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 job Site meeting for the purpose of laying out and phasing the Work as required.

1.2 BUILDING PERMIT

.1 The Building Permit application will be made prior to the award of the Contract. The Building Permit application will be transferred to the Contractor upon award of the Contract who will be responsible for coordinating, following up, etc. on the permit. The costs of the Building permit will be paid by The City and the costs shall not be included in the bid price. Contractor shall be responsible for applying for and paying for all other required permits.

1.3 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.

1.4 LAYOUT OF WORK

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

1.5 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.

1.6 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.

1.7 SECURITY

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

1.8 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 Contractor and its 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 Fire Watch:

.1 Follow Winnipeg Transit Fire Watch Procedure.

.4 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.

.5 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.

.6 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.

.7 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.

1.9 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.

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 Storage space is to be determined in construction meeting.

1.6 PARKING

.1 A Contractor parking area is available in the facilities.

END OF SECTION

Part 1 General

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 Operations shall remain during construction as much as possible. Coordinate the shut down of areas with The City on Site.

.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 job Site.

.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

Part 1 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 MAINTENANCE & REPAIR BUILDING

.1 The bidders may use any Roofing Subcontractor that meets the requirements of the Bid Opportunity and this specficiation. There is no warranty remaining on the existing roof.

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 Contract Administrator 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 or approved in accordance with B7.

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: SOPRAFLASH STICK by SOPREMA or approved in accordance with B7.

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 Type II EPS designed to create a min 2 percent (%) slope to the roof system.

.5 Specified product : PlastifabType II EPS or approved in accordance with B7

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	No cracking	
.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	No cracking	
.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 (%)	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	No cracking	
.9	Lap joint strength (kN/m)	Pass > 4 kN/m	

.14 Specified Product: SOPRAPLY TRAFFIC CAP by SOPREMA or approved in accordance with B7

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	No cracking	
.9	Lap joint strength (kN/m)	Pass > 4 kN/m	

.18 Specified Product: SOPRAPLY TRAFFIC CAP by SOPREMA or approved in accordance with B7

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	No cracking	
.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 RUBBER MAT BETWEEN ROOF DECK AND HRU PLATFORM STAIR STRINGER

.1 Provide Sooner Groove rubber mat between roof deck and HRU platform stair stringer available locally at Roof Mart. Protective Traffic cap required under rubber mat and primary roof membrane.

2.13 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

2.14 ROOF PROTECTION PLAN

.1 Roof protection plans shall be submitted by all Contractors Working on or near roof.

Part 3 Execution

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 45º 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 selvedges 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-selvedge 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 selvedge with the edge of the roof.

.3 Cut off corners at end laps at areas to be covered by the next roll.

.4 Each selvedge 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 selvedge 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.

3.22 ROOF PROTECTION PLAN

.1 Refer to Appendix B.

- 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 Equipment, Materials and Products - Mechanical.
.2 Section 21 08 10 – Insulation.
.3 Section 22 40 10 – Plumbing.
.4 Section 22 50 10 – Fire Protection.
.5 Section 23 80 10 – Air Distribution.
.6 Section 23 90 10 – Testing, Adjusting and Balancing.
.7 Section 25 10 10 – Controls - General Requirements.
.8 Section 25 20 10 – Controls - Hardware, Software and Devices.
.9 Section 25 30 10 – Controls - Sequences of Operation.

.2 All Mechanical Work to be bid as a single complete Subcontractor even though Work of various mechanical Contractors has been further sub-divided into each Section noted above.

1.3 EXISTING CONDITIONS

.1 Examine Site, existing adjacent buildings and local conditions affecting Work under this Contract. Examine Structural, Architectural, 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 has been brought to Contract Administrator's attention, in writing, prior to closing of Bid Opportunity in accordance with B4.

1.4 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.

1.5 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.

1.6 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 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.

1.7 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".

1.8 MECHANICAL SHOP DRAWINGS

.1 Submit for review PDF (Electronic Copy) of detailed Shop Drawings.

.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.

.7 Allow a minimum of ten (10) working days for Contract Administrator’s review of each submission.

1.9 MECHANICAL SUBCONTRACTOR

.1 Refer to Bid Opportunity – Subcontractor list.

1.10 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. In general, Work on the new areas to be performed during normal hours. Work in remainder of building to be scheduled so as to provide minimum of inconvenience to The City. i.e. Perform Work either where areas are vacated during night period or at periods when it is permissible to Work in the existing areas to be approved by The City. Suitable periods for shutting off mechanical services to be arranged with The City's appointed representative. Perform Work requiring shutdown of air systems during night period or on weekends.

.2 Refer to clause D2, Scope of Work, in Supplemental Conditions which is part of front-end Specification.

1.11 DRAWINGS

.1 Drawings are diagrammatic only and do not show all details. Information involving accurate measurements of building to be taken from Architectural Drawings and/or at building. 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" or future extension to buildings, to be left clear as noted on Drawings so that future connections can be made.

1.12 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 aubcontractors 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 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.

1.13 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.

1.14 MISCELLANEOUS APPARATUS AND APPLIANCES

.1 Make all required mechanical connections (direct or indirect) to devices, equipment, and appliances furnished by other trades or The City, as indicated or implied on the Drawings or in the Specifications.

.2 Verify mechanical connection requirements of all equipment prior to rough-in. Report any discrepancies to Contract Administrator immediately. Revise pipe/duct size, and configurations as required to accommodate the mechanical service characteristics of the equipment supplied by other trades or The City.

.3 Provide all required mechanical fittings, connections, and components to ensure proper and complete installation.

.4 Install all devices and components shipped loose with equipment/appliances for field installation.

.5 Coordinate with supplier, installer, other trade, and/or The City to ensure a proper and complete installation.

1.15 ELECTRIC MOTORS, STARTERS AND WIRING

.1 Provide electric motors for all equipment supplied in this Division. Motors to operate at 29 r/S (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) or equivalent;
- .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, or equivalent].

.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 All motors shall be high efficiency type with minimum efficiencies in accordance with the latest edition of the Manitoba Energy Code for Buildings. List information on Shop Drawings.

.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 Division 25 to be performed by Division 25 except as noted otherwise. Refer also to Division 25 for further requirements.
- .1 Division 26 - Electrical to perform all wiring and make final connections to all controls for roof-top HVAC units 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.

.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 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 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 or equal. 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 Division 03. 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 bracketed from wall. Where wall thickness is inadequate to permit such brackets, carry supports to either ceiling or floor, or both as required.

.4 Fire hose cabinets to be c/w suitable bases or mounting brackets. Where shown on or in walls, angle or channel iron supports to be installed to bear equipment.

1.19 FLASHING

.1 Where pipes or ducts go through a roof or wall, they should be boxed-in and flashed as per Division 07. 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 Contractor 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 Finished areas (copper sleeves) - 6mm (1/4")
.3 Mechanical rooms, kitchens and washrooms - 100mm (4")
.4 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, chilled water and ice water lines 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 job Site approval by the Structural 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 23 60 10 and 23 80 10 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 glass for each gauge glass installed.

.2 One set of v-belts for each piece of machinery.

.3 One set of filters for each filter bank installed. i.e. 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 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.

.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 Divisions 21, 22, 23 and 25 Subcontractors 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 General Contractor, The City and Contract Administrator stating that all mechanical openings have been fire stopped in accordance with fire stop mfg. methods to maintain integrity of fire separation being penetrated.

1.27 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.

1.28 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 Pressure relief valves
- .2 Carbon monoxide detectors
- .3 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.

1.29 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'. Refer also to 'General Conditions'.

.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.

1.30 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.

1.31 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 digital format. Coordinate with The City for final video format.

.2 Provide The City with one (1) electronic copy and two (2) hardcopies 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.

1.32 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 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 Contractor Administrator. Stencil all pipes at access doors also.

.7 All colours shall be approved by Contract Administrator.

1.33 IDENTIFICATION OF PIPING

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

1.34 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.

1.35 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 Divisions 21, 22, 23 and 25 - Mechanical in Bid Opportunity price. Divisions 21, 22, 23 and 25 - Mechanical to employ and pay appropriate Subcontractor whose Work is involved, for carrying out Work described above.

1.36 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.

.3 Coordinate removal and disposal of makeup air units with The City and ACM.

1.37 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 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	Gas Valves*	Milliken
.2	Hangers and Supports	Anvil; Crane; Myatt; Erico
.3	Alignment Guides	Adsco; Flexon; Fulton; Yarway
.4	Drainage specialties* (floor drains, cleanouts, etc.)	Watts; Zurn; J.R. Smith; Mifab;
.5	Strainers*	Spirax-Sarco; Watts; Toyo; Crane; Colton
.6	Gas cocks*	Toyo; Milliken; Anvil
.7	Gas regulators*	Fisher; Equimeter; Norgas (Itron)

.5 FIRE PROTECTION

.1	Automatic sprinkler equipment*	Reliable; Viking; Victaulic; Tyco Fire Products (Gem, Star, Central)

.6	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; Flanders
	.4	Heat recovery units*	Tempeff
	.5	Diffusers, registers & grilles*	E.H. Price; Hart & Cooley; Titus; Carnes; Nailor
	.6	Acoustic duct insulation*	Manville; Fibreglas; Ultralite; Knauf
	.7	Vibration control*	Airmaster; Vibro-Acoustics; Vibron; Kinetics
	.8	Motorized damper*	Tamco; Alumavent; JCI
	.9	Gas Fired Infra Red Heaters	Superior Radiant Products;
.7	CONTROLS/INSTRUMENTATION		
	.1	Temperature control system*	Johnson Controls (Metasys) (Winnipeg Office)
	.2	Gas detection sensor*	Honeywell Analytics (Vulcain)
.8	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 or approved equal. 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 deg. 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 deg. 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 The 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 or an approved equal, 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.

