings and include all costs for demolition.
- .3 Refer to Specification Section 26 05 05 - Work in Existing Building.

3.15 TESTING

- .1 Test all circuits and wires for continuity, insulation resistance and high impedance grounds. Those circuits which test non-continuous, with an insulation resistance less than 2 Megohms or with high impedance grounds shall be replaced.
- .2 All empty conduits shall be left with an insulated #14 AWG fish wire.
- .3 Test all panels under full load and make necessary reconnection of single phase loads from one leg or phase to another to balance the load on legs or phases as nearly as possible. Test results, test values measured, date of each measurement, company name and signature of person making each measurement shall be neatly recorded. Record all changes on Record Drawings.
- .4 Keep a record of all final tests, bind, and turn over typewritten results to the Contract Administrator as a part of the maintenance manual. All final test values measured, date of each measurement, company name and signature of person making each measurement shall be neatly recorded. After all tests have been successfully completed, each test report shall contain a summary which clearly states that all results were satisfactory.
- .5 Upon completion of the Work and adjustments of all equipment, all systems shall be tested in the presence of the Contract Administrator to demonstrate that all equipment furnished and installed or connected as a part of this section of the Contract shall function electrically in the required manner as determined by the Contract Administrator.
- .6 All circuits shall be tested to ensure that the circuit numbers are correct and that the proper neutral conductors have been provided and installed.
- .7 Voltage tests shall be conducted and transformer taps adjusted or other corrective measures carried out as directed by the Contract Administrator.

- .8 Refer to other Sections for details.
- .9 Submit a report that includes test results, observations, summary, etc. Test report to clearly state that all results are acceptable.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

- .1 Section 26 05 00 - Common Work Results - For Electrical.
- .2 Section 26 05 21 - Wires and Cables.
- .3 Section 26 05 32 - Outlet Boxes, Conduit Boxes and Fittings.
- .4 Section 26 05 34 - Conduits, Conduit Fastenings and Conduit Fittings.

1.2 REFERENCES

- .1 American National Standards Institute/Institute of Electrical and Electronics Engineers (ANSI/IEEE).
- .2 Canadian Standards Association (CSA)
 - .1 CSA C22.2No.0.4, Bonding and Grounding of Electrical Equipment.

1.3 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Section Front End Specifications, and with the 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.

1.4 COORDINATION

- .1 The building shall remain open and in normal operation during the construction period.
- .2 Where existing services such as electrical power, fire alarm system, gas detection system, etc. are required to be disrupted and/or shut down, coordinate the shut-downs with The City and carry out the work at a time and in a manner acceptable to them. Carefully schedule all disruption and/or shut-downs and ensure that the duration of same is kept to the absolute minimum. Refer to Division 1 for required duration of shut-down notice to the City. Obtain City's written consent prior to implementing.
- .3 Should any temporary connections be required to maintain services during work in the existing building, supply and install all necessary material and equipment and provide all labour at no extra cost. Should any existing system be damaged, make full repairs without extra cost, and to the satisfaction of the City and Contract Administrator.
- .4 If existing equipment shown on drawings is defective, it shall be brought to the Contract Administrator and City's attention prior to work completion.
- .5 Refer to General Conditions for phasing and staging of work and adhere to that schedule. Comply with instructions regarding working hours necessary to maintain the building in operation.

1.5 EXISTING DEVICES IN NEW CONSTRUCTION

- .1 Existing junction boxes in walls and ceiling spaces required to maintain existing circuits shall remain accessible.
- .2 Where services are concealed within walls, floors or ceilings and cannot be visually identified, Contractor shall provide electronic scanning devices or other approved means to locate and identify concealed services prior to drilling.

1.6 SCHEDULE OF WORK

- .1 Carefully note and refer to the Contract Administrator's general schedule of work and include for all requirements to conform to it.

Part 2 Products

2.1 MATERIALS

- .1 Provide all materials required for the complete interface and reconnection installation as herein described and as indicated on the drawings.
- .2 New fire alarm devices, starters, panelboards, etc. required to be tied in to existing systems shall match the existing devices.
- .3 New wiring required to interconnect new devices to existing systems shall be provided to suit the manufacturers requirements and instructions.

Part 3 Execution

3.1 INSTALLATION

- .1 Install boxes, conduit and wiring through existing areas as required for the new installation.
- .2 Add modules, switches, etc. in existing control panels, as required, to extend existing systems to new or renovated areas.
- .3 Patch and repair walls and ceilings in existing areas that have been damaged or cut open due to the new electrical installation.
- .4 Where new cables or conduits have been installed through existing fire rated walls, seal opening around cables and conduit to maintain fire rating.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

- .1 Section 26 05 00 - Common Work Results - For Electrical

1.2 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CAN/CSA-C22.2No.18, Outlet Boxes, Conduit Boxes, Fittings and Associated Hardware.
 - .2 CSA C22.2No.65, Wire Connectors.
- .2 Electrical and Electronic Manufacturers' Association of Canada (EEMAC)
 - .1 EEMAC 1Y-2, Bushing Stud Connectors and Aluminum Adapters (1200 Ampere Maximum Rating).
- .3 National Electrical Manufacturers Association (NEMA)

Part 2 Products

2.1 MATERIALS

- .1 Pressure type wire connectors to: CSA C22.2No.65, with current carrying parts of copper sized to fit copper conductors as required.
- .2 Fixture type splicing connectors to: CSA C22.2No.65, with current carrying parts of copper sized to fit copper conductors 10 AWG or less.
- .3 Clamps or connectors for armoured cable, aluminum sheathed cable, mineral insulated cable, flexible conduit, non-metallic sheathed cable as required to:
CAN/CSA-C22.2No.18.

Part 3 Execution

3.1 INSTALLATION

- .1 Remove insulation carefully from ends of conductors and:
 - .1 Install pressure type wire connectors and tighten according to manufacturers recommendations.
 - .2 Install mechanical pressure type connectors and tighten screws with appropriate compression tool recommended by manufacturer. Installation shall meet secureness tests in accordance with CSA C22.2No.65.
 - .3 Install fixture type connectors and tighten. Replace insulating cap.
 - .4 Install bushing stud connectors in accordance with EEMAC 1Y-2 and NEMA.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

- .1 Section 26 05 00 - Common Work Results - For Electrical
- .2 Section 26 05 20 - Wire and Box Connectors - 0 - 1000 V.

1.2 REFERENCES

- .1 CSA C22.2 No .0.3, Test Methods for Electrical Wires and Cables.
- .2 CSA C22.2 No. 38 Thermoset Insulated Wires and Cables.
- .3 CSA C22.2 No. 51 Armoured Cables.
- .4 CSA C22.2 No. 131, Type TECK 90 Cable.

1.3 SUBMITTALS

- .1 Submit product data in accordance with Section 26 05 00 - Common Work Results - For Electrical.

Part 2 Products

2.1 BUILDING WIRES

- .1 Wires and cables manufactured to CSA 22.2 No. 38.
- .2 Conductors: stranded for 10 AWG and larger. Size as indicated. Minimum size: 12 AWG.
- .3 Copper conductors: size as indicated, with minimum 600 V insulation of cross-linked polyethylene (XLPE) material, rated RW90. For burial installations use RWU90.

2.2 AC90 (BX, COPPER)

- .1 Cable to C22.22 No.51
- .2 Conductors: Solid copper #12 AWG, stranded copper #10 AWG and larger, minimum size #12 AWG.
- .3 Insulation: 60V, cross-linked polyethylene (XLPE), 90°C.
- .4 Configuration: Multi-conductor, complete with a separate bare copper conductor.
- .5 Armor: Bare interlocked aluminum.

2.3 TECK CABLE

- .1 Cable: to CAN/CSA-C22.2 No. 131.

- .2 Conductors:
 - .1 Bonding conductor: copper.
 - .2 Phase conductors: copper, size as indicated. Minimum size 12 AWG.
- .3 Insulation:
 - .1 Cross-linked thermosetting polyethylene rated type RW90, minimum 1000 V.
 - .2 Colour code: Black, red, blue and white in 4C cable.
- .4 Inner jacket: Polyvinyl chloride (PVC) material.
- .5 Armour: interlocking aluminum.
- .6 Outer jacket: PVC jacket, FT4 rated.
- .7 Fastenings:
 - .1 One hole straps to secure surface cables 50 mm and smaller. Two hole steel straps for cables larger than 50 mm.
 - .2 Channel type supports for two or more cables.
 - .3 Threaded rods: Minimum 6 mm dia. to support suspended channels.
- .8 Connectors:
 - .1 To be approved for TECK cable.

2.4 CONTROL CABLES

- .1 Type LVT: soft annealed copper conductors, sized as indicated, with thermoplastic insulation, outer covering of thermoplastic jacket, and armour of closely wound aluminum wire.

2.1 VARIABLE FREQUENCY DRIVE (VFD) POWER CABLES

- .1 Metal sheathed VFD power cable, for output wiring to the motor from the VFD.
 - .1 Manufactured to CSA C22.2 No. 123 Metal Sheathed Cables.
 - .2 CSA approved to standard C22.2 No. 123.
 - .3 Minimum conductor size: 12 AWG, copper.
 - .4 Overall jacket: PVC, FT4 rated.
 - .5 Impervious, continuous corrugated aluminum sheath.
 - .6 Manufactured by Nexans, type Teck Drive RX.
 - .7 Teck Drive RX cable to be connected to equipment enclosures using connectors specifically made for use with the Drive RX cables. Connectors to be rated for use for TECK Drive RX cables.
 - .8 Installation: Install Teck Drive RX cable, from the VFD output to the motor. Remove metal sheath from cable end. Removed metal sheath to be replaced with liquid tight flexible conduit. Terminate liquid tight conduit to the end of sheath of Drive RX cable and the motor. Length of liquid tight conduit shall not be greater than the essential length for the degree of flexibility required. Installation of liquid tight flexible conduit to meet Canadian Electrical Code, Rule 12-1302. Notify

Contract Administrator of any discrepancies. Provide liquid tight conduit connectors.

- .9 Where output filter is specified, install Drive RX cable from VFD output to output line reactor/dv/dt filter and from output line reactor/dv/dt filter to motor.
- .10 Terminate phase and bonding conductors per the cable manufacturer's instructions, using bushings as directed. The connections to be made at the points indicated by the VFD manufacturer. Coordinate with Division 25.
- .11 Install per manufacturer's instructions.

Part 3 Execution

3.1 GENERAL

- .1 To Minimize Voltage Drop
 - .1 All branch circuit wiring and conduit shall be installed to minimize voltage drop. Install additional conduit runs as required to take the most direct and shortest route to outlets, light fixtures, etc.

3.2 INSTALLATION OF BUILDING WIRES

- .1 Install wiring as follows:
 - .1 In conduit systems.
 - .2 In cabletroughs (where available).

3.3 INSTALLATION OF TECK CABLE 0 -1000 V

- .1 Group cables wherever possible on channels.
- .2 Single conductor cables shall be installed one cable diameter apart on suspended cable tray or channel supports and shall be clamped with aluminum cable clamps. Cables shall be terminated using non-magnetic connectors. Cable armor shall be grounded via an aluminum plate at the supply end and isolated via an insulating plate, at the load end of the cable. A #3/0 AWG bare (unless otherwise noted) copper ground wire shall be installed with each feeder. Cable bending radius shall be at least twelve times the overall cable diameter and bends shall not damage or distort the outer sheath.