Outside Diameter of Line (mm)	Size of Letter (mm)
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. For following spell out entire identification word(s) onto colour band in place of fluid service code identification stencil.

.1 Fire Quenching Lines: STANDPIPE, SPRINKLER, PRE-ACTION SPRINKLER, CARBON DIOXIDE, DRY CHEMICAL or FIRE MAIN

.2 Radioactive Waste: RADIOACTIVE WASTE CLASS 1, 2 or 3

.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 Equipment, Materials and Products - Mechanical.

.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 equivalent 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 On pipes 62mm (2-1/2") diam. and larger, use 25mm (1") Fibreglas 88 kg/m(5-1/2 lb./cu. ft.) density pipe insulation with ASJ jacket, c/w vapor barrier.

.2 Location

.1 All domestic cold water piping.

.2 Roof drains and storm drain piping.

2.4 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.

2.5 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 Domestic water piping located 12’ and lower above finished floor.

2.6 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 return/exhaust air ducts on roof to/from heat recover units.

.2 All round supply and return/exhaust air ducts to/from heat recover units from roof back to building for a length of 1.8m (6'-0").

.3 All round infrared heater intake ducting from roof to infrared heater.

.4 Round intake duct (keynote 8 on M4.1) inside building.

.5 Round exhaust fan duct (keynote 6 on M4.1) from roof back to building for a length of 1.8m (6’-0”).

2.7 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 return/exhaust air ducts on roof to/from heat recover units.

.2 All rectangular supply and return/exhaust air ducts to/from heat recover units from roof back to building for a length of 1.8m (6'-0").

.3 All rectangular infrared heater intake ducting from roof to infrared heater.

.4 Rectangular intake duct (keynote 8 on M4.1) inside building.

.5 Rectangular exhaust fan duct (keynote 6 on M4.1) from roof back to building for a length of 1.8m (6’-0”).

2.8 REFRIGERANT PIPE INSULATION

.1 Insulate all refrigerant piping lines with 12mm (1/2") Armstrong Armaflex AP sealed with Armstrong 520 adhesive. Refinish exposed and exterior insulation with Armstrong WB Armaflex finish.

.2 Cover outdoor insulation with aluminum jacket CSA HA Series-M1980.

.1 Crimped or embossed alloy jacketing 0.4mm thick with longitudinal slip joints and 50mm end laps with factory attached protective liner on interior surface. Aluminum alloy butt straps with mechanical fastener.

.2 Jackets on fittings, 0.4mm thick, die shaped components of alloy with factory attached protective liner on interior surface.

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 degree 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 INSULATION CLADDING

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

3.4 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 Cold Pipe

.1 Fitting systems below ambient temperature must have a continuous vapor retarder, either with Proto PVC Tape, Proto Butt Strips, Proto PVC Adhesive, or a vapor retarder mastic as specified by the Contract Administrator. When using Proto PVC Tape, a 2" (51mm) minimum downward overlap is recommended for optimum performance. Care should be taken not to stretch the last 2" (51mm) of Proto PVC Tape, to avoid stretching or creeping.

3.5 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.

.2 Outdoor Ducts

.1 On roof and other ductwork located outside of building, provide 26 ga. G.I. sheet metal cover to protect insulation. Seal all joints and make weathertight.

.2 On square or rectangular ductwork provide slight peak along top centre line so moisture will run off.

.3 Exposed Ducts

.1 Recover ducts exposed to view with 170 g. (6 oz.) canvas secured with Bakor 120-18 white fire retardant lagging adhesive. Finish with brush coat of same adhesive.

3.6 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.

.3 Exposed Ducts

.1 Recover ducts exposed to view with 170 g. (6 oz.) canvas secured with Bakor 120-18 white fire retardant lagging adhesive. Finish with brush coat of same adhesive

.4 Outdoor Ducts

.1 On roof and other ductwork located outside of building, provide 26 ga. G.I. sheet metal cover to protect insulation. Seal all joints and make weathertight.

.2 On square or rectangular ductwork provide slight peak along top centre line so moisture will run off.

3.7 REFRIGERANT PIPE INSULATION

.1 Insulate fittings, valve bodies, etc.

.2 All fittings shall be insulated with mitre-cut pieces of Armaflex AP pipe insulation the same size as on adjacent piping.

.3 Seal joints and seams with adhesive, and refinish exposed fittings with specified finish. Refinish all exposed piping with two additional coats.

.4 Where insulation comes in close contact with adjacent equipment or piping having surface temperatures above 100 deg. C, provide additional protection to ensure against deterioration of insulation by heat.

.5 Allow adhesive joints of Pipe insulation to dry 24 hours to 36 hours before applying finish. Apply finish directly to clean, dry insulation in two coats. Wipe surface with cloth dampened with non-oily solvent such as alcohol or toluol to clean surface and remove powdered lubricant. Allow first coat to dry minimum of two hours before applying second coat. Before applying finish, read precautionary information on can label.

.6 Finish insulation located outdoor with Armstrong WB black Armaflex finish. Do not apply over joints freshly cemented with 520 adhesive. Allow adhesive joints of Armaflex pipe insulation to dry 24 hours to 36 hours before applying finish. Apply finish directly to clean, dry Armaflex insulation in two coats. Wipe surface with cloth dampened with non-oily solvent such as alcohol or tuluol to clean surface and remove powdered lubricant. Allow first coat to dry minimum of two hours before applying second coat. Before applying Armaflex WB finish, read precautionary information on can label.

.7 For aluminum jacketting installation install in strict accordance with manufacturer's published recommendations. Make weathertight application.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 Design, engineering, approvals by AHJ, permits, installation, testing, certification, and commissioning of wet pipe sprinkler systems as described herein, within related Contract documents, and as diagrammatically illustrated on the Contract Drawings.

1.2 REFERENCES

.1 Reference Standards:

.1 National Fire Prevention Association (NFPA)

.1 NFPA 13 - the latest version, Standard for the Installation of Sprinkler Systems.

.2 NFPA 25 - the latest version, Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems.

.2 Underwriter's Laboratories of Canada (ULC)

.1 CAN4 S543-M984, Standard for Internal Lug Quick Connect Couplings for Fire Hose.

.2 Codes and By-laws:

.1 Manitoba Building Code - the latest version

.2 National Building Code of Canada - the latest version

.3 Additional codes and bylaws applicable at the location of the Work as required by the AHJ.

1.3 ADMINISTRATIVE REQUIREMENTS

.1 Coordination:

.1 General: Division 21 – Fire Suppression.

.2 Sequencing:

.1 Install the Work to facilitate connection of other fire protection/suppression/alarm or safety systems tying into or combined with sprinkler system(s).

1.4 ACTION SUBMITTALS

.1 Product Data:

.1 Provide manufacturer's printed product literature and data sheets, and include product characteristics, performance criteria, physical size, finish and limitations.

.2 Shop Drawings:

.1 Provide detailed engineered layout of wet pipe sprinkler system meeting requirements of AHJ.

.1 Include:
- .1 Hazard Analysis,
- .2 Working Plans,
- .3 Assembly Details,
- .4 Water Supply Information,
- .5 Hydraulic Calculations, and
- .6 Hydraulic Calculation Forms.

.2 Materials to show:
- .1 Finishes,
- .2 Method of anchorage,
- .3 Number of anchors,
- .4 Supports, and
- .5 Accessories.

1.5 QUALITY ASSURANCE

.1 Qualifications:
- .1 Installers: Journey person(s) specializing in wet pipe sprinkler system assembly with provincial certification applicable at the location of the Work.
- .2 Licensed Professionals: Professional Engineer(s) Licensed to practice engineering at the location of the Work.

.2 Supply grooved joint couplings, fittings, grooving tools and specialties from a single manufacturer.

Part 2 Products

2.1 PERFORMANCE / DESIGN CRITERIA

.1 Design: in accordance with required and advisory provisions of NFPA 13.
- .1 Sizing: by hydraulic calculations for uniform distribution of water over design area for compliance with requirements for hazard classification to satisfaction of the AHJ.

.2 Include with each system all Materials, accessories, and equipment inside and outside building to provide each system complete and ready for use.

.3 Design and provide each system giving full consideration of blind spaces, piping, electrical equipment, ducts, and other construction and equipment as located in Drawings including changes made during Bid Opportunity and construction.

.4 Locate sprinkler heads in consistent pattern with ceiling grid, lights, and air supply diffusers. Coordinate sprinkler head layouts and head types with Contract Administrator prior to submission of final Shop Drawings.

.5 Devices and equipment for fire protection service: ULC approved for use in wet pipe sprinkler systems.

.6 Location of Sprinkler Heads:

.1 Locate heads in relation to ceiling and spacing of sprinkler heads not to exceed that permitted by NFPA 13.

.2 Uniformly space sprinklers on branch lines.

.7 Water Distribution:

.1 Make distribution, where possible, uniform throughout the entire zone.

.8 Sizing:

.1 Size pipe to provide specified density when system is discharging specified total maximum required flow.

.2 Include factor of safety in sizing.

.9 Water Supply: In accordance with local AHJ requirements.

.10 Sprinkler Discharge Area:

.1 Area: hydraulically most remote area as defined in NFPA 13.

.11 Hose Allowances:

.1 Include allowance in hydraulic calculations for outside and inside hose streams to meet NFPA 13 and satisfaction of AHJ.

.12 Friction Losses:

.1 Calculate losses in piping in accordance with NFPA 13.

2.2 MATERIALS

.1 Pipe, Fittings and Valves

.1 General: Materials shall meet requirements of NFPA 13 and The City's Insurer requirements including when not listed herein.

.2 Pipe:

.1 Ferrous:

.1 Material: Schedule 40 black steel meeting requirements of NFPA 13 and the following:

.1 Diameter: Nominal Pipe Size to ASTM A53.

.2 Type: Electric resistance welded (Type E), Grade B to ASTM A53.

.3 Tensile Strength: minimum 415 MPa (60,000 psi).

.4 Yield Strength: minimum 240 MPa (35,000 psi).

.2 Bending: Not permitted unless specifically approved by Contract Administrator. Where bending is required pipe meeting ASTM A53 Grade A may be required as directed by Contract Administrator.

.2 Copper tube: Type L to requirements of NFPA 13.

.3 Fittings and joints:

.1 Ferrous: screwed, welded, flanged, or roll grooved to requirements of NFPA 13.

.2 Copper tube: screwed, soldered, brazed, or roll grooved to requirements of NFPA 13.

.3 Welded:

.1 To CSA C W117.2.

.2 Welder certified to CSA B51 and provincial authority having jurisdiction.

.3 Weld joints and connection outlets in fabrication shop; field welding of final connections will be permitted.

.4 Conform to regulatory requirements including fire watch.

.4 Ensure fittings, mechanical couplings, and rubber gaskets are supplied by same manufacturer.

.5 Hole drilled outlets: to use rubber gasket and coupled housing for mounting.

.4 Valves:

.1 All valves to meet requirements of NFPA 13.

.2 Valves to open using counter-clockwise operators.

.3 Working pressure: minimum 175psi, use appropriately rated valves where pressures exceed 175psi.

.4 Non-supervisory

.1 Up to NPS 2: Full port ball valve, threaded or grooved end.

.2 Drain valve: Size to NFPA 13, minimum NPS 1, complete with hose end, cap and chain.

.3 Inspector's test connections: pre-manufactured test and drain assembly with orifice matching system design criteria.

.5 Supervisory

.1 Operators to be designed to meet Valve Closure Time requirement stated in NFPA 13.

.2 Up to NPS 2: Gear operated ball valve, threaded or grooved end, integral supervisory switch.

.3 NPS 2 1/2 and over: Gear operated butterfly valve with flag type indicator and integral supervisory switch.

.6 Check valves: spring actuated swing type, composition disc seal.

.5 Pipe hangers: to NFPA 13.

.1 Provide engineered pipe hangers as required.

.2 Sprinkler Heads

.1 General: to NFPA 13 and ULC listed for fire services.

.2 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.

.3 When sprinklers are exposed to damage, fit with approved wire guards.

.4 Rapid response sprinkler head design shall be provided at locations required by NFPA and local Code.

.3 Compliance: comply with manufacturer's written recommendations and Specifications, including product technical bulletins and handling, storage and installation instructions, and datasheets.

.4 Hangers and supports

.1 Sprinkler system shall be in accordance with NFPA #13.

Part 3 Execution

3.1 INSTALLATION

.1 Install, inspect and test to acceptance in accordance with NFPA 13, NFPA 25, and AHJ.

3.2 FIELD PAINTING

.1 Paint piping, conduit, hangers, supports, miscellaneous metalwork, and accessories.

3.3 FIELD QUALITY CONTROL

.1 Test and Observation:

.1 Perform test to determine compliance with specified requirements in presence of The City and Contract Administrator to satisfaction of AHJ.

.2 Preliminary Tests:

.1 Hydrostatically test each system as required by authority having jurisdiction with no leakage or reduction in pressure.

.2 Flush piping with potable water in accordance with NFPA 13.

.3 Piping above suspended ceilings: tested, inspected, and approved before installation of ceilings.

.4 Test alarms and other devices.

.5 Test water flow alarms by flowing water through inspector's test connection. When tests have been completed and corrections made, submit signed and dated certificate in accordance with NFPA 13.

.3 Develop, with The City, detailed instructions for Operations and Maintenance Manual for routine testing of systems.

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 Provide complete plumbing systems as shown on the Drawings and described herein in accordance with National Plumbing Code of Canada, Provincial or Territorial Plumbing Code and Local Authority Having Jurisdiction.

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 Storm Drainage System
- .2 Cold Water Supply System
- .3 Natural Gas Piping System

1.3 RELATED WORK SPECIFIED ELSEWHERE

.1 Section 21 05 00 – Mechanical General Provisions.

.2 Section 21 05 10 – Acceptable Equipment, Materials and Products - Mechanical.

.3 Section 21 08 10 – Insulation.

.4 Section 22 50 10 – Fire Protection.

.5 Section 23 05 48 – Vibration Control.

.6 Section 23 80 10 – Air Distribution.

.7 Section 25 10 10 – Controls - General Requirements.

.8 Section 25 20 10 – Controls - Hardware, Software and Devices.

.9 Section 25 30 10 – Controls - Sequences of Operation.

.10 Division 26 – Electrical.

Part 2 Products

2.1 PIPE AND FITTINGS

.1 Storm Drain Pipe and Fittings
- .1 Cast Iron Pipe and Fittings
  - .1 Piping above and below ground: Class 4000 to CAN/CSA-B70.
  - .2 Joints, Above Ground:
    - .1 Neoprene or butyl rubber compression gaskets: to CAN/CSA-B70.
    - .2 Neoprene or butyl rubber compression gaskets with stainless steel clamps.
  - .3 Joints, below ground

.1 Neoprene or butyl rubber compression gaskets with corrugated stainless steel sleeve with band clamps for no hub cast iron soil pipe.
.2 Maintains joint alignment and rigidity.
.3 Conforms to ASTM C564.
.4 Resistant to shear forces.

.2 Water Piping - Domestic Cold
.1 Piping
.1 Above ground: copper tube, hard drawn, type L: to ASTM B88M.
.2 Fittings
.1 Cast bronze threaded fittings, Class 125.
.2 Cast copper solder joint pressure fittings.
.3 Joints
.1 Bolts, nuts, hex head and washers: to ASTM A307, heavy series.
.2 Copper solder joints: lead free tin & silver solder with minimum melting point of 221 deg. C (430 deg. F). Use water soluble solder fluxes.

.3 Natural Gas System
.1 Pipe
.1 Up to 150mm (6"): - Schedule 40 carbon steel, continuous weld or electric resistance weld pipe conforming to ASTM A53 Grade B.
.2 Fittings
.1 Up to 50mm (2"):
.1 Screwed fittings - 1034 kPa (150 psi) black malleable iron, banded.
.2 Socket weld fittings - 13,800 kPa (2000 psi) forged steel.
.3 Unions - 1034 kPa (150 psi) brass to iron seat.
.4 Thread-O-Lets and Weld-O-Lets to be manufactured to ASTM A181, Grade 1.

2.2 WALL SLEEVE SEALS

.1 Where water and sanitary service lines are sleeved through concrete wall, provide schedule 40 stainless steel pipe sleeves and LINK-SEAL sleeve seals.

2.3 VALVES - GENERAL

.1 Valves of similar type to be of single manufacturer.

.2 Submit brochure of valves selected, indicating:
.1 Manufacturer
.2 Figure numbers
.3 Material of construction
.4 Intended use.

.3 Products to have CRN registration numbers.

.4 All valves shall conform to the requirements of the Manufacturer’s Standardization Society (MSS)

2.4 VALVES – DOMESTIC WATER

.1 Ball Valves
.1 Up to including 50mm (2”) 4137 kPa (600 psi) non shock CWP
.1 Standard Specification: MSS-SP-110

.2 NSF/ANSI 61 compliant
.3 Connections: Solder or Thread ends
.4 Full port
.1 Operator: Removable, plated steel lever handle with plastic cover
.5 Body and cap: Forged brass; Cast bronze
.6 Stem: Stainless steel
.7 Stem seal: Flourocarbon FKM; TFE; PTFE
.8 Ball seat: PTFE; TFE
.9 Ball: Stainless Steel

2.5 VALVES – NATURAL GAS

.1 Valves up to 50mm (2") size - Toyo 5044A and Kitz Code No. 58 ball valve or Newman Hattersley 1969F. Newman-Milliken 200M, lubricated screwed plug valve.

2.6 PLUMBING FIXTURE AND EQUIPMENT

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

.2 Natural gas pressure reducing valves
.1 Direct-operated, spring-loaded regulators
.2 20 psi to 7-14” W.C.
.3 Fisher CS400 series or equal in accordance with B7

.3 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. ¾” (19mm) adapter vacuum breaker.

Part 3 Execution

3.1 GENERAL PLUMBING PIPING INSTALLATION

.1 Install in accordance with National Plumbing Code, Manitoba Plumbing Code and Local Authority Having Jurisdiction.

.2 Provide single manufacturer for the following plumbing piping and fixtures:
.1 Drain pipe
.2 Water pipe

.3 Connect to fixtures/equipment/accessories and install in accordance with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and datasheets.

.4 Cut all pipe accurately to measurements taken at Site, installed without springing or forcing. All changes in direction made with fittings.

.5 Provide unions or flanges on all connections to equipment.

.6 Affix applicable labels (ie. storm, sanitary, vent, etc.) c/w directional arrows.

.7 Remove valve working parts during installation to prevent damage from heat where brazing or soldering is used.

.8 Route all piping in accessible pipe spaces in such a way that it does not interfere with free access into pipe space.

.9 Co-operate with all Subcontractors to properly locate all equipment connections.

.10 Weld all pipe joints in compressed air lines concealed in walls or other inaccessible locations.

.11 Comply with latest CSA Standard W117.2 "Code for Safety in Welding and Cutting".

.12 When brazing or soldering protect adjacent surfaces from heat and flame.

.13 Make threaded joints in steel piping in accordance with ASME B1.20.1. Apply approved non-toxic joint compound to male threads only. Do not apply joint compound to the first two threads. Avoid squeezing excess compound into pipes. Ream and file all pipes. Leave full bore, clean and free of scale.

.14 Where black steel pipe and welding fittings are specified or permitted, welding to be performed by welder holding current welder's certificate applicable for Province of project Site.