3.4 INSTALLATION OF ARMoured CABLES

- .1 Type AC90 armoured cable (BX) shall be used for connections from conduit systems to recessed luminaires in accessible ceilings. Cable to be of sufficient length to allow the lighting fixture to be relocated to any location within a 6' (1.8M) radius. Cable shall be clamped before entering the lighting fixture and shall be clipped before entering the conduit system junction box.

3.5 INSTALLATION OF CONTROL CABLES

- .1 Install control cables in conduit.
- .2 Ground control cable shield.

3.6 INSTALLATION OF FIRE ALARM CABLES

- .1 Do not install cables that are part of the fire alarm system in PVC conduit. This includes but not limited to the following: wiring to fire alarm devices, annunciators, communications wiring, power supply wiring, etc.

3.7 INSTALLATION IN EQUIPMENT

- .1 Group and lace-in neatly wire and cable installed in switchboards, panelboards, cabinets, wireways and other such enclosures.

3.8 TERMINATIONS

- .1 Terminate wires and cables with appropriate connectors in an approved manner.
- .2 Compression adapters intended to terminate larger feeders on small lugs are not acceptable. All lugs, including breaker lugs, are to be sized to accommodate the cable being terminated.

3.9 IDENTIFICATION

- .1 Wire in conduit #2 AWG and smaller shall have solid coloured insulation, colour coded as listed below.
- .2 Wire in conduit 1/0 AWG and larger and single conductor cables for normal power feeders shall be identified at each outlet box and termination with a 150 mm band of coloured vinyl tape of the appropriate colour. Emergency power feeders shall be provided with an additional 75 mm band of red vinyl tape installed adjacent to the 150 mm band of the coloured phase identification tape, as listed below. Neutral and ground conductors shall be identified. Paint or other means of colouring the insulation shall not be used.
- .3 Colour code wire in conduit and single conductor cables as follows:
 - Phase A - red
 - Phase B - black
 - Phase C - blue
 - Neutral - white
 - Ground - green
- .4 Maintain phase sequence and colour coding throughout project.
- .5 Use colour coded wires in communication cables, matched throughout system.
- .6 Identify control conductors in motor control equipment, contactors, fire alarm panels, etc. with mylar/cloth wire markers.
- .7 Refer to 26 05 00 for additional requirements.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

- .1 Section 26 05 00 - Common Work Results – For Electrical.
- .2 Section 26 05 21 - Wires and Cables (0-1000V)

1.2 REFERENCES

- .1 CSA C22.2 No. 0.4, Bonding of Electrical Equipment
- .2 CSA C22.2 No. 41, Grounding and Bonding Equipment
- .3 IEEE 142, Recommended Practice for Grounding of Industrial and Commercial Power Systems

1.3 SHOP DRAWINGS

- .1 Submit shop drawings in accordance with Section 26 05 00 - Common Work Results - For Electrical.
- .2 Include:
 - .1 Ground grid connection components

Part 2 Products

2.1 EQUIPMENT

- .1 Grounding and bonding conductors shall be green insulated, unless noted otherwise, stranded copper, sized in accordance with the Canadian Electrical Code, minimum #12 AWG.
- .2 When insulated conductors are installed in free air inside buildings, conductors shall be type RW-90, FT-4 rated.
- .3 Grounding and bonding clamps shall be brass where attached to copper pipes. Clamps for other materials and applications shall be of a type and material that will minimize deterioration from galvanic action due to dissimilar metals.
- .4 Use one or two hole copper compression lugs for grounding and bonding connections in equipment.
- .5 Compression connectors, lugs, etc., used in outdoor locations, shall have bolts, nuts, etc., of silicon bronze alloy.
- .6 Non-corroding accessories necessary for grounding and bonding systems, type, size, material as indicated, including but not limited to:
 - .1 Grounding and bonding bushings.
 - .2 Bolted type conductor connectors.

- .3 Pressure type conductor connectors.
- .4 Bonding jumpers, braided straps.

Part 3 Execution

3.1 INSTALLATION

- .1 General (Applies to bonding and grounding)
 - .1 Install complete, permanent, continuous, system and power circuit, equipment, grounding and bonding systems including but not limited to, conductors, connectors, bushings, accessories, as indicated, to conform to Canadian Electrical Code, applicable standards and requirements of local authority having jurisdiction.
 - .2 Conductors shall be continuous, without splices.
 - .1 Where splicing cannot be avoided (i.e. due to installation alleviation, unavailability of required conductor lengths, delivery issues, transportation issues, etc.), the Contractor must inform the Contract Administrator in writing and provide the reasons for splicing.
 - .2 Don't proceed with splicing without written approval from Contract Administrator.
 - .3 If splicing is approved by Contract Administrator, provide only crimped (compression type) or cadwelded splicing.
 - .3 Protect exposed conductors from mechanical damage by rigid metal conduit, steel guards, or other suitable shields. Bond metal guards to ground.
 - .4 Where grounding or bonding conductors are installed in metal conduit or other metallic encasement, the conductors shall be permanently and effectively bonded to the conduit/encasement at both ends of its length. Use solderless lugs, clamp or ground bushing at each end. This requirement applies to all such conduits/encasements regardless of length.
 - .5 Where conductors pass through fire rated floor, or wall, etc., provide rigid metal conduit of the required size. Connect each conduit end to the conductor with solderless lug, clamp or grounding bushing.
 - .6 All surfaces to which conductors are to be bolted shall be cleaned of all paint and applied with rust preventing agent.
 - .7 Unless otherwise noted in specification, shown on drawings or required by equipment manufacturer, accessible connections may be bolted, or crimped.
 - .8 Connections between dissimilar metals such as between copper and steel, must be thoroughly sealed or painted against moisture to minimize corrosion.
 - .9 Soldered connections shall not be used.
 - .10 Install conductor connectors in accordance with manufacturer's instructions.
 - .11 Make connections in radial configuration only, with connections terminating at single point. Avoid loop connections.
 - .12 Provide labels at each end on grounded, transformer neutral grounding and bonding and grounding conductors inside equipment.
- .2 Bonding to ground

- .1 The bonding of the electrical equipment and systems shall conform to the requirements of the electrical code, referenced standards, the inspection authority having jurisdiction and as described in this specification and as shown on the drawings.
 - .2 Install bonding conductor for flexible conduit, connected at both ends to conduit by using grounding bushing, solderless lug or clamp.
 - .3 In wet or damp areas and near tanks containing liquids, all equipment frames, tanks, boxes, outlets, etc., shall be bonded to ground.
 - .4 Bond single conductor, metallic armoured cables to ground at supply end, and provide non-metallic entry plate at load end.
 - .5 Conduit runs containing feeders and branch circuits shall be complete with an insulated green bonding conductor, bonded to all outlet boxes, junction boxes, pull boxes, equipment enclosures, equipment ground busses, etc. The conduit system shall be continuous but shall not be relied on to serve as the equipment bonding means.
 - .6 Bonding conductors shall be sized according to the Canadian Electrical Code, but shall be minimum #12 AWG.
- .3 Grounding
- .1 The grounding of the electrical equipment and systems shall conform to the requirements of the electrical code, referenced standards, the inspection authority having jurisdiction and as described in this specification and as shown on the drawings.

3.2 SINGLE CONDUCTOR CABLE METAL SHEATH GROUNDING

- .1 Single conductor cables shall have their metal armor, tape shields or concentric neutral conductors bonded to ground at the supply end only. The metal armor, tape shields or concentric neutral conductors shall be isolated from ground at the load end. Provide non-metallic entry plate at load end for cables with metal armor.
- .2 Bond metal armor, tape shields or concentric neutral conductors to ground by #2/0 green insulated copper conductor.
- .3 A separate bonding conductor shall be installed with the single conductor cables to carry the fault current, and shall be bonded to ground at each end.

3.3 BONDING EQUIPMENT ENCLOSURES TO GROUND

- .1 Connect bonding conductors installed with feeders to non-current carrying parts of equipment included in, but not necessarily limited to following list: panelboards, transformers, frames of motors, motor control centres, starters, control panels, building steel work, control panels, etc.
- .2 Make bonding connections in radial configurations only.

3.4 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section 26 05 00.
- .2 Perform tests before energizing electrical system.

- .3 Disconnect ground fault indicator, if provided, during tests.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

- .1 Section 26 05 00 - Common Work Results - For Electrical

Part 2 Products

2.1 SUPPORT CHANNELS

- .1 U shape, size and thickness as required, surface mounted, suspended.

Part 3 Execution

3.1 INSTALLATION

- .1 Secure equipment to masonry, tile and plaster surfaces with lead anchors or nylon shields.
- .2 Secure equipment to poured concrete with expandable inserts.
- .3 Secure equipment to hollow masonry walls or suspended ceilings with toggle bolts.
- .4 Support equipment, conduit or cables using clips, spring loaded bolts, cable clamps designed as accessories to basic channel members.
- .5 Fasten exposed conduit or cables to building construction or support system using straps.
 - .1 One-hole steel straps to secure surface conduits and cables 50 mm and smaller.
 - .2 Two-hole steel straps for conduits and cables larger than 50 mm.
 - .3 Beam clamps to secure conduit to exposed steel Work.
- .6 Suspended support systems.
 - .1 Support individual cable or conduit runs with 6 mm dia threaded rods and spring clips.
 - .2 Support 2 or more cables or conduits on channels supported by 6 mm dia threaded rod hangers where direct fastening to building construction is impractical.
- .7 For surface mounting of two or more conduits use channels.
- .8 Provide metal brackets, frames, hangers, clamps and related types of support structures where indicated or as required to support conduit and cable runs.
- .9 Ensure adequate support for raceways and cables dropped vertically to equipment where there is no wall support.
- .10 Do not use wire lashing or perforated strap to support or secure raceways or cables.
- .11 Do not use supports or equipment installed for other trades for conduit or cable support except with permission of other trade and approval of Contract Administrator.

- .12 Install fastenings and supports as required for each type of equipment cables and conduits, and in accordance with manufacturer's installation recommendations.

END OF SECTION

Part 1 General**1.1 RELATED SECTIONS**

- .1 Section 26 05 00 - Common Work Results - For Electrical.
- .2 Section 26 05 34 Conduits, Conduit Fastenings and Conduit Fittings

1.2 SUBMITTALS

- .1 Submit Shop Drawings and product data for cabinets in accordance with Section 26 05 00 - Common Work Results - For Electrical.

Part 2 Products**2.1 JUNCTION AND PULL BOXES**

- .1 Welded steel construction with screw-on flat covers for surface mounting.
- .2 Covers with 25 mm minimum extension all around, for flush-mounted pull and junction boxes.
- .3 Cast type with gasketed covers where exposed to moisture or weather or where specified.
- .4 NEMA 4X enclosure for all junction or pull boxes installed on the rooftop.

Part 3 Execution**3.1 JUNCTION, PULL BOXES, CABINETS AND ENCLOSURE INSTALLATION**

- .1 Install pull boxes in inconspicuous but accessible locations.
- .2 Mount cabinets with top not higher than 2 m above finished floor.
- .3 Install pull boxes so as not to exceed 30 m of conduit run between pull boxes.
- .4 Install junction and pull boxes clear of all mechanical ductwork and piping.