.15 Expansion and Contraction of Piping:
- .1 Make provision for expansion and contraction of piping. Use swing connections where shown or necessary.
- .2 Provide expansion joints where shown on the Drawings.
- .3 Provide anchors and guides as recommended by the manufacturer.

.16 Cleaning and Flushing:
- .1 Flush out piping systems before installation of equipment, fixtures, etc. in order to remove any foreign Material in piping.
- .2 Clean all fixture screens, aerators, and strainers immediately after system has been flushed.
- .3 Clean out plumbing fixtures.

3.2 DRAINAGE SYSTEMS INSTALLATION

.1 General:
- .1 Provide sisson joints:
  - .1 On all drain pipes routed into, or through, slab on grade to take up movement of slab.
  - .2 At base of all multi-story risers.
- .2 Plastic piping:
  - .1 Do not use plastic piping in any shafts spaces.
  - .2 Do not use exposed plastic piping in any egress corridors or stairs. Installation within rated enclosures acceptable.
  - .3 Use fire rated piping within return air plenums.
  - .4 Do not use plastic piping for drainage systems serving:
    - .1 Commercial kitchens
    - .2 Humidification systems
- .3 Cleanouts:
  - .1 Install cleanouts:
    - .1 At all changes of direction
    - .2 At intervals of not over 15m (50') in horizontal runs
    - .3 At all points where obstructions might be formed

.4 At base of soil/waste stacks and rainwater leaders
.5 At points required by plumbing regulations or shown on Drawings.

.2 Provide chrome plate cap tight to wall for cleanouts on sink waste and vent pipes.
.3 Ensure cleanouts are accessible. Extend cleanouts to face of structure with access cover and frame where located above furred ceilings or in concrete slabs on grade.
.4 Provide access panel for cleanouts located behind walls. Co-operate in locating cleanouts adjacent to access panels, etc.
.5 Seal all metallic cleanout plugs with Teflon tape. Check all cleanouts are secured immediately prior to turning the job over to the The City.
.6 Rough-in clean-outs in conformance with manufacturer's installation instructions to ensure proper transition and tie-in to adjacent flooring Material.
.7 Coordinate with other Contractors on Site to apply finish to cleanout covers to ensure they will be flush with wall, floor surface, inconspicuous, and accessible.

.4 Brace fittings where necessary to prevent joints coming apart under pressure.

.2 Storm Drain Installation
.1 Provide complete system of storm drain piping to serve all roof drains.
.2 Start-up only after pressure tests have been completed.
.3 Provide continuous supervision during start-up.
.4 Roof drains:
.1 Check security, removability of dome.
.2 Clean out sumps.
.3 Verify provisions for movement of roof systems.

3.3 DOMESTIC WATER PIPING INSTALLATION

.1 Provide complete system of water supply piping (cold water) to serve all fixtures, equipment, etc. Tempered water piping above 29 deg.C (85 deg.F) is considered to be hot water piping.

.2 Install cold water piping below and away from hot water and hot water recirculation piping and other hot piping so as to maintain temperature of cold water as low as possible.

.3 Piping below grade and in inaccessible locations: continuous, without joints.

.4 Grade horizontal runs of piping to drain through risers.

.5 Provide dielectric insulating unions between all pipes or apparatus constructed of dissimilar metals.

.6 Provide balancing valve for each recirculating branch.

.7 Start up:
.1 Ensure systems are complete prior to flushing, testing and startup.
.1 Verify systems can be completely drained.
.2 Ensure that pressure booster systems are operating properly
.3 Ensure all air chambers and expansion compensators are installed properly
.2 Start up systems after:
.1 Pressure tests have been completed.

.2 Disinfection procedures have been completed.
.3 Water treatment systems are operational.
.3 Provide continuous supervision during start-up.
.4 Start-up procedures:
.1 Establish circulation and ensure that air is eliminated.
.2 Check pressurization to ensure proper operation and to prevent water hammer, flashing and/or cavitation.
.3 Establish water treatment systems for proper operation.
.4 Monitor cold water supply piping systems for freedom of movement and pipe expansion.
.5 Check control, limit, safety devices for normal and safe operation.
.5 Rectify start-up deficiencies.

.8 Flushing and Disinfection
.1 Flush clean entire piping thoroughly, disinfect and rinse domestic water system before being placed into service.
.2 Chlorinate all piping and equipment throughout their entire lengths.
.3 Use method approved by the Contract Administrator and Authority Having Jurisdiction to introduce disinfectant into lines.
.4 Add chlorine to attain concentration of fifty ppm (50 ppm) throughout system and retain for twenty-four hours (24 hr), after which time chlorine concentration must not have dropped below 5 ppm.
.5 After chlorination is complete flush piping throughout until replacement water is equal chemically and bacteriologically to supply.
.6 On completing chlorination of piping, set system in operation as directed by Contract Administrator.

.9 Performance Verification
.1 Verify system performance after:
.1 Pressure and leakage tests
.2 Flushing and disinfection, and
.3 Certificate of Completion has been issued by Authority Having Jurisdiction.
.2 Procedures:
.1 Verify that flow rate and pressure meet Design Criteria.
.2 Adjust pressure regulating valves while withdrawal is maximum and inlet pressure is minimum.
.3 Reports:
.1 In accordance with Section 01 91 13 – General Commissioning (Cx) Requirements: Reports, using report forms as specified in Section 01 91 13 – General Commissioning (Cx) Requirements: Report Forms and Schematics.
.2 Include certificate of water flow and pressure tests conducted on incoming water service, demonstrating adequacy of flow and pressure.

3.4 DOMESTIC WATER VALVES

.1 Install rising stem valves in upright position with stem above horizontal.

.2 Remove internal parts before soldering or brazing.

.3 Install check valves on parallel operation pump discharges and where noted. Install swing type check valves in a horizontal section of piping.

.4 Provide drain valves with hose thread outlet with vacuum breaker and cap/chain in following locations:
- .1 Where shown and necessary for complete drainage.
- .2 On system low points

.5 Provide shut off valves with unions or flanges to allow servicing, maintenance, and equipment removal in following locations:
- .1 At all connections to major pieces of equipment
- .2 In all branches to fixtures or groups of fixtures.
- .3 Where shown on the Drawings and details.

.6 Provide unions or flanges to allow servicing, maintenance, and equipment removal in the following locations:
- .1 At all connections to major pieces of equipment.
- .2 Where shown on the Drawings and details.

.7 Provide 50mm (2") stem extensions and extended handles of non thermal conductive Material for valves in insulated piping to allow operation of the valve without breaking the vapour seal or disturbing the insulation. Ensure memory stops are fully adjustable after insulation is applied.

.8 Asbestos packing and gaskets are prohibited.

3.5 NATURAL GAS PIPING SYSTEM

.1 Make arrangements with gas utility company to bring in service and install regulator. Pay all service and installation charges.

.2 Run piping as shown to serve equipment. Take out permits and connect equipment ready for use. Provide gas regulators as specified under Products section of this Specification. Run vent piping from relief valves to atmosphere. Install gas piping in accordance with Provincial Department of Labour regulations. Provide gas cock at each piece of equipment. Provide drip pockets at each piece of equipment and at low points. Grade horizontal piping 1:500 (1" in 40 ft.) to drain through risers.

3.6 TESTING

.1 General:
- .1 Perform operating tests to all systems and equipment in accordance with local regulations and manufacturer's instructions.
- .2 Give 48 hours notice to Contract Administrator in advance of all tests.
- .3 Provide test report to Contract Administrator.
- .4 Include test reports in Operating and Maintenance Manuals
- .5 Include in Commissioning Manuals

.2 Plumbing drainage systems:
- .1 Pressure test systems in accordance with local regulations.
- .2 Ball test to verify grades and freedom from obstructions.

.3 Natural gas piping systems:
- .1 Pressure test systems in accordance with local regulations.

.4 Water supply piping systems:
- .1 Test with water to 690 kPa (100 psi) at the highest point of the system.
- .2 Maintain pressure without loss for 4 hours.

3.7 ROOF HYDRANTS

.1 Install roof hydrant as per manufacturers standard instructions as well as the following:
- .1 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.
- .2 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, Materials, plant, tools, equipment and services necessary and reasonably incidental to completion of air conditioning and/or ventilation Work.

1.3 RELATED WORK SPECIFIED ELSEWHERE

.1 Section 21 05 00 – Mechanical Basic Materials & Methods.

.2 Section 21 05 10 – Acceptable Equipment, Materials and Products - Mechanical.

.3 Section 22 40 10 – Plumbing.

.4 Section 23 90 10 – Testing, Adjusting & Balancing.

.5 Section 25 10 10 – Controls - General Requirements.

.6 Section 25 20 10 – Controls - Hardware, Software and Devices.

.7 Section 25 30 10 – Controls - Sequences of Operation.

.8 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 DUCTWORK CONSTRUCTION

.1 References: Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)

- .1 SMACNA HVAC Duct Construction Standards – Metal and Flexible, current edition.
- .2 SMACNA HVAC Air Duct Leakage Test Manual, current edition.

.2 Duct Pressure Class:
.1 Ductwork to/from HRU-1/2 shall be constructed to the following pressure class to meet SMACNA HVAC Duct Construction Standards:
.1 +/- 2" W.C. for all supply/exhaust to/from building for HRU-1/2.
.2 +/- 6" W.C. for all intake/exhaust to/from outdoors for HRU-1/2.
.2 For ductwork not listed above, ductwork shall be constructed to the pressure class suitable for the ESP produced by fans and air handlers to meet SMACNA HVAC Duct Construction Standards.
.3 Consult the Contract Administrator prior to bidding or performing any Work.

.3 Duct Seal Classification
.1 To SMACNA Classification as follows:

Seal Class	Sealing Required	Static Pressure Construction Class
A	All transverse joints longitudinal seam and applicable duct wall penetrations.	1000 Pa (4 in. wc and up)
B	All transverse joints and longitudinal seams	(750 Pa) 3 in. wc
C	Transverse joints	500 Pa (2 in. wc)

.2 Sealant
.1 Indoor duct sealant:
.1 Type: Water based, vinyl acrylic, non-fibrous
.2 Service temperature: -7 deg. C to 93 deg. C (19 deg. F to 200 deg. F)
.3 Flame spread: 0
.4 Smoke developed: 0
.5 ULC listed.
.6 Conform to NFPA 90A and 90B
.7 VOC limit: 48 g/L maximum
.8 Standard of Acceptance: Duro Dyne DWN
.9 Acceptable Manufacturers: Duro Dyne; 3M; Flexa-Duct; Bakor; Nova Flex (Duct Bond).
.3 Tape
.1 Tape: polyvinyl treated, open weave fiberglass tape, 50 mm wide.
.2 Standard of Acceptance: Duro Dyne FT-2

.4 Materials: galvanized steel of lock-forming grade to ASTM A653 and A924 standards, unless otherwise noted.

.5 Thickness, fabrication and reinforcement: to SMACNA HVAC Duct Construction Standards
.1 Indoor ductwork: to SMACNA
.2 Outdoor ductwork: two gauges heavier than SMACNA tables

.6 Joints: to SMACNA HVAC Duct Construction Standards

.7 Duct fittings: to SMACNA HVAC Duct Construction Standards
.1 Fabrication: to SMACNA.
.2 Radiused elbows:
.1 Rectangular: 1.5 times width of duct.
.2 Round: 1.5 times diameter.
.3 Mitred elbows, rectangular:

.1 Single thickness turning vanes. Refer to mechanical details. Provide additional support for segments larger than 600 mm (24").
.2 Standard of Acceptance: Duct Mate.

.4 Branches:
.1 Rectangular main and branch: with 45 degrees entry on branch.
.2 Round main and branch: enter main duct at 45 degrees with conical connection.
.3 Provide volume control damper in branch duct near connection to main duct.
.4 Main duct branches: with splitter damper.
.5 Duct sidewall grilles:
.1 Provide air volume extractor at duct branches with hex key operator accessible through the face of the grille.
.2 Standard of Acceptance: Price AE1 w/ type 3 operator

.5 Transitions: to SMACNA HVAC Duct Construction Standards
.6 Offsets: to SMACNA HVAC Duct Construction Standards
.7 Easements: split duct in two with original duct cross sectional area being maintained per SMACNA standards.
.8 Round spiral duct shall be used in exposed finished areas.
.9 Spiral duct branch fittings shall be machine-fabricated, not field-constructed.

.8 Ductwork to be galvanized steel unless noted otherwise.

.9 Outdoor ductwork to be two gauges heavier than directed above.

.10 Turning vanes (Ducturns)
.1 Use duct elbows which have throat radius of 1-1/2" times the diameter.

.11 Provide E.H. Price AE-1 c/w #3 operator at all supply registers.

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 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 Schedule.

2.6 HEAT RECOVERY UNITS

.1 Refer to HRU Schedule and Specification below for reference.

.2 General Description
.1 Configuration: Fabricate as detailed on Drawings.
.2 Performance: As detailed in schedules.

.3 Unit Construction

.1 Fabricate unit with galvanized steel 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 24 gauge 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 L/240 deflection for an unsupported 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 Control cabinet shall be sealed from the air flow and have self-contained ventilation and heating (external enclosure with hood, dampers with actuators, temperature controls, transformer, cooler, heater and etc.).

.4 Supply / Return Fans
.1 Provide direct-drive airfoil plenum 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 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 All controls shall be located on the side of the unit for ease of servicing. Controls located on the top or the bottom of the unit are not acceptable.
.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 Controls must include Self Diagnostics with fault error and PLC error code. On board fault detection and diagnostics that sense and alerts when the damper is not operating correctly.
.5 Fan motors shall be 1800 rpm, totally enclosed fan-cooled (TEFC) type. Motors shall be premium efficiency, and inverter duty rated. Electrical characteristics shall be as shown in schedule.
.6 Provide and mount ABB variable speed drives in heated enclosure for each fan.
.7 Air handler manufacturer shall provide and mount a damper hand-off-auto (HOA) switch.
.8 Unit shall be supplied with single point power connection complete.

.6 Indirect Fired Gas Heat Exchanger

.1 Provide indirect gas-fired furnace models listed by Intertek Testing Services (ITS / ETL), a Nationally Recognized Testing Laboratory (NRTL), to the current edition of ANSI Z83.8 / CSA 2.6 Standard for Gas-Fired Duct Furnaces for installation on the positive pressure side of the circulating air blower only and provide a minimum combustion efficiency of 80%.

.2 Duct Furnaces shall be listed for either outdoor installation (or) for indoor installation in accordance with Category I and Category III venting systems without need for additional power venting.

.3 Duct Furnaces shall be listed for either outdoor installation (or) for indoor installation in accordance with Category I and Category III venting systems without need for additional power venting.

.4 Gas-fired furnace provided shall have a tubular heat exchanger constructed of Type 409 Stainless Steel .044 Min. Wall thickness produced to ASTM A268. Heat exchanger tubes shall be mechanically secured to vestibule panels and design shall be suitable to withstand 3.0" w.c. total external static pressure.

.5 Duct Furnaces shall be Listed for application downstream of refrigeration and cooling systems and shall provide means for removal of condensate that occurs in the heat exchanger tubes during cooling operation. Heat exchanger tubes shall have (integral formed dimpled restrictors; formed turbulators) to provide for an unobstructed drainage path and tubes shall be formed to provide a positive pitch to promote condensate drainage. Drainage shall be configured so that burners are not exposed to condensate.

.6 The Duct Furnace shall include:

- .1 A 20 gauge galvanized steel cabinet
- .2 1 inch thick, minimum 1 ½ lb./ft.3 density thermal insulation for exterior cabinets
- .3 Patented in shot gas burners, with integral carryovers, capable of operation at 5:1 turndown with modulating controls
- .4 An induced-draft combustion air blower to provide for positive venting of flue gases
- .5 Provision for attachment of a vent system to exhaust flue gases to outdoors.
- .6 Combustion air pressure switch to prove air supply for combustion
- .7 Direct spark ignition of the gas burners with remote flame sensor to prove carryover across all burners
- .8 Listed Combination Gas Valve incorporating redundant (two) electric safety shut-off valves, manual shut-off , and gas regulator which regulates gas pressure to burner supply manifold.
- .9 A 1/8" NPT tapped test gauge connection in the gas manifold for measuring gas pressure
- .10 A union fitting downstream of gas control to facilitate installation and service
- .11 An automatic reset type high limit switch to limit maximum outlet air temp to less than 250 ºF
- .12 Manual reset flame rollout switch(es).
- .13 A Class II step down transformer to provide 24 VAC control voltage at selected supply voltage
- .14 60 inch flue extension shall be included with gas heat exchanger section.

.7 Duct Furnace shall incorporate a Direct Spark Ignition control module that is design certified by a NRTL to ANSI Z21.20 and CAN/CSA-C22.2. The control shall provide:

.1 100% safety shut-off
.2 A minimum 15 second pre-purge to provide a minimum of four (4) air changes
.3 A maximum 0.8 second flame failure response time
.4 Two additional ignition retrials preceded by an inter-purge period
.5 A minimum 30 second post-purge
.6 An automatic reset after one hour should a lockout occur
.7 A LED indicator light to provide a flash code to identify operating condition of control
.8 An Alarm capable contact

.8 All electrical components shall be listed or recognized by a NRTL (ETL, UL, CSA, etc.).
.9 Duct Furnace and burners provided are listed for use on Natural or Propane gases as specified at the time of order.
.10 Ratings listed in Submittal Tables are for installations between 0 and 2000 feet (0 to 610m). For installations above 2000 feet, unit must be de-rated in accordance with National Standards.
.11 The fully assembled Duct Furnace shall be factory fire tested prior to shipment.
.12 Duct Furnace shall be accompanied by wiring diagrams for the control system supplied and printed instructions for proper installation, start-up, operation and maintenance.
.13 Burner and components are warranted for one year from date of installation or 18 months from date of manufacture. Heat exchanger is warranted for ten (10) years on a pro-rated basis. See Heatco Standard Warranty for full details.
.14 Initial on sight start-up must be completed by qualified installation and service agency. A Start-up data sheet is provided for recording operating data and the final heater adjustments. The indicated portion of the Start-up data sheet must be returned to Heatco to validate factory warranty.

.7 Particulate Filters
.1 Filter section with filter racks and guides with hinged and latching access doors 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 MERV 10 panel filters.

.8 Bypass Damper
.1 Unit shall include a supply air bypass damper for additional fresh air. The damper shall be TAMCO 9000 damper with 2-position actuator.

.9 Energy Recovery
.1 Dual Core$_{TM}$ Energy Recovery
.1 Unit shall be equipped with Dual Core$_{TM}$ 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 0.7mm (0.0276”) thick 1100 Series aluminum. Thinner aluminum is unacceptable to prevent deformation should cleaning be required to maintain indoor air quality. Spacing between plates shall be minimum 9

mm (0.35") to assure that frost growth will not restrict airflow or reduce performance. Heat exchangers shall be a minimum or 995 mm (39") long to assure minimum 60 second dwell time. Time between switchovers shall be minimum 60 seconds. Must be able to meet scheduled supply air temperature and efficiency switching at a minimum 60 seconds Technologies employing shorter heat exchangers are not acceptable due to high cross leakage, and excessive cycling. Maximum allowable face velocity across heat exchangers shall be 490 fpm. Heat exchanger face velocities exceeding 490 fpm are not acceptable.