3.2 IDENTIFICATION

- .1 Provide equipment identification in accordance with Section 26 05 00 - Common Work Results - For Electrical.
- .2 Install size 2 identification labels indicating system name, voltage and phase.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

- .1 26 05 00 - Common Work Results - For Electrical
- .2 26 05 34 - Conduits, Conduit Fastenings, and Conduit Fittings

1.2 REFERENCES

- .1 CSA C22.1, Canadian Electrical Code, Part 1.

Part 2 Products

2.1 OUTLET AND CONDUIT BOXES GENERAL

- .1 Size boxes in accordance with CSA C22.1.
- .2 102 mm square or larger outlet boxes as required for special devices.
- .3 Gang boxes where wiring devices are grouped.
- .4 Blank cover plates for boxes without wiring devices.
- .5 Combination boxes with barriers where outlets for more than one system are grouped.
- .6 Sectional boxes shall not be used without specific approval of the Contract Administrator.
- .7 In moist or dusty areas, gasketed watertight or dust tight boxes and covers shall be provided.

2.2 SHEET STEEL OUTLET BOXES

- .1 Electro-galvanized steel single and multi gang flush device boxes for flush installation, minimum size 102 mm square outlet boxes with extension and plaster rings as required.
- .2 Electro-galvanized steel utility boxes for outlets connected to surface-mounted EMT conduit, minimum size 102 x 54 x 48 mm.

2.3 CONDUIT BOXES

- .1 Cast FS or FD feraloy boxes with factory-threaded hubs and mounting feet for surface wiring of switches and receptacle where exposed to moisture.

2.4 FITTINGS - GENERAL

- .1 Bushing and connectors with nylon insulated throats.
- .2 Knock-out fillers to prevent entry of debris.
- .3 Conduit outlet bodies for conduit up to 32 mm and pull boxes for larger conduits.

- .4 Double locknuts and insulated bushings on sheet metal boxes.

Part 3 Execution

3.1 INSTALLATION

- .1 Support boxes independently of connecting conduits.
- .2 Fill boxes with paper, sponges or foam or similar approved Material to prevent entry of debris during construction. Remove upon completion of Work.
- .3 Provide correct size of openings in boxes for conduit, and armoured cable connections. Reducing washers are not allowed.
- .4 Wires in outlet, junction and switch boxes, not having a connection within box shall not be spliced, but shall continue unbroken through the box.
- .5 Maintain continuity of vapor barrier where boxes are installed in exterior walls and ceilings. Use air/vapor barrier boxes for outlets installed in walls or ceilings with a vapor barrier.
- .6 Boxes to be mounted plumb and square with building lines.
- .7 Install pull boxes, or fittings, in conduit runs where more than four bends are necessary.
- .8 Install pull boxes where run exceeds 23m (75 feet) in length.
- .9 All junction, outlets and pull boxes shall be so installed that they are always readily accessible.
- .10 No power driven pins (Ramset) shall be utilized to secure boxes without specific approval from Contract Administrator.
- .11 All concealed junction boxes, conduit fittings, etc. to be c/w galv. steel covers, secured with two bolts.
- .12 Apply acoustic sealant to seal wires penetrating moulded vapour barrier boxes.
- .13 No more than two extension rings shall be used in sequence.
- .14 For installations in moist areas, dusty areas, etc., meet all requirements of authorities having jurisdiction.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

- .1 Section 26 05 00 - Common Work Results - For Electrical
- .2 Section 26 05 32 - Outlet Boxes, Conduit Boxes and Fittings.

1.2 REFERENCES

- .1 Canadian Standards Association (CSA)
 - .1 CAN/CSA C22.2 No. 18, Outlet Boxes, Conduit Boxes, and Fittings and Associated Hardware.
 - .2 CSA C22.2 No. 45, Rigid Metal Conduit.
 - .3 CSA C22.2 No. 56, Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit.
 - .4 CSA C22.2 No. 83, Electrical Metallic Tubing.
 - .5 CAN/CSA C22.2 No. 227.3, Flexible Nonmetallic Tubing.

Part 2 Products

2.1 CONDUITS

- .1 Rigid metal conduit: to CSA C22.2 No. 45, galvanized steel threaded.
- .2 Electrical metallic tubing (EMT): to CSA C22.2 No. 83, with couplings.
- .3 Flexible metal conduit: to CSA C22.2 No. 56, and liquid tight flexible metal conduit.
- .4 Minimum size of conduit shall be 19mm.

2.2 CONDUIT FASTENINGS

- .1 One hole steel straps to secure surface conduits 50 mm and smaller. Two hole steel straps for conduits larger than 50 mm.
- .2 Beam clamps to secure conduits to exposed steel Work.
- .3 Channel type supports for two or more conduits.
- .4 Threaded rods to support suspended channels, sized for the load.

2.3 CONDUIT FITTINGS

- .1 Fittings: manufactured for use with conduit specified. Coating: same as conduit.
- .2 Factory "ells" where 90° bends are required for 25 mm and larger conduits.
- .3 Steel set screw connectors and couplings. Insulated throat liners on connectors.

- .4 Raintight connectors and fittings c/w O-rings for use on weatherproof or sprinklerproof enclosures.
- .5 Raintight couplings to be used for surface conduit installations exposed to moisture or sprinkler heads.

2.4 EXPANSION FITTINGS FOR RIGID CONDUIT

- .1 Weatherproof expansion fittings with internal bonding assembly suitable for 200 mm linear expansion.
- .2 Watertight expansion fittings with integral bonding jumper suitable for linear expansion and 19 mm deflection in all directions.
- .3 Weatherproof expansion fittings for linear expansion at entry to panel.

2.5 FISH CORD

- .1 Polypropylene with 3m spare length at each conduit end.

Part 3 Execution

3.1 INSTALLATION

- .1 Drawings do not indicate all conduit runs. Those indicated are in diagrammatic form only.
- .2 Produce layout sketches of conduit runs through mechanical and electrical service areas in order to pre-avoid any conflict with other construction elements and to determine the most efficient route to run conduit.
- .3 Install conduits to conserve headroom in exposed locations and cause minimum interference in spaces through which they pass.
- .4 Use electrical metallic tubing (EMT) except where specified otherwise.
- .5 Use flexible metal conduit for connection to motors in dry areas, transformers and equipment subject to vibration or movement. Provide a separate insulated grounding conductor within flexible conduit.
- .6 Use liquid tight flexible metal conduit for connection to motors or vibrating equipment in damp, wet or corrosive locations.
- .7 Minimum conduit size for power circuits: 19 mm.
- .8 Bend conduit cold. Replace conduit if kinked or flattened more than 1/10th of its original diameter.
- .9 Mechanically bend steel conduit over 19 mm diameter.
- .10 Field threads on rigid conduit must be of sufficient length to draw conduits up tight.
- .11 Install fish cord in empty conduits.

- .12 Remove and replace blocked conduit sections. Do not use liquids to clean out conduits.
- .13 Dry conduits out before installing wire.
- .14 The conduit sizes as shown or indicated are the minimum acceptable and shall not be reduced without the approval of the Contract Administrator.
- .15 Conduit to be sized as per Canadian Electrical Code or as shown on Drawings and Specifications. Note that the sizes of branch circuit conductors scheduled and/or specified on the Drawings are minimum sizes and must be increased as required to suit length of run and voltage drop in accordance with Canadian Electrical Code. Where conductor sizes are increased to suit voltage drop requirements, increase the conduit size to suit.
- .16 Running threads will not be permitted; proper couplings shall be used.
- .17 Liquid tight flexible conduit runs shall not exceed 1.5m.
- .18 All conduit runs passing across expansion joints of the building shall be installed utilizing approved expansion fittings, and bonding devices.
- .19 Refer to 26 05 00 for identification requirements.
- .20 No power driven pins (Ramset) shall be utilized to secure any portion of the conduit.

3.2 SURFACE CONDUITS

- .1 Run parallel or perpendicular to building lines.
- .2 Locate conduits behind infrared or gas fired heaters with 1.5 m clearance.
- .3 Run conduits in flanged portion of structural steel.
- .4 Group conduits wherever possible.
- .5 Do not pass conduits through structural members except as indicated.
- .6 Do not locate conduits less than 75 mm parallel to steam or hot water lines with minimum of 25 mm at crossovers.

END OF SECTION

Part 1 General

1.1 RELATED WORK SPECIFIED ELSEWHERE

- .1 Section 26 05 00 – Common Work Results - For Electrical.
- .2 Section 26 28 21 – Moulded Case Circuit Breakers.

1.2 REFERENCES

- .1 ASTM - American Society of Testing Materials
- .2 CAN/CSA – C22.2, No. 31 – Switchgear Assemblies
- .3 CSA C22.2 No.0.4, Bonding and Grounding of Electrical Equipment (Protective Grounding).
- .4 CSA Standard C22.2 No. 29 - Panelboards and Enclosed Panelboards
- .5 CSA Standard C22.2 No. 5 - Molded Case Circuit Breakers
- .6 NEMA AB 1 - Molded Case Circuit Breakers
- .7 NEMA PB 1 - Panelboards
- .8 NEMA PB 1.1 - Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.

1.3 SUBMITTALS

- .1 Submit Shop Drawings and product data.
- .2 Indicate on Shop Drawings:
 - .1 Power ratings.
 - .2 Enclosure type.
 - .3 Single line diagrams.
 - .4 Breaker sizes, and kA ratings.
 - .5 Trip unit models and sizes.
 - .6 Trip unit range of each adjustable setting.
 - .7 Bus kA rating (bracing).
 - .8 System kA rating.
 - .9 Customer meter model (where applicable).
 - .10 Floor or wall anchoring method and foundation template.
 - .11 Dimensioned cable entry and exit locations.
 - .12 Dimensioned position and size of bus.
 - .13 Overall length, height and depth of complete distribution.
 - .14 Dimensioned layout of internal and front panel mounted components.
 - .15 Weight of each section.
- .3 Include time-current characteristic curves for breakers as required for the coordination study.

1.4 MAINTENANCE DATA

- .1 Provide maintenance data for incorporation into maintenance manuals.

1.5 STORAGE

- .1 Store distribution on Site in protected dry location. Cover with plastic to keep off dust.

1.6 APPROVED MANUFACTURERS

- .1 Eaton, and Schneider/Square D.
- .2 The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these Specifications in their entirety. Products in compliance with the Specification and manufactured by others not named will be considered only if pre-approved by the Contract Administrator ten (10) days prior to bid date.

Part 2 Products

2.1 RATING

- .1 Distribution shall be totally enclosed, dead front fabricated from formed and welded #12 gauge steel and front accessible only. Verify with plans for maximum overall dimensions. The distribution shall be CDP type, minimum 38" wide.
- .2 Distribution shall have door in door design. The distribution trim shall be hinged to the tub to allow full access to all buswork, wireways, breakers, etc. in the interior of the distribution. Bolted trim is not acceptable. A separate door in the trim shall allow access to the front of the breakers. Door over breakers to have lock. All locks to be keyed alike.
- .3 Main circuit breaker or switch, where indicated on the Drawings, shall be molded case type of size and type as shown on the Drawings. Circuit breaker or switch shall have the continuous ampere rating engraved into operating handle such that rating is clearly visible after installation of panel cover.
- .4 Feeder circuit breakers shall be moulded case of sizes and types as shown on the Drawings. Each circuit breaker shall have the continuous ampere rating engraved into breaker handle such that rating is clearly visible after installation of panel cover.
- .5 All breakers to be CDP type breakers using CDP type connector mounting hardware. Smaller frame breakers that require additional mounting means, additional panelboard interiors, etc. will not be allowed.
- .6 Breakers with 400A frames and smaller shall utilize twin breaker hardware mounting kits. Breakers shall be mounted double wide to save space.
- .7 Bus bars shall be tin plated copper braced to withstand a short circuit current as shown on Drawings. Bus bars shall extend the full length of each section. Neutral bus shall be full capacity. Copper ground bus shall be continuous and extend through main breakers or switch section and each feeder breaker section.