.3 Heat exchangers shall be sectioned for a maximum section weight of 30 kg (66 lbs) so that the heat exchangers can be easily removed for cleaning to maintain indoor air quality. Sections weighing more are not acceptable. Heat exchanger that require special equipment to remove for cleaning (cranes, hoist etc.) are not acceptable. Heat exchangers shall be durable enough to handle high pressure power washing without deformation.

.4 Unit Cross-leakage shall be maximum 1-3% as defined and tested in accordance with ASHRAE 84 Test Methods. Cross leakage exceed this amount is unacceptable. Manufacturer shall produce testing data reflecting this performance in accordance with ASHRAE 84 test method. Testing must use the tracer gas method prescribed by ASHRAE 84.

.5 Switchover damper section shall be comprised of multi section low leakage dampers operated by fast acting electric actuators. Pneumatic actuators are not acceptable. 800 CFM-7,000 CFM shall have damper switching times of 0.75 seconds. 7000 CFM-20,798 CFM shall have damper switching times of 1.25 seconds. Dampers that do not switch within the specified times without objectionable noise are not acceptable. This switch over must limit any internal cross leakage below 3%. Test report must be provided showing that the damper configuration meets this requirement. Testing must use the tracer gas method prescribed by ASHRAE 84.

.6 Single blade damper sections are not acceptable. Each damper shall control one of the four airways upper front, upper back and lower front, lower back. Dampers shall be capable of orienting to close off outside air to the building without needing external shut off dampers.

.7 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. Re-circ design must be capable of pre-warming both heat exchangers simultaneously for morning warm-up cycle. Strategies that only warm one heat exchanger is unacceptable.

.8 Damper seals shall be ½" heavy thickness EPDM bulb seal. Single blade seals are unacceptable due to high leakage and poor sealing.

.9 Damper bearings shall be heavy duty greaseable pillow block flange bearings. Bronze or plastic bearings are not acceptable due to high cycle requirements. Bearings shall have a minimum diameter:

.1 800 – 7000 CFM: ¾" Bearings, maximum of 4 shafts per unit

.2 7,000 – 20,798 CFM: 1" Bearings, maximum of 4 shafts per unit

.3 Damper shafts shall be large diameter shafts meeting:

.4 800 – 7,000 CFM ¾" Chromium Shafts, maximum of 4 shafts per unit

.5 7,000 – 20,798 CFM - 1" Chromium Shafts, maximum of 4 shafts per unit

.10 Technologies employing smaller diameter shafts, or more shafts per unit are unacceptable as that would be considered light duty, and insufficient to withstand the demanding nature of the application.

.11 Damper manufacturer must provide written documentation that the dampers are capable of a minimum duty cycle of 500,000 cycles annually. Damper Manufacturer shall provide a written warranty on damper manufactures letterhead confirming the warranty.

.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.

.14 Additional feature

.1 Exterior casing: 24 gauge G90 galvanized steel
.2 Interior casing: 24 gauge G90 galvanized steel
.3 10HP WEG ODP premium efficiency 4 pole 215T frame
.4 10HP WEG ODP premium efficiency 4 pole 215T frame
.5 Supply air drive: ACH580-01-022A-6
.6 Return air drive: ACH580-01-022A-6
.7 1" seismic spring isolation
.8 Supply air pre-filter: Dafco Merv 10 (2") 400 HC
.9 Heatco HDB-HPP-300-900 indirect gas burner 15:1 burndown
.10 Insulated bypass dampers with 2 position Belimo actuator
.11 Single point power
.12 Quick connect
.13 Low limit
.14 8" 10 gauge baseframe
.15 Core defrost Dwyer DH3 Digihelic Differential Pressure sensor
.16 External enclosure w/ hood
.17 Enclosure dampers w/ actuators
.18 Enclosure temperature controls
.19 Enclosure transformer
.20 Enclosure cooler
.21 Enclosure heater
.22 2" foam injected panels
.23 All sections c/w hinged access doors and locking latches
.24 Multi-damper switchover section c/w actuators
.25 Stainless steel drain pans under heat exchanger(s) w/ 1" NPT connections

.26 Galvanized heat exchanger frames
.27 Galvanized damper blades, damper rods and axles
.28 Removal bypass duct hood

.15 The following DDC points are available from the manufacturer:
.1 Supply Fan Status and Command
.2 Exhaust Fan Status and Command
.3 Supply Fan Speed
.4 Exhaust Fan Speed
.5 Supply Air Temperature
.6 Exhaust Air Temperature
.7 Pre Heat Air Temperature (ie Temperature before Gas Heating Section)
.8 Supply Air Low Limit Status (ie Freeze Stat)
.9 Free Cooling Command
.10 Filter Differential Sensor
.11 Space Temperature
.12 Core Differential Sensor
.13 Bypass Opening On/Off
.14 Control Cabinet Temperature

2.7 REFRIGERANT PIPING AND ACCESSORIES

.1 General
.1 Reports:
.1 Submit certified test reports from approved independent testing laboratories indicating compliance with Specifications for specified performance characteristics and physical properties.
.2 Submit Shop Drawings indicating refrigerant piping layout c/w sizing calculations to Contract Administrator for review prior to Work commencing.
.3 Provide system start-up report showing:
.1 Date of start-up with ambient temperature noted.
.2 Suction/discharge and oil operating pressures (per circuit).
.3 Voltage and amperage draws of all compressor motors and drives associated with the system.
.4 Thermostatic expansion valve super heat settings
.5 Refrigerated (air conditioned) space initial pull down time to achieve designed system temperatures.
.6 Refrigerant and oil levels (per circuit).
.7 System refrigerant charge weight (per circuit).
.8 Superheat of circuit
.4 Provide detailed wiring diagrams showing:
.1 All power and control wiring related to refrigeration cycle, including refrigerant solenoid pilot control, interlocks between condensing units and supply fan, temperature control inter locks and all other control wiring for complete refrigeration system operation to approval of refrigeration equipment manufacturer and Contract Administrator.
.2 Certificates: submit certificates signed by manufacturer certifying that Materials comply with specified performance characteristics and physical properties.

.2 Quality Assurance

.1 Retain services of experienced Refrigerant Subcontractor to provide complete refrigeration installation.
.2 All trades people working on refrigeration system shall be Red Seal journeymen or registered apprenctices under the supervision of Red Seal journeymen.

.3 Tubing
.1 Processed for refrigeration installations, deoxidized, dehydrated and sealed.
.1 Hard copper: to ASTM B280, type ACR.
.2 Annealed copper: to ASTM B280, with minimum wall thickness per CSA B52 and ASME B31.5.

.4 Fittings
.1 Service: design pressure 4826 kPa (700 PSIG) and temperature 121 deg. C (250 deg. F).
.2 Brazed:
.1 Fittings: wrought copper to ASME B16.22.
.2 Joints, copper to copper: 15% Ag / 80% Cu / 5% P
.1 Acceptable Product: Silvaloy 15
.3 Joints, copper to brass or steel: 50% Ag / 20% Cu / 28% Zn / 2% Ni then finish with 15% Ag / 80% Cu / 5%P.
.1 Acceptable Products: Silvaloy 505, Silvaloy 15
.3 Flanged:
.1 Bronze or brass, to ASME B16.24, Class 150 and Class 300.
.2 Gaskets: suitable for service.
.3 Bolts, nuts and washers: to ASTM A307, heavy series.

.5 Pipe Sleeves
.1 Hard copper or steel, sized to provide 6 mm clearance around between sleeve and uninsulated pipe or between sleeve and insulation.

.6 Valves
.1 22 mm (7/8”) and under: Class 500, 3.5 Mpa, globe or angle non-directional type, diaphragm, packless type, with forged brass body and bonnet, moisture proof seal for below freezing applications, brazed connections.
.2 Over 22 mm (7/8”): Class 375, 2.5 Mpa, globe or angle type, diaphragm, packed type, back-seating, cap seal, with cast bronze body and bonnet, moisture proof seal for below freezing applications, brazed connections.
.3 No ball valves.

.7 Sight Glass
.1 Provide sight glasses with moisture indicator to suit system size and type.
.2 Maximum working pressure: 3447 kPa (500 PSIG)
.3 Working temperature range: -40 to 85 deg. C (-40 to 185 deg. F)
.4 Material: Solid brass construction, hermetically sealed, brazed connections
.5 UL/cUL listed, CE certified
.6 Compatible with all refrigerants and oils used on this project.

.8 Provide Shop Drawing submittals for review per Section 21 05 00 - Mechanical General Provisions.

.9 Filter Drier
.1 Provide sealed filter driers to suit system size and type.
.2 Maximum working pressure: 4206 kPa (610 PSIG)
.3 Working temperature range: -40 to 100 deg. C (-40 to 212 deg. F)

.4 Material: Powder coated carbon steel, solid copper ODS connections, steel spring, galvanized steel perforated plate, 100% molecular sieve core, non-woven polyester filter pad, stainless steel filter mesh.
.5 Liquid line models shall be solid core design composed of 80% molecular sieves, 20% activated alumina.
.6 Solid particle filtration down to 150 microns
.7 UL/cUL listed
.8 Compatible with all refrigerants and oils used on this project.
.9 Provide Shop Drawing submittals for review per Section 21 05 00 - Mechanical General Provisions.

.10 Thermostatic Expansion Valve
.1 Provide thermostatic expansion valves to suit system size and type. Ensure valves are installed in upright position.
.2 Provide Shop Drawing submittals for review per Section 21 05 00 - Mechanical General Provisions.

.11 Solenoid Valve
.1 Provide solenoid valves to suit system size and type.
.2 Provide Shop Drawing submittals for review per Section 21 05 00 - Mechanical General Provisions.

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

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

2.9 GAS-FIRED RADIANT HEATERS

.1 Supply and install Superior Radiant SRP U series infrared radiant heaters.

.2 Construct and certify gas fired radiant heaters in accordance with Latest Edition Z83.6 "Gas-Fired Infrared Heaters", including all current supplements.