- .8 Distribution enclosure shall be treated to inhibit rusting and painted with a primer and two (2) coats of ASA61 grey enamel.
- .9 Enclosure shall be NEMA 1, protected from spray from sprinkler heads as outlined in Canadian Electrical Code.
- .10 Where exposed to weather minimum NEMA 4 shall be provided.
- .11 All breakers shall have individual lamacoid nameplates securely fastened with rivets on panel cover adjacent to respective breaker.
- .12 Interrupting capacity of main breaker or switch and feeder circuit breakers shall be RMS symmetrical at applied voltage and as follows:
 - .1 Up to 250V bus and breakers interrupting capacity (RMS Symmetrical) as shown on Drawings, 10 ka minimum when not shown.
 - .2 347/600V panelboards: bus and breakers interrupting capacity (RMS Symmetrical) as shown on Drawings, 14 ka minimum when not shown.
- .13 All devices must be fully rated. Series rated devices are not acceptable.
- .14 All current carrying components such as buswork, interconnecting components, etc. shall be copper. No aluminum components will be allowed.
- .15 All feeder terminations to be two hole long barrel copper compression lugs sized to the conductor. This includes phase, neutral and ground connection points. Multi ranging lugs and dieless crimpers are not to be used.
- .16 Double tub distributions are to be sub-feed type.
- .17 Distribution to have full height vertical bus.
- .18 Distribution shall have a metal frame welded to the inside of panel door, as large as possible but minimum (220 x 280mm) (9" x 11"), and shall be c/w typewritten index card and protective transparent cover. On shop Drawings, indicate proposed size of metal frame.

2.2 EQUIPMENT IDENTIFICATION

- .1 Provide equipment identification per Section 26 05 00.

Part 3 Execution

3.1 INSTALLATION

- .1 Locate distribution as indicated and mount securely, plumb, true and square, to adjoining surfaces.
- .2 Distribution shall be floor mounted on concrete housekeeping pads or mounted on wall. Provide strut channel between pad and enclosure bottom or between wall and back of enclosure.
- .3 Connect breakers in distribution to feeders.
- .4 Connect control and communication wiring (where applicable).

- .5 Check factory made connections for mechanical security and electrical continuity.
- .6 Program all trip units per coordination study.
- .7 Test all breakers after trip units are programmed.
- .8 Provide test report to Contract Administrator for review.
- .9 Incorporate test report in maintenance manuals.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

- .1 Section 26 05 00 - Common Work Results - For Electrical.
- .2 Section 26 05 21 - Wires and Cables.
- .3 Section 26 05 32 - Outlet Boxes, Conduit Boxes and Fittings.
- .4 Section 26 05 34 - Conduits, Conduit Fastenings and Conduit Fittings.
- .5 Section 26 28 23 - Disconnect Switches - Fused and Non-Fused up to 1000V.

1.2 REFERENCES

- .1 American National Standards Institute/Institute of Electrical and Electronics Engineers (ANSI/IEEE).
 - .1 ANSI/IEEE 837, Qualifying Permanent Connections Used in Substation Grounding.
- .2 Canadian Standards Association (CSA)
 - .1 CSA C22.2No.0.4, Bonding and Grounding of Electrical Equipment (Protective Grounding).

1.3 SYSTEM DESCRIPTION

- .1 Provide complete electrical power and control connections for mechanical equipment, except as noted herein.

1.4 COORDINATION

- .1 Review all mechanical Shop Drawings prior to submittal to the Contract Administrator. Resolve internal conflicts prior to submission.
- .2 Verify electrical supply characteristics of all equipment prior to rough-in. Report any discrepancies immediately. Revise wire sizing, device type, connection type, breaker size, etc., as required, to accommodate the electrical supply characteristics of the equipment supplied by other trades.

Part 2 Products

2.1 MATERIALS

- .1 Include motor starters, disconnects, conduit, wire, fittings, interlocks, outlet boxes, junction boxes, and all associated equipment required to provide power wiring for mechanical equipment, unless otherwise indicated.

- .2 Include pushbutton stations, motor protective switches, interlocks, conduit, wire, devices and fittings required to provide control wiring for mechanical equipment except for temperature/humidity control systems.
- .3 Unless otherwise noted, motors and control devices shall be supplied by Div. 25. Motor horsepower ratings shall be as shown in the Mechanical Specifications. Motor voltage and phase ratings shall be as shown on the Div. 26 Drawings or schedule.

2.2 EXTERIOR EQUIPMENT

- .1 All equipment mounted on the exterior of the building shall be weatherproof.

Part 3 Execution

3.1 POWER WIRING

- .1 Install power feeders, starters, disconnects and associated equipment and make connections to all mechanical equipment.
- .2 Install branch circuit wiring for mechanical systems control panels and control transformers.
- .3 Install main power feeders to starter/control panels furnished by Mechanical. Install branch circuit wiring for motors, electric coils, etc.

3.2 CONTROLS

- .1 Install all electrical controls except controls supplied under Mechanical, unless otherwise noted herein. Controls which have both electrical and mechanical connections shall be installed by the trade supplying the control.
- .2 Wire and connect remote thermostats, control panels, P/E switches, etc. for electric heaters and rooftop HVAC units.
- .3 Wire and connect float switches, pressure switches, alternators, alarms, etc. for booster pumps, jockey pumps and compressors.
- .4 Install, wire and connect controls which are an integral part of any packaged unit and are supplied by the trade supplying the packaged unit. Include wiring for controls for such items as roof-top air handling units, boilers, chillers, including all interlock wiring.
- .5 Division 25 shall supply and install all conduit, wire, devices and fittings required to wire and connect control systems specified. Control wiring shall be installed in conduit.
- .6 Wire and connect electrical interlocks for starters supplied by Div. 26.
- .7 Wire and connect thermistor control devices, built-in to large motors, to motor starters as per wiring diagrams provided by Div. 25.

3.3 COORDINATION

- .1 Refer to mechanical Drawings for the exact location of motor control devices, and other mechanical equipment requiring an electrical connection.
- .2 Obtain full information from Mechanical, regarding wiring, controls, overload heaters, equipment ratings and overcurrent protection. Notify the Div. 21, 22, 23, 25 Subcontractor, at once, if any information provided is incorrect or unsatisfactory.
- .3 Coordinate control wiring requirements and provide all control wiring and connections as required to make the control systems operate as specified.
- .4 Refer to Divisions 21, 22, 23 & 25 Specifications for any further electrical requirements.

3.4 SHOP DRAWING REVIEW

- .1 Review Mechanical equipment Shop Drawings and adjust breaker/feeder sizes as required.

END OF SECTION

Part 1 General

1.1 RELATED WORK SPECIFIED ELSEWHERE

- .1 Section 26 05 00 - Common Work Results - For Electrical.
- .2 Section 26 05 32 - Outlet Boxes, Conduit Boxes and Fittings.

1.2 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CSA-C22.2 No.42, General Use Receptacles, Attachment Plugs and Similar Devices.
 - .2 CSA-C22.2 No.111, General-Use Snap Switches (Bi-national standard, with UL 20, twelfth edition).

1.3 SUBMITTALS

- .1 Submit Shop Drawings and product data in accordance with Section 26 05 00 - Common Work Results - For Electrical.

Part 2 Products

2.1 SWITCHES

- .1 Toggle operated general purpose AC Switches 15A and 20A 120Vac single pole, double pole, as indicated, with the following features:
 - .1 Terminal holes approved for No. 10 AWG wire.
 - .2 Silver alloy contacts.
 - .3 Urea molding.
 - .4 Suitable for back and side wiring.
 - .5 Brown toggle for normal power.
 - .6 Up to 80% of rated capacity of motor loads.
- .2 Switches of one manufacturer throughout project.
- .3 Switches to be premium Specification grade.
- .4 Acceptable manufacturers:

<u>Manufacturer</u>	<u>120 Volt</u>	<u>347 Volt</u>
Hubbell	1200 Series	18200 Series
Bryant	4800 Series	6800 Series
Leviton	1200 Series	18200 Series
Pass & Seymour	AG-1 Series	3700 Series
Smith & Stone	4-4800 Series	1-3700 Series
Slater	710 Series	3400 Series

2.2 RECEPTACLES

- .1 Duplex receptacles, CSA type 5-15 R, 125 Vac, 15 A, U ground, with following features:
 - .1 Nylon face, brown or ivory for normal power, red for emergency power.
 - .2 Suitable for No. 10 AWG for back and side wiring.
 - .3 Break-off links for use as split receptacles.
 - .4 Double wipe contacts and rivetted grounding contacts.
- .2 Single receptacles CSA type 5-15 R, 125 VAC, 15 A, U ground with following features:
 - .1 Nylon face, brown or ivory for normal power, red for emergency power.
 - .2 Suitable for No. 10 AWG for back and side wiring.
- .3 Receptacles of one manufacturer throughout project.
- .4 Acceptable manufacturers: Hubbell, Arrow Hart, Bryant, Pass & Seymour, Slater. Catalogue No. 5262 for all manufacturers.
- .5 Acceptable manufacturers for ground fault receptacles shall be:
 - .1 Arrow Hart - GF 5242
 - .2 Bryant - GFR 52FT
 - .3 Hubbell - GF 5252
 - .4 Pass & Seymour - 1591-R

2.3 COVER PLATES

- .1 Cover plates from one manufacturer throughout project.
- .2 Sheet steel utility box cover for wiring devices installed in surface-mounted utility boxes.
- .3 Cast gasketed cover plates for wiring devices mounted in surface-mounted FS or FD type conduit boxes.
- .4 Weatherproof double lift spring-loaded cast aluminum cover plates, complete with gaskets for duplex receptacles as indicated.
- .5 Weatherproof spring-loaded cast aluminum cover plates complete with gaskets for single receptacles as indicated.
- .6 Receptacles of configurations 5-15R, 5-20R, 5-20RA, 6-15K, 6-20R and 6-20RA where exposed to weather, shall be provided with cover plates suitable for wet locations whether or not a plug is inserted into receptacle.
 - .1 Approved Manufacturers:
 - .1 Cooper WIU-1 (1 gang), WIU-2 (2 gang).
 - .2 Appleton WCDIU1 (1 gang), WCIU2 (2 gang).
 - .3 Hubbell RW57300 (1 gang), RW57750 (2 gang).
- .7 Where receptacles are installed facing downward, at an angle of 45° or less from horizontal, standard cover plates may be used.
- .8 Weatherproof cover for switch with gaskets as indicated.

Part 3 Execution

3.1 INSTALLATION

.1 Switches:

- .1 Install single throw switches with handle in "UP" position when switch closed.
- .2 Install switches in gang type outlet box when more than one switch is required in one location.
- .3 Mount toggle switches at height specified in Section 26 05 00 or as indicated.
- .4 Where pilot lights are required, or shown on the Drawings, install flush neon pilots in outlet box grouped with associated switch.
- .5 Study the drawings and co-operate with other trades so that the location and elevation of switch outlets shall not necessitate any unnecessary cutting of dados, fitments, etc. If this is not done, this Electrical Subcontractor will be required to move these outlets at no additional cost to the Contract. Properly locate all switches with reference to door swing, regardless of indicated position or door swing shown on electrical Drawings.
- .6 Switches shall be mounted 1.4m (4'-6") above finished floor on the strike side of the door.

.2 Receptacles:

- .1 Install receptacles in gang type outlet box when more than one receptacle is required in one location.
- .2 Mount receptacles horizontally at height specified in Section 26 05 00 or as indicated.
- .3 Horizontally mounted receptacles shall have the hot line terminal on the bottom.
- .4 Where switch and convenience outlets are shown close to one another, mount receptacles below and in line with the switch.
- .5 Suitably ground all receptacles with #12 green insulated wire to outlet box. Provide additional separate ground conductor to isolated ground receptacles.

.3 Coverplates:

- .1 Install suitable common cover plates where wiring devices are ganged.
- .2 Do not use cover plates intended for flush outlet boxes on surface-mounted boxes.
- .3 Provide a coverplate on each outlet.

3.2 IDENTIFICATION

- .1 Identify receptacles with size 1 nameplate indicating panel and circuit number. Nameplates to be mechanically fastened. Refer to Section 26 05 00.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

- .1 Section 26 05 00 - Common Work Results - For Electrical.

1.2 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CAN/CSA-C22.2 No.144, Ground Fault Circuit Interrupters.
- .2 National Electrical Manufacturers Association (NEMA)
 - .1 NEMA PG 2.2, Application Guide for Ground Fault Protection Devices for Equipment.

1.3 SUBMITTALS

- .1 Submit product data and Shop Drawings in accordance with Section 26 05 00 - Common Work Results - For Electrical.
- .2 Submit test report for field testing of ground fault equipment to Contract Administrator and a certificate that system as installed meets criteria specified herein.

Part 2 Products

2.1 MATERIALS

- .1 Equipment and components for ground fault circuit interrupters (GFCI): to CAN/CSA-C22.2 No.144 NEMA PG 2.2.
- .2 Components comprising ground fault protective system to be of same manufacturer.

2.2 BREAKER TYPE GROUND FAULT INTERRUPTER

- .1 Single pole ground fault circuit interrupter for 15 A, and 20 A, 120 V, 1 phase circuit c/w test and reset facilities.

2.3 GROUND FAULT PROTECTOR UNIT

- .1 Self-contained with 15 A, 120 V circuit interrupter and duplex single receptacle complete with:
 - .1 Solid state ground sensing device.
 - .2 Facility for testing and reset.
 - .3 CSA Enclosure 1, surface flush mounted with stainless steel painted face plate.

Part 3 Execution

3.1 INSTALLATION

- .1 Do not ground neutral on load side of ground fault relay.
- .2 Pass phase conductors including neutral through zero sequence transformers.
- .3 Connect supply and load wiring to equipment in accordance with manufacturer's recommendations.

3.2 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results - For Electrical.
- .2 Arrange for field testing of ground fault equipment by Contractor before commissioning service.
- .3 Demonstrate simulated ground fault tests.
- .4 Submit report of tests to Contract Administrator and a certificate that system as installed meets criteria specified herein. Include copies of report in maintenance manuals.

END OF SECTION

Part 1 General

1.1 RELATED WORK SPECIFIED ELSEWHERE

- .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 26 24 16 CDP Type Distribution (Up to 1200A).

1.2 REFERENCES

- .1 Canadian Standards Association (CSA International).
 - .1 CSA-C22.2 No. 5-02, Moulded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures (Tri-national standard with UL 489, tenth edition, and the second edition of NMX-J-266-ANCE).

1.3 SUBMITTALS

- .1 Submit product data & Shop Drawings in accordance with Section 26 05 00 - Common Work Results - For Electrical.
- .2 Include time-current characteristic curves for breakers with ampacity of 100 A and over.

Part 2 Products

2.1 BREAKERS GENERAL

- .1 Moulded-case circuit breakers, Circuit breakers, and Ground-fault circuit-interrupters: to CSA C22.2 No. 5
- .2 Bolt-on moulded case circuit breaker: quick- make, quick-break type, for manual and automatic operation with temperature compensation for 40 degrees C ambient.
- .3 Common-trip breakers: with single handle for multi-pole applications.
- .4 Magnetic instantaneous trip elements in circuit breakers to operate only when value of current reaches setting.
 - .1 Trip settings on breakers with adjustable trips to range from 5-10 times current rating.
- .5 Circuit breakers with interchangeable trips as indicated.
- .6 All devices must be fully rated. Series rated devices are not acceptable.
- .7 Interrupting ratings (RMS symmetrical) to match bus interrupting ratings shown on Drawings.
- .8 When interrupting ratings are not shown on Drawings shall be as follows:
 - .1 Up to 250 Volts - 10,000 Amps
 - .2 347/600 Volts - 14,000 Amps

- .9 Maximum breaker sizes, except for motors:

- .1 20A for #12 copper conductor.
- .2 30A for #10 copper conductor.

2.2 THERMAL MAGNETIC BREAKERS DESIGN

- .1 Moulded case circuit breaker to operate automatically by means of thermal and magnetic tripping devices to provide inverse time current tripping and instantaneous tripping for short circuit protection.

2.3 MAGNETIC BREAKERS DESIGN

- .1 Moulded case circuit breaker to operate automatically by means of magnetic tripping devices to provide instantaneous tripping for short circuit protection.

2.4 SOLID STATE TRIP BREAKERS (LSI)

- .1 Moulded case circuit breaker to operate by means of a solid-state trip unit with associated current monitors and self-powered shunt trip to provide inverse time current trip under overload condition, and long time, short time, instantaneous and ground fault tripping.
 - .1 Each breaker shall have the following independent and fully adjustable curve shaping characteristics:
 - .1 Adjustable long time pickup
 - .2 Adjustable long time delay
 - .3 Adjustable short time pickup
 - .4 Adjustable short time delay with selective curve shaping
 - .5 Adjustable instantaneous pickup with instantaneous OFF function
 - .6 Adjustable ground fault pickup (where shown on Drawings)
 - .7 Adjustable ground fault delay with selective curve shaping (where shown on Drawings)
 - .2 Breakers feeding transformers 45 kVA and larger shall have solid state trips, fully and independently adjustable LSI settings.
 - .1 The range of the instantaneous settings shall be suitable for coordination with the inrush current of the protected transformer. The band of the instantaneous portion of the breaker time-current curve must clear the transformer inrush current at value which is 12 times the transformer full load current.

2.5 MANUFACTURERS

- .1 Acceptable manufacturers: Eaton, Schneider/Square D.

2.6 REQUIRED FEATURES

- .1 Include:
 - .1 Shunt trip.
 - .2 Auxiliary switch.
 - .3 Motor-operated mechanism c/w time delay unit.
 - .4 Under-voltage release.
 - .5 On-off locking device.
 - .6 Handle mechanism.

- .2 Enclosure shall be NEMA 1, protected from spray from sprinkler heads as outlined in Canadian Electrical Code.
- .3 Where exposed to weather minimum NEMA 4 shall be provided.

Part 3 Execution

3.1 INSTALLATION

- .1 Install circuit breakers as indicated.
- .2 Program/adjust programmable/adjustable breakers
- .3 Test breakers as follows:
 - .1 Breakers in CDP's.
 - .2 Breakers in MCC's.
 - .3 Programmable/adjustable breakers.
 - .4 Refer to Specification Section 26 05 00 for details on testing.

END OF SECTION

Part 1 General

1.1 RELATED WORK SPECIFIED ELSEWHERE

- .1 Section 26 05 00 - Common Work Results - For Electrical

1.2 SUBMITTALS

- .1 Submit product data in accordance with Section 26 05 00 - Common Work Results - For Electrical.

1.3 REFERENCES

- .1 Canadian Standards Association (CSA International).
 - .1 CAN/CSA C22.2 No.4, Enclosed Switches.
 - .2 CSA C22.2 No.39, Fuseholder Assemblies.

Part 2 Products

2.1 DISCONNECT SWITCHES

- .1 Fusible and non-fusible disconnect switch in CSA Enclosure and size as indicated.
- .2 Enclosure shall be NEMA 1 protected from spray from sprinkler heads as outlined in Canadian Electrical Code.
- .3 Where exposed to weather minimum NEMA 4 shall be provided.
- .4 Metal enclosure with provision for padlocking in on-off switch position by three locks.
- .5 Mechanically interlocked door to prevent opening when handle in ON position.
- .6 Quick-make, quick-break action, heavy duty industrial grade.
- .7 ON-OFF switch position indication on switch enclosure cover.
- .8 Disconnect switches located at motors connected to variable frequency drives are to be provided with one Form 'C' electrical contact to interlock from the disconnect to the VFD. The interlock is to operate prior to the main power contacts opening to the motor.

2.2 EQUIPMENT IDENTIFICATION

- .1 Provide equipment identification in accordance with Section 26 05 00 - Common Work Result - For Electrical.
- .2 Indicate name of load controlled and voltage on size 6 nameplate.

2.3 APPROVED MANUFACTURERS

- .1 Schneider Electric.

- .2 Eaton.

Part 3 Execution

3.1 INSTALLATION

- .1 Install disconnect switches complete with fuses as indicated.
- .2 Install additional brackets, supports, etc. required for mounting the disconnect switches.
- .3 Provide conduit and wire to interlock between VFD and motor disconnect to power down VFD when motor disconnect is operated.

END OF SECTION

Heat Recovery Units

AIR HANDLING UNIT No.	HRU-5			
SERVICE AREA	North Section of Bus Storage Track 1-12			
MANUFACTURER	Tempeff			
MODEL	RG 33000			
SUPPLY FAN - SIZE/TYPE	ATZAF 32-32			
AIRFLOW RATE (cfm) (l/s)	23800		11232	
TOTAL STATIC REQUIRED (in.H ₂ O) (Pa)	2.91		727.50	
EXTERNAL STATIC REQUIRED (in.H ₂ O) (Pa)	1.50		375.00	
MOTOR (Bhp/Hp) (bkW/kW)	15.50	20.00	11.56	14.91
SPEED (rpm)	1770			
EXHAUST FAN - SIZE/TYPE	ATZAF 32-32			
AIRFLOW RATE (cfm) (l/s)	23800		11232	
TOTAL STATIC REQUIRED (in.H ₂ O) (Pa)	1.60		400.00	
EXTERNAL STATIC REQUIRED (in.H ₂ O) (Pa)	1.00		250.00	
MOTOR (Bhp/Hp) (bkW/kW)	10.65	15.00	7.94	11.19
SPEED (rpm)	1775			
SUPPLY FILTER TYPE	Merv-10			
EXHAUST FILTER TYPE	None			
HEAT RECOVERY SECTION				
AIRFLOW (cfm) (l/s)	23800		11232	
SUMMER ENERGY RECOVERY (MBH) (kW)	293.60		86.0	
SUMMER RECOVERY FACTOR (%)	77.20			
SUMMER SUPPLY AIR TEMP. AFTER UNIT (°F) (°C)	78.40		25.78	
WINTER ENERGY RECOVERY (MBH) (kW)	2227.73		652.9	
WINTER RECOVERY FACTOR (%)	87.80			
WINTER SUPPLY AIR TEMP. AFTER UNIT (°F) (°C)	57.81		14.34	
HEATING COIL				
SIZE, h x l (in) (mm)	82.5	68	2096	1727
QUANTITY OF COILS	1			
MEDIUM	55% Ethylene Glycol			
ENTERING FLUID TEMP (°F) (°C)	170.0		76.7	
LEAVING FLUID TEMP. (°F) (°C)	130.0		54.4	
ENTERING AIR TEMP (°F) (°C)	58.0		14.4	
LEAVING AIR TEMP (°F) (°C)	90.0		32.2	
UNIT TOTAL LENGTH (in.) (mm)	304.3		7728	
UNIT TOTAL WIDTH (in.) (mm)	237.9		6042	
UNIT TOTAL HEIGHT (in.) (mm)	92.0		2337	
UNIT WEIGHT (lbs) (kg)	18271		8288	