.3 Install system in accordance with Z223.1 Fuel Gas Code.

.4 Equipment
.1 Reflector Design: Reflector shall be 10-sided reflector design reflecting virtually 100% of the infrared energy out and away from the emitter tubes. Reflector shall be “Deep Dish: design with emitter tubes fully recessed within reflector. Reflectors shall have a minimum 10 reflective surfaces. Reflectors with fewer surfaces allow energy to bounce back to the main heat exchanger tubing, and shall not be allowed. Reflector end caps shall be factory provided as standard and shall be fitted to the end of each reflector run to minimize convective heat loss. Reflectors shall provide a distribution pattern of 90 degrees inclusive beneath the heater. When called for in the Contract Documents and Specifications, directing of radiant pattern outside the standard distribution pattern shall be accomplished through use of side shields or bottom shields preferably. 45 degree, tipped reflectors increase the convective loss of the heater and shall not be allowed, unless called for in the Contract documents.
.2 Heat Uniformity: Burner shall distribute hot gases evenly along the length of the emitter tubes.
.3 Serviceability: Burner controls shall be located outside of the air supply stream.
.4 Service and diagnostic control checks shall be possible with the blower fan running. Controls shall be proven, name brand supported manufacturer.

.1 Control Box: Heavy-duty powder coated galvanized steel.

.2 Emitter Tube: Shall be 4 inch (102 mm) diameter, minimum 16 gauge thickness and shall be one of, or a combination of, the following allowed Materials as called for in the Contract documents

1) Hot rolled steel tube
2) Heat-treated Type 1 aluminized steel tube (Required on Model UXR).
3) Type 409 Stainless steel tube.
4) High temperature epoxy coated steel tube.

.3 Combustion Tube: 4 inches (102 mm) diameter, 16 gauge, heat treated type 1 aluminized steel tubing shall be required for all firing rates. Hot rolled steel shall not be allowed. Combustion tubing shall incorporate a welded, 11 gauge steel, 4 bolt flange to orient the burner to the tube as designed.

.4 Couplings: Shall be 16 gauge aluminized steel, minimum 12 inches in length and be of heavy duty design incorporating two 1-inch wide draw bands.

.5 Reflector: Deep dish, 100% efficient, mill-finished aluminum, ASTM 1100, .024 inch thickness aluminum sheet metal with two reflector support brackets for each 10 feet (3048 mm) reflector section. Reflectors shall extend below the lowest position of the tubing at all times, and include standard end caps.

.6 Reflector Extension Shields: When called for in the Contract documents, reflector extensions shall be the same Material as reflectors, arranged for fixed connection to lower reflector lip and incorporate rigid support to provide 100 percent cutoff of direct radiation from tubing at angles greater than 30 degrees from vertical.

.7 Reflector end caps: Shall be fitted to the end of each reflector run to reduce convective heat loss, and shall be standard equipment.

.8 Hangers: Heavy duty (minimum 0.3125 inch), chrome plated, wire-formed hangers shall be included as standard. Stainless steel hangers shall be an approved alternate. Hangers shall allow for tipping the reflector up to 45 degrees from horizontal centerline of the heat exchanger.

.9 Burner: Shall be a positive pressure burner system, where exhaust gases and other products of combustion are not routed through the blower. The burner shall operate at a minimum gas inlet pressure of 5.0 inches W.C. (natural gas) or 11.5 inches W.C. (propane) and draw no more than 1 Amp at 120VAC, 60Hz.

.10 Burner head shall be chrome plated steel.

.11 Burner operation controls: Shall be factory assembled, piped, and wired. Gas and electric controls shall be separated from the combustion air stream.

.12 Burner Safety Controls:

1) Gas Control Valve shall be a proportional, regulated, redundant 24VAC electric gas valve, incorporating a pressure regulator and manual shutoff all in one body.
2) Control Panel Interlock: Burner shall be serviceable while system is running with no requirements for safety interlock.
3) Integral air pressure switches shall provide for air proving and shall monitor adequate inlet air and vent flow.

4) Indicator Lights: Burner on and run indicator lights shall be standard equipment.

.13 Burner ignition system: Shall be direct spark (DSI) with gas ignition and flame proving taking place within the main burner cup for reliability. Igniters that traverse the gas stream add turbulence to the burner flame and shall not be allowed. DSI ignition control shall:

1) Provide for 3 trials for ignition before lockout.
2) Recycle again in one hour after lockout, with 3 subsequent trials for ignition.
3) Provided a lighted diagnostic display capability.
4) Provide openly accessible sense current measurement contacts within the housing.
5) Provide a standard blower post purge function when called for in the Contract documents.
6) Accept 24V thermostat wiring
7) For Model UXR, the ignition control shall be potted to seal against moisture and contamination.

.14 Air blower motor shall be Permanent Split Capacitor (PSC) type, totally enclosed requiring no oiling and shall be equipped with a thermal overload switch Electrical supply: 120V, 60Hz, 35W, 0.3A

.15 Secure burner fastening: Hanger shall incorporate chrome plated fastening means to secure burner and prevent rotation about the centerline axis of the heat exchanger over time.

.16 Combustion-Air Connection: Duct connection to burner for combustion air to be drawn directly from outside or inside shall be provided as factory standard.

.17 Heaters shall be factory designed and approved to operate on either Natural gas (NG) or Liquid propane gas (LPG) as called for in the Contract documents.

.18 Products.

1. Low Intensity Single Stage Infrared Tube Heaters: Heavy duty industrial/commercial infrared heater featuring the best overall performance in the industry. Firing rates as called for in the Contract documents within the range of 40 MBH to 220 MBH. 100% efficient reflector design with minimum 65% radiant factor as determined by independent lab testing to EN416-2 Standard. Baffles required as per manufacturer's instructions.

.19 Product shall be Low Intensity Infrared Heater: Model UA (sealed blower design), Model UX (enclosed burner design), or Model UXR (enclosed, moisture sealed burner design for rugged, harsh environments or outdoor use) as manufactured by Superior Radiant Products.

a. Input rate shall be as called for in the Contract documents within the range of 40,000 to 220,000 BTU/H.
b. Radiant Tube Length shall be as called for on the Contract documents within the range of 10 feet (3048 mm) to 70 feet (21336 mm). Refer to Drawing schedule.
c. Recommended Range of Minimum Hanging Heights shall be 10 feet to 29 feet (3048 to 8839 mm) as called for in the Contract documents.
d. All burner operating components shall be enclosed in burner housing.

.5 Alternate Manufacturers

.1 Other low intensity radiant heaters of equal or greater thermal efficiency and with the same or lower burner firing rate capacity, and with the radiant distribution pattern shown on Drawing may be acceptable provided they meet the intent of these Specifications and prior approval in writing is obtained from the Contract Administrator at least twenty (20) days before the bid date. If such systems are approved, the Contractor assumes responsibility for the design, performance and expanse of same. The redesigned system, gas piping, and electric wiring shall be done by a registered mechanical Contract Administrator. Shop Drawings of the entire new system shall be provided by this Contractor. The Contractor should state the amount to be credited to the The City due to this substitution.

.2 Where approved substitutes are used, the Contractor assumes all responsibility for physical dimensions and all other resulting changes. This responsibility extends to cover all extra Work as necessitated by other trades as a result of the substitutions.

.3 The Contract Administrator reserves the right to require the Contractor to remove and replace any Material or equipment which does not meet Specifications or does not have any prior approval as a substitute item. Work shall be completed immediately without cost or inconvenience to the The City.

.6 Field Quality Control

.1 Start-Up: Start-up, test, and adjust gas fired, radiant heaters in accordance with manufacturer's start-up instructions, and Utility Company's requirements. Check and calibrate controls, adjust burners if applicable according to manufacturer's instructions for maximum efficiency.

.7 Closeout Procedures

.1 Training: Provide services of manufacturer's technical representative to instruct operating personnel in operation and maintenance of gas fired radiant heaters.

.1 Schedule instruction with operating building The City, provide at least 7 days notice.

.8 Warranty

.1 Provide written warranty, by manufacturer, agreeing to replace/repair, within warranty period, components of gas fired radiant systems furnished by manufacturer, which are defective in either Material or workmanship, provided manufacturer's instructions for handling, installing, protecting, and maintaining units have been adhered to during warranty periods follows:

.1 Warranty Period: 3 year warranty on all components.

.2 Warranty Period: 5 year warranty on hot rolled heat exchanger without post purge feature.

.3 Warranty Period: 7 year warranty on hot rolled heat exchanger with post purge feature and aluminized or stainless steel heat exchanger without post purge feature.

.4 Warranty Period: 10 year warranty on aluminized or stainless steel heat exchanger with post purge feature

.9 Refer to Specification for Radiant Heater Schedule.

Part 3 Execution

3.1 DUCT OPENINGS

.1 Locate only openings in walls, floors, partitions, beams, etc. required for ducts, equipment, etc. General 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 23 90 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 DUCT CONSTRUCTION

.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 ducturns in all elbows of ducts 1200mm (48") wide and greater, in segments of 600mm (24") maximum.

.4 Single thickness partitions between ducts not accepted.

.5 Provide openings for thermostats and controllers by Division 25.

.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 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.

.8 Assemble round duct sections using beaded couplings attached with sheet metal screws.

.9 Drawings indicate general layout of ductwork. Additional offsets or changes in direction to be made at no extra cost to The City.

.10 On round and spiral ductwork, outside sleeve surface and duct to be brushed with sealing compound before assembly. Place sheet metal screws on 200mm (8") centres, with three screws, each side of joint. After assembly, brush both joint and screws with sealing compound. Seal all duct seams, and joints between ducts, fillings, etc. with Duro-Dyne S-2 duct sealer and Duro-Dyne FT-2 fiberglass duct tape. Prior to installation ductwork to be clean, dry and free of grease. Apply duct sealer with a 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.