Heat Recovery Unit Schedule

Project:

Transit Storage Track 1-12
Ventilation Upgrade

File:

16-149-02

Designer:

JTRH

Date:

Aug-17

Sheet:

MS-1a

Heat Recovery Units

AIR HANDLING UNIT No.	HRU-6			
SERVICE AREA	South Section of Bus Storage Track 1-12			
MANUFACTURER	Tempeff			
MODEL	RG 33000			
SUPPLY FAN - SIZE/TYPE	ATZAF 32-32			
AIRFLOW RATE (cfm) (l/s)	23120		10911	
TOTAL STATIC REQUIRED (in.H ₂ O) (Pa)	2.91		727.50	
EXTERNAL STATIC REQUIRED (in.H ₂ O) (Pa)	1.50		375.00	
MOTOR (Bhp/Hp) (bkW/kW)	15.50	20.00	11.56	14.91
SPEED (rpm)	1770			
EXHAUST FAN - SIZE/TYPE	ATZAF 32-32			
AIRFLOW RATE (cfm) (l/s)	23120		10911	
TOTAL STATIC REQUIRED (in.H ₂ O) (Pa)	1.60		400.00	
EXTERNAL STATIC REQUIRED (in.H ₂ O) (Pa)	1.00		250.00	
MOTOR (Bhp/Hp) (bkW/kW)	10.65	15.00	7.94	11.19
SPEED (rpm)	1775			
SUPPLY FILTER TYPE	Merv-10			
EXHAUST FILTER TYPE	None			
HEAT RECOVERY SECTION				
AIRFLOW (cfm) (l/s)	23120		10911	
SUMMER ENERGY RECOVERY (MBH) (kW)	293.60		86.0	
SUMMER RECOVERY FACTOR (%)	77.20			
SUMMER SUPPLY AIR TEMP. AFTER UNIT (°F) (°C)	78.40		25.78	
WINTER ENERGY RECOVERY (MBH) (kW)	2227.73		652.9	
WINTER RECOVERY FACTOR (%)	87.80			
WINTER SUPPLY AIR TEMP. AFTER UNIT (°F) (°C)	57.81		14.34	
HEATING COIL				
SIZE, h x l (in) (mm)	82.5	68	2096	1727
QUANTITY OF COILS	1			
MEDIUM	55% Ethylene Glycol			
ENTERING FLUID TEMP (°F) (°C)	170.0		76.7	
LEAVING FLUID TEMP. (°F) (°C)	130.0		54.4	
ENTERING AIR TEMP (°F) (°C)	58.0		14.4	
LEAVING AIR TEMP (°F) (°C)	90.0		32.2	
UNIT TOTAL LENGTH (in.) (mm)	304.3		7728	
UNIT TOTAL WIDTH (in.) (mm)	237.9		6042	
UNIT TOTAL HEIGHT (in.) (mm)	92.0		2337	
UNIT WEIGHT (lbs) (kg)	18271		8288	



Heat Recovery Unit Schedule

Project:

Transit Storage Track 1-12
Ventilation Upgrade

File:

16-149-02

Designer:

JTRH

Date:

Aug-17

Sheet:

MS-1b

Grilles, Registers and Diffusers

[illegible]


Grille, Register and Diffuser Schedule

Project: **City of Winnipeg Fort Rouge Transit
Storage Track 1-12 Ventilation Upgrade**

File: 16-149-02 Designer: JTRH
Date: Aug-17 Sheet: **MS-2**

<u>Pumps</u>								
NO.	SERVICE	LOCATION	MODEL / SIZE	CAP. (gpm) (l/s)	HEAD (ft) (m)	MTR. (HP) (kW)	SPD. (rpm)	REMARKS
P-5	Glycol Heating Secondary Loop	Mech Room	Armstrong 4300 0206-010.0	170 10.71	100 30.49	10 7.46	3076	IVS Sensorless Duty / Standby (w/ P-6) FTV-3FA Angle Flo-trex SG-32 Suction Guide
P-6	Glycol Heating Secondary Loop	Mech Room	Armstrong 4300 0206-010.0	170 10.71	100 30.49	10 7.46	3076	IVS Sensorless Duty / Standby (w/ P-5) FTV-3FA Angle Flo-trex SG-32 Suction Guide

Fluid: 55% Ethylene Glycol



SMS
ENGINEERING

Pump Schedule

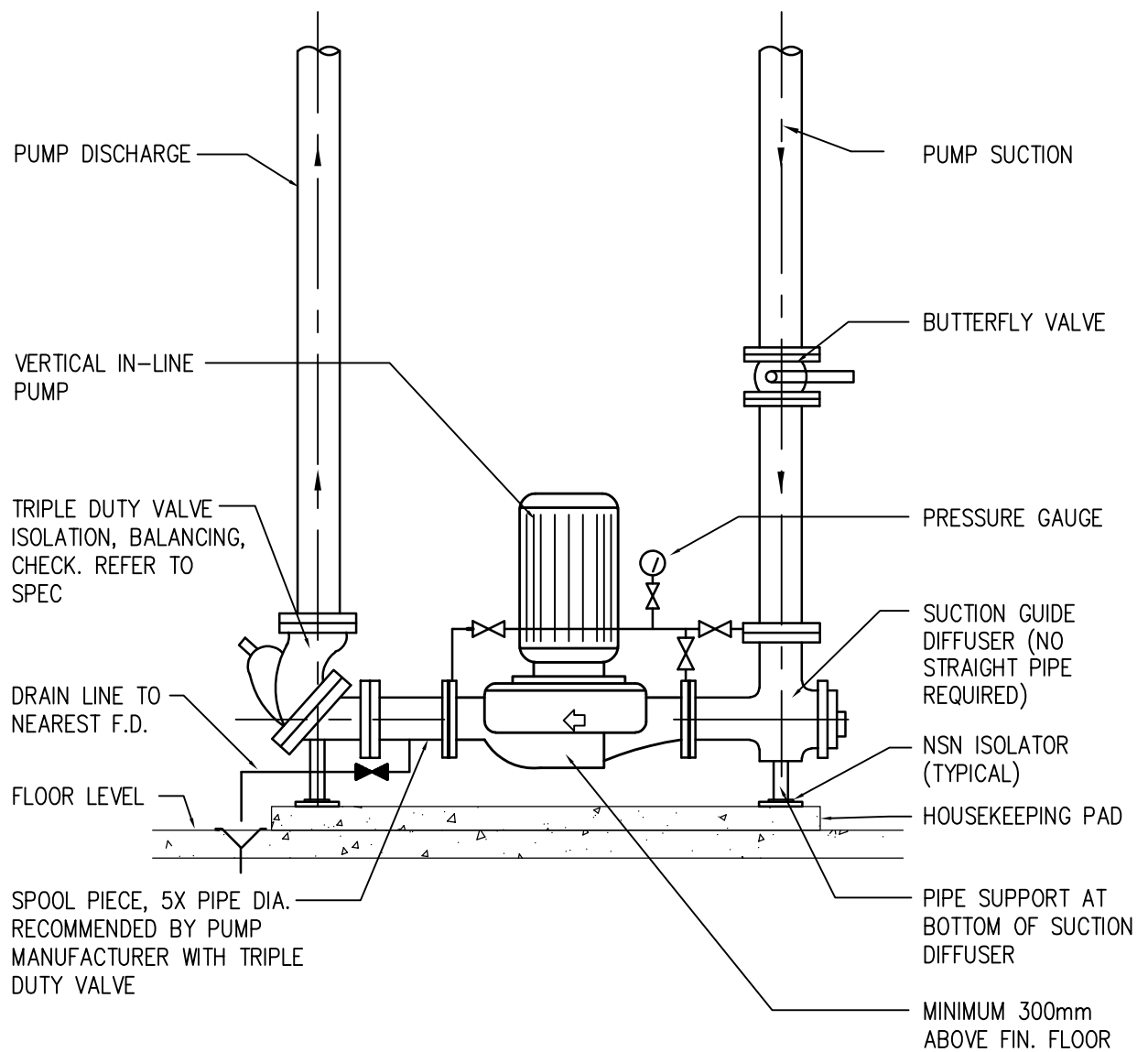
Project: **City of Winnipeg Fort Rouge Transit**
Storage Track 1-12 Ventilation Upgrade

File: 16-149-02 Designer: JTRH
 Date: Aug-17 Sheet: **MS-3**

MECHANICAL EQUIPMENT SCHEDULE



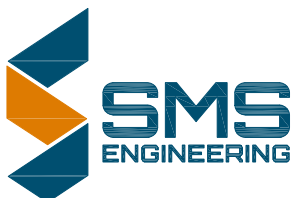
MOTOR/ EQUIP ID	NAME	LOCATION	H.P. (kW)	VOLTS	STARTER & ACC.				SOURCE	STARTER LOCATION	FEEDER	REMARKS
					MAN	MAG	PL	HOA				
HRV-5	HEAT RECOVERY VENTILATOR	ROOF G.L. 54-55/Q-R	37.7FLA 43MCA 70MOP	600V 3PH					CDP RS	PACKAGED UNIT	3#4	
HRV-6	HEAT RECOVERY VENTILATOR	ROOF G.L. 54-55/U-V	37.7FLA 43MCA 70MOP	600V 3PH					CDP RS	PACKAGED UNIT	3#4	
P-5	PUMP	MECHANICAL RM 004	10HP	600V 3PH					CDP MDP2-A	PACKAGED UNIT (VFD)	3#12	VFD included with pump.
P-6	PUMP	MECHANICAL RM 004	10HP	600V 3PH					CDP MDP2-A	PACKAGED UNIT (VFD)	3#12	VFD included with pump.



VERTICAL IN-LINE PUMP INSTALLATION

N.T.S.