.11 90 degree elbows to be 5-piece mitred construction. 200mm(8") diam. 90 degree elbows or less can be solid 1-piece molded type. Use conical connections throughout installation.

.12 Install flat oval ducts as per manufacturer's published Bulletin F.O. #6. Brace with United truss couplings or angle flanges on four foot centres. Use companion angle flanges with maximum width (major axis dimension) exceeds 660mm (26"). This bracing to limit wall deflection from static pressure to maximum of 100mm (.41") at 1.2 kPa (5") static pressure. Provide matched fittings. Install and seal as per requirements for round and spiral ductwork.

3.5 HEAT RECOVERY UNITS

.1 Comply with manufacturer’s written recommendations or Specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

3.6 GAS-FIRED RADIANT HEATERS

.1 Comply with manufacturer’s written recommendations or Specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

3.7 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.

3.8 MANUAL VOLUME DAMPERS

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

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 ROOF AIR INTAKE AND EXHAUST HOODS

.1 Install units as per detail sheet. Sizes shown as roof openings on Drawings. Insulation held on with metal clips.

3.11 REFRIGERANT PIPING AND ACCESSORIES

.1 General
- .1 Install in accordance with CSA B52, EPS1/RA/1 and ASME B31.5.

.2 Brazing Procedures
- .1 Continuously bleed oil free nitrogen gas at positive pressure into pipe during brazing.
- .2 Remove all burrs and ream corners on all cut piping.
- .3 Remove valve internal parts, solenoid valve coils, sight glass.
- .4 Do not apply heat near expansion valve and bulb.

.3 Piping And System Installation
- .1 General:
  - .1 System capacity 24,000 BTUH and lower: Soft annealed copper tubing: bend without crimping or constriction.
  - .2 System capacity above 24,000 BTUH: Hard drawn copper tubing: do not bend. Reduce use of fittings to minimize friction loss.
  - .3 Refrigerant piping shall be pressure tested and witnessed by Contract Administrator prior to insulating.
  - .4 Provide separate piping for split refrigerant circuits.
  - .5 Installation in accordance with good refrigerant piping practice.
  - .6 Provide back seating valves as required to isolate individual system components to minimize refrigerant loss during replacement of individual components.
  - .7 Provide flexible vibration eliminators on liquid and suction pipe connections to condensing unit.
  - .8 Pipe sizes as specified in schedule on detail sheet.
  - .9 Provide horizontal and vertical piping support in accordance with accepted standards.
  - .10 Install refrigerant controls supplied by condensing unit manufacturer.
  - .11 Install thermo-expansion valve on each DX coil liquid line with external equalizer connection.
  - .12 Install solenoid pilot control with filter drier in external equalizer line for on-off control of refrigerant flow.
  - .13 Install Henry angle drier immediately upstream of thermo-expansion valve.
  - .14 Provide Henry sight glass between drier and valve only on DX coils located above air cooled condensers.
  - .15 Provide refrigeration equipment manufacturer - approved wiring diagram illustrating all electrical wiring for refrigeration system.
  - .16 Supply all control transformers and all necessary auxiliary controls to provide complete operational system to approval of equipment manufacturer and Contract Administrator. Division 25 shall provide single or multiple stage start/stop control contacts and interconnecting wiring only.
- .2 Suction Lines:

.1 Provide oil traps and grade lines toward compressor to ensure oil return to compressor. Grade all horizontal lines in direction of flow.
.2 Provide double suction risers with oil traps and inverted loop connections for all vertical lines in system.

.3 Hot gas lines:
.1 Pitch at least 1:240 down in direction of flow to prevent oil return to compressor during operation.
.2 Provide trap at base of risers greater than 2400 mm high and at each 7600 mm thereafter.
.3 Provide inverted deep trap at top of risers.
.4 Provide double risers for compressors having capacity modulation.
.1 Large riser: install traps as specified.
.2 Small riser: size for 5.1 m^3/s at minimum load. Connect upstream of traps on large riser.

.4 Pressure and Leak Testing
.1 Close valves on factory charged equipment and other equipment not designed for test pressures.
.2 Leak/pressure test with nitrogen in accordance with CSA B52 prior to evacuation.
.1 R-407C Systems: pressure test to 2068 kPa (300 psig) for 4 hours.
.2 R-410A Systems: pressure test to 3120 kPa (450 psig) for 24 hours.
.3 Test procedure: build pressure up to 35 kPa with dry nitrogen on high and low sides. Supplement with nitrogen to required test pressure. Test for leaks with electronic or halide detector. Repair leaks and repeat tests.

.5 Field Quality Control
.1 Site Tests/Inspection:
.1 Close service valves on factory charged equipment.
.2 Ambient temperatures to be at least 13 deg. C for at least 12 hours before and during dehydration.
.3 Use copper lines of largest practical size to reduce evacuation time.
.4 Use two-stage vacuum pump with gas ballast on 2nd stage capable of pulling 5 Pa absolute and filled with dehydrated oil.
.5 Measure system pressure with vacuum gauge. Manifold gauges shall not be used for evacuation readings. Take readings with valve between vacuum pump and system closed.
.6 System Evacuation:
.1 System evacuation process shall take place from both service valves to ensure entire system is evacuated. Ensure solenoid valves are open during evacuation process.
.2 Triple evacuate system components containing gases other than correct refrigerant or having lost holding charge as follows:
.1 To 1000 microns and hold for 1 hour.
.2 To 500 microns and hold for 1 hour.
.3 To 200 Microns and hold for 1 hour.
.4 Change vacuum pump oil between each evacuation.
.5 Isolate pump from system, record vacuum and time readings until stabilization of vacuum.
.6 Submit test results to Contract Administrator.
.7 Charging:

.1 Provide initial charge of refrigerant and oil, as well as any additional amounts required during system warranty. Refrigeration Contractor shall use virgin refrigerant only
.2 Initial charge of refrigerant into the system shall be in liquid state. Once system is in operation additional refrigerant to top off system shall be charged into the system in gaseous state.
.3 Charge system through filter-drier and charging valve on high side. Low side charging not permitted.
.4 With compressors off, charge only amount necessary for proper operation of system. If system pressures equalize before system is fully charged, close charging valve and start up. With unit operating, add remainder of charge to system.
.5 Re-purge charging line if refrigerant container is changed during charging process.

.8 Checks:
.1 Make checks and measurements as per manufacturer's operation and maintenance instructions.
.2 Record and report measurements as indicated in Part 2 of this Specification section.
.3 Refrigeration Subcontractor shall include for normal Fall shutdown services as recommended by refrig. manufacturer. Include in quotation for startup during second cooling season. Issue reports for each operation to The City and Contract Administrator. Refrigeration Subcontractor shall ensure that The City's representative is present during second cooling season start-up to verify that refrigerant and oil levels are satisfactory. Provide The City with 48 hour prior notice.

.9 Manufacturer's Field Services:
.1 Have manufacturer of products, supplied under this Section, review Work involved in the handling, installation/application, protection and cleaning, of its products and submit written reports, in acceptable format, to verify compliance of Work with Contract.
.2 Provide manufacturer's field services consisting of product use recommendations and periodic Site visits for inspection of product installation in accordance with manufacturer's instructions.
.3 Schedule Site visits, to review Work, at stages listed:
.1 After delivery and storage of products, and when preparatory Work, or other Work, on which the Work of this Section depends, is complete but before installation begins.
.2 Twice during progress of Work: at project start and prior to equipment start-up.
.3 Upon completion of the Work, after cleaning is carried out.
.4 Obtain reports, within 3 days of review, and submit, immediately, to Contract Administrator.

.6 Demonstration
.1 Refrigeration Subcontractor shall provide startup services of refrigeration system with The City's representative present. Instruct The City on proper operation of the system and equipment. Providing that equipment functions satisfactorily, Refrigeration Subcontractor shall confirm in writing date of this startup to Mechanical Subcontractor, Contractor, The City and Contract Administrator. This letter will form part of warranty period documents.
.2 Instructions:

.1 Post instructions in frame with glass cover in accordance with Section 01 78 00 - Closeout Submittals and CSA B52.

.7 Warranty

.1 Manufacturer's warranty for refrigeration compressor to be 5 years from substantial performance.

.2 Refrigerant Subcontractor to provide 13-month warranty on entire refrigeration system including equipment, piping and accessories, such that any further adjustments or alterations during warranty period required to achieve specified refrigeration system performance to be at no additional cost to The City.

.3 Warranty to commence after date of satisfactory start-up and upon receipt of refrig. manufacturer's report of the overall system. Actual date to be determined by the Contract Administrator.

.4 Provide additional amounts of oil and refrigerant required during system warranty.

.5 Refrigeration Subcontractor shall include for system check-out during extreme cold weather in first year of operation (below -28 deg. C) outdoor ambient) to ensure proper operation. Reports for operation shall be issued to Division 25, and Contract Administrator. Refrigeration Subcontractor shall insist that The City's representative be present during check-out to verify that system operates properly and that refrigerant and oil levels are satisfactory.

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 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 confliction 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.

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.

1.3 RELATED WORK SPECIFIED ELSEWHERE

.1 Section 21 05 00 – Mechanical General Provisions.

.2 Section 23 80 10 – Air Distribution.

.3 Division 25 – 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.

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 23 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 return 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 or variable speed drives shall not be used to reduce fan capacity to achieve balance condition. Balance on fan drive only with VAV or VSD at 100% capacity.

.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, return 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 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.

3.4 LEAK TESTING OF AIR DUCTS

.1 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 operation conditions.

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 Manger 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 2º F to 5º 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°F.
Duct Temperature	$\pm$ .5°F.
All Others	$\pm$ .75°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 $\pm$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" NFT 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 that 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 NO_2 Gas Detectors

.1 Honeywell E^3Point 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 handers 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 Magnehelic gauges (4 in West High Bay) 