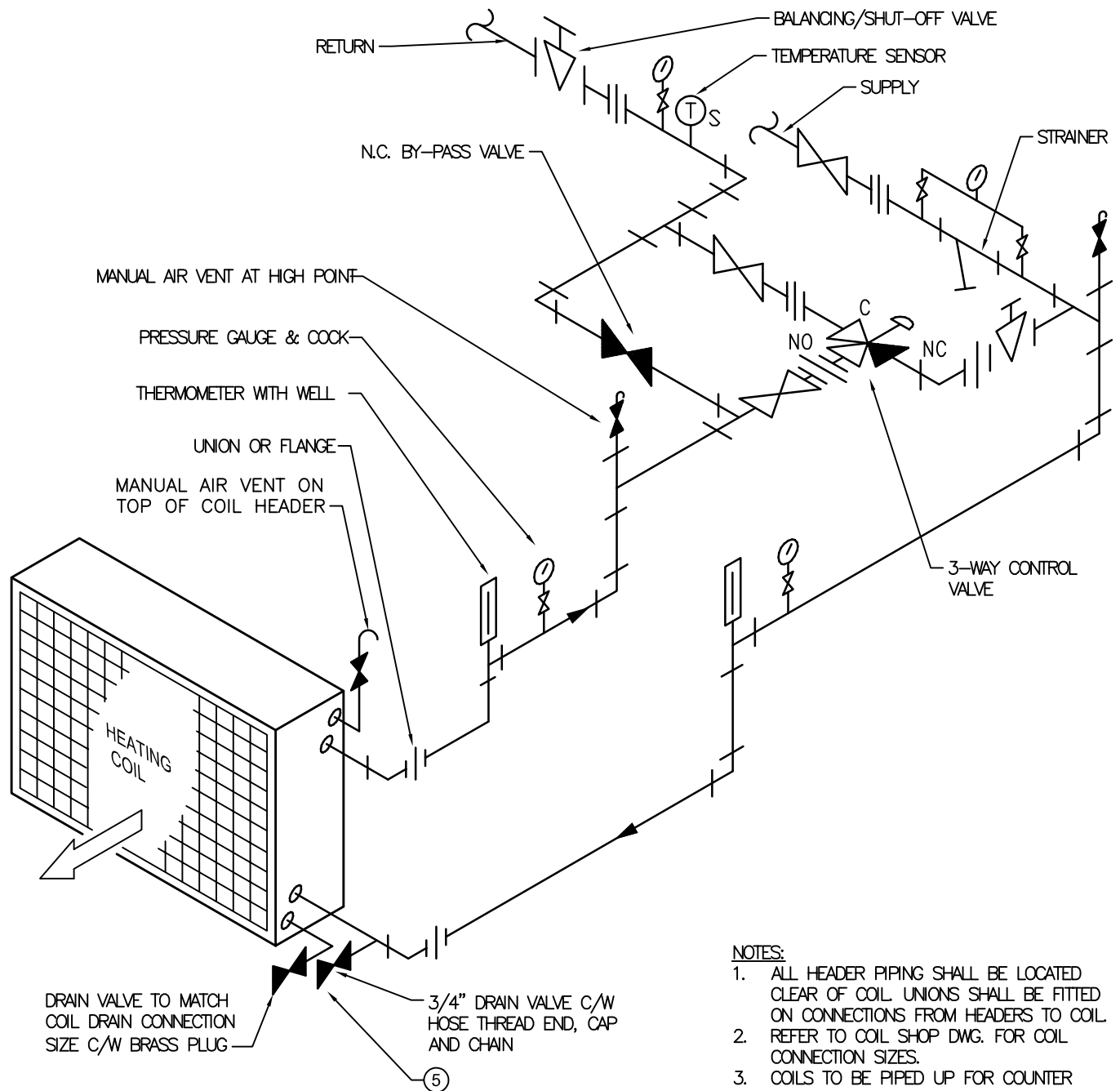
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STORAGE TRACK 1-12
VENTILATION UPGRADE

VERTICAL IN-LINE PUMP DETAIL FLOOR SUPPORT

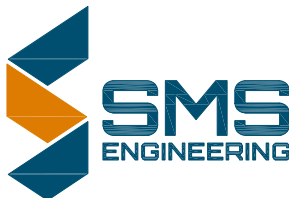
Drawn By SMS	Approved By SMS	Reference 6072
File No. 16-149-01	Date NOV. 2016	Detail Sheet MD-1



NOTES:

1. ALL HEADER PIPING SHALL BE LOCATED CLEAR OF COIL. UNIONS SHALL BE FITTED ON CONNECTIONS FROM HEADERS TO COIL.
2. REFER TO COIL SHOP DWG. FOR COIL CONNECTION SIZES.
3. COILS TO BE PIPED UP FOR COUNTER FLOW OPERATION.
4. GRADE TUBES UP 20mm/METRE OF COIL LENGTH TOWARDS THE RETURN FOR POSITIVE VENTING.
5. NOT REQUIRED IF COIL DRAIN CONNECTION IS $\frac{3}{4}$ " OR LARGER. IN THIS CASE COIL DRAIN VALVE SHALL BE C/W HOSE THREAD END, CAP AND CHAIN.

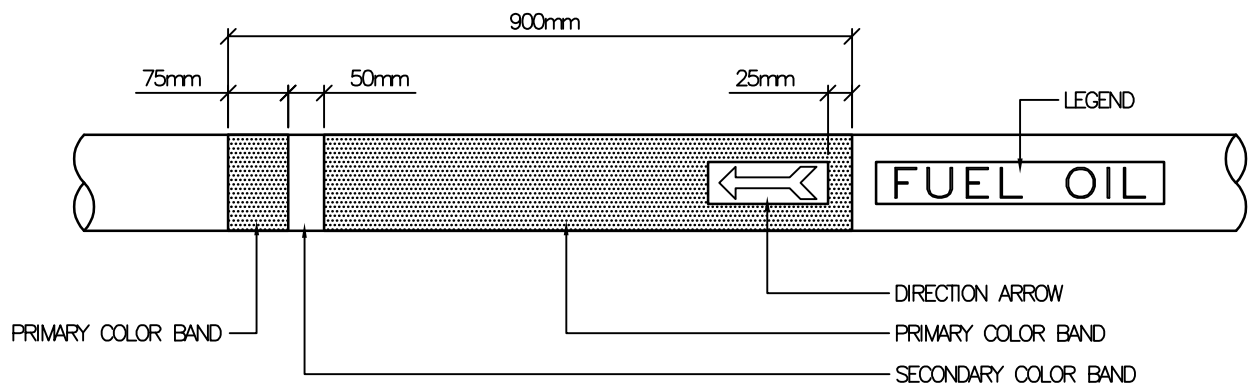
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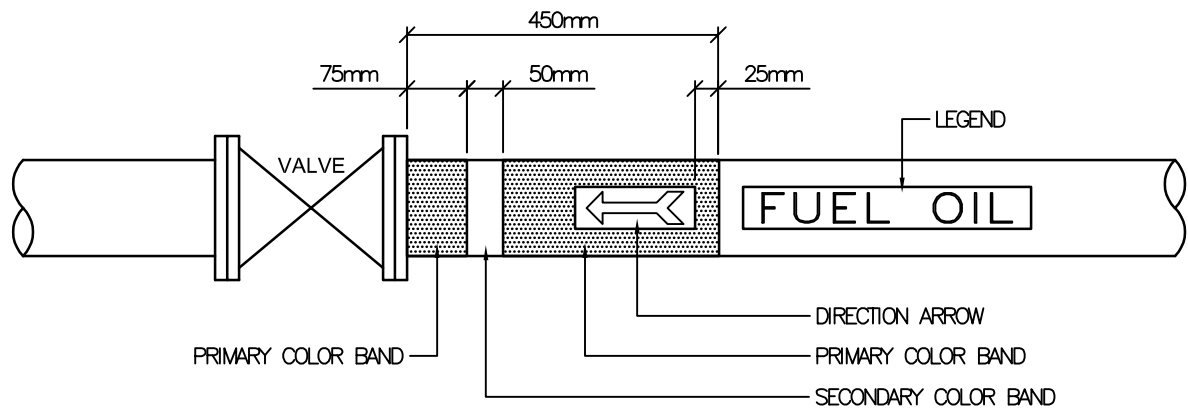
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VENTILATION UPGRADE

**GLYCOL HTG. COIL
SINGLE BANK, 3-WAY CONTROL**

Drawn By SMS	Approved By SMS	Reference 6079
File No. 16-149-01	Date NOV. 2016	Detail Sheet MD-2

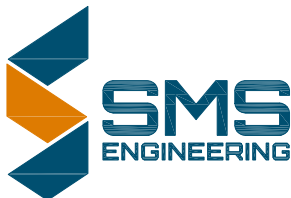


STRAIGHT PIPE RUNS



AT VALVES AND FITTINGS

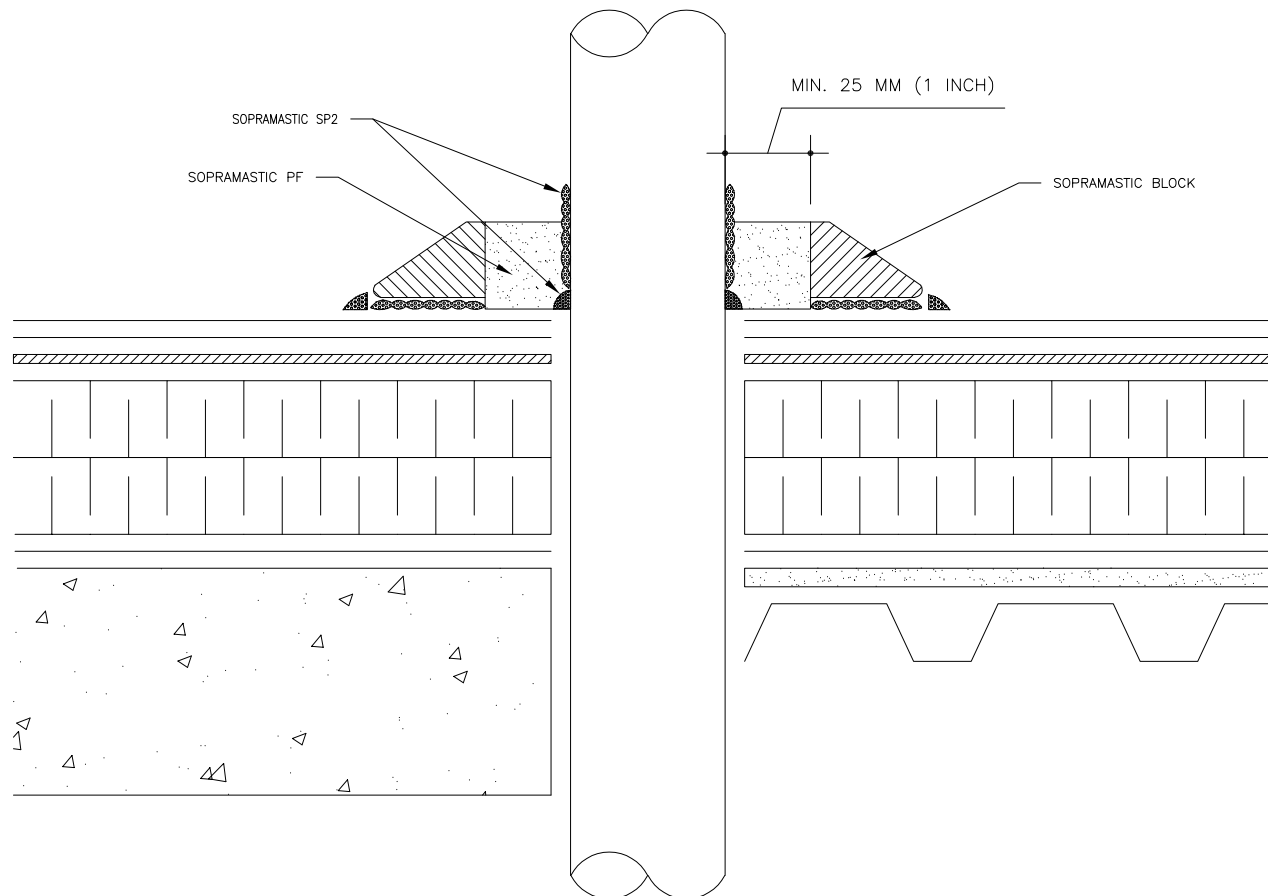
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STORAGE TRACK 1-12
VENTILATION UPGRADE

IDENTIFICATION OF PIPING SYSTEMS

Drawn By SMS	Approved By SMS	Reference 0051
File No. 16-149-01	Date NOV. 2016	Detail Sheet MD-3

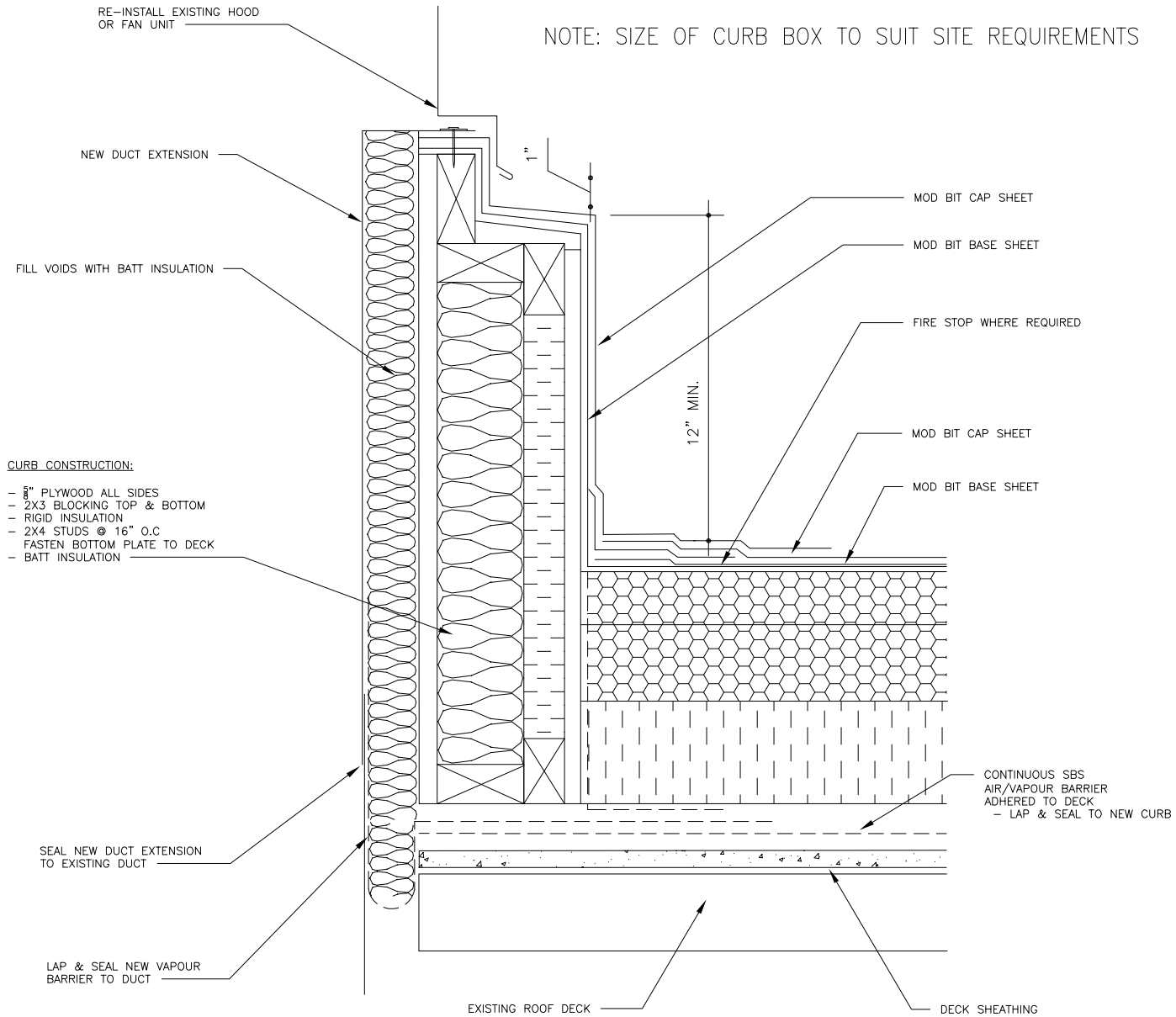


GENERAL NOTES:

1. SOPRAMASTIC SP2 MUST EXCEED 25 MM (1 INCH) OVER SOPRAMASTIC BLOCK.
2. THE DISTANCE BETWEEN THE BLOCK INNER WALL AND THE PENETRATIONS MUST HAVE AT LEAST 25 MM (1 INCH).

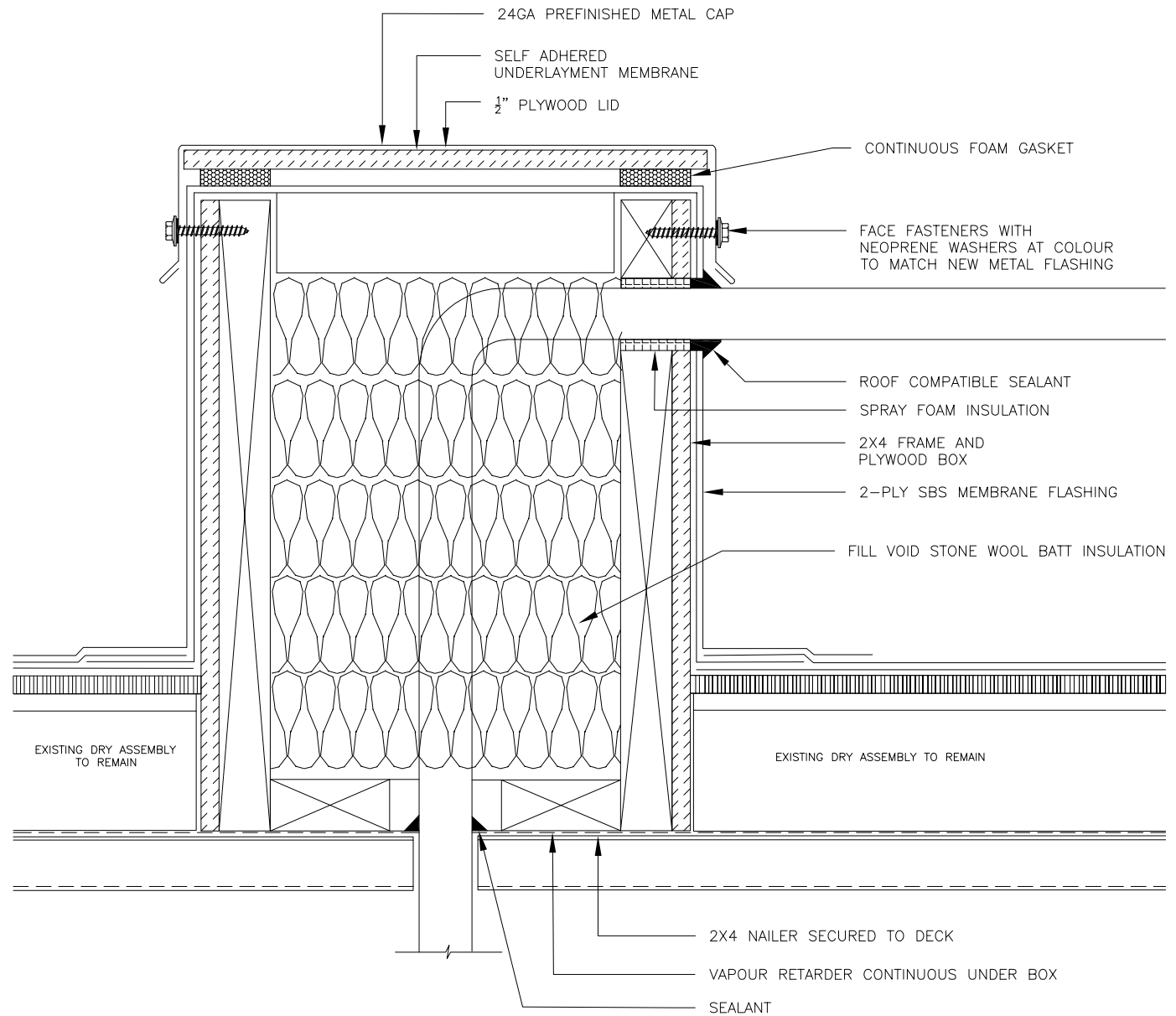
**QCA BUILDING
ENVELOPE LTD.**

DRAWING:	SOPRAMASTIC BLOCK SYSTEM (HZ.)
CLIENT:	XXX-XXXX
PROJECT:	1005-2016
SCALE:	N.T.S
SHEET NO:	RD-1



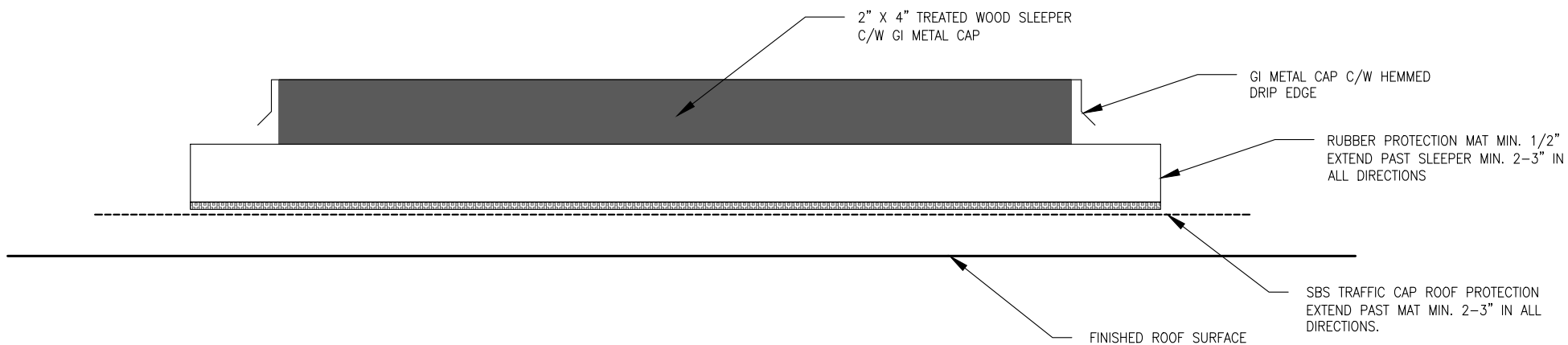
**QCA BUILDING
ENVELOPE LTD.**

DRAWING:	ROOF CURB @ DUCT DETAIL
CLIENT:	XXX-XXXX
PROJECT:	1005-2016
SCALE:	N.T.S
SHEET NO:	RD-2



**QCA BUILDING
ENVELOPE LTD.**

DRAWING:	CONDUIT BOX DETAIL
CLIENT:	xxx-xxxx
PROJECT:	1005-2016
SCALE:	N.T.S
SHEET NO:	RD-3



TYPICAL SLEEPER SUPPORT DETAIL

QCA BUILDING
ENVELOPE LTD.

PROJECT NAME:	PROVISION OF ROOF REPLACEMENT
CLIENT:	1005-2016
eFile:	1005-2016_Drawing_RD-4
SCALE:	N.T.S.
SHEET NO:	RD-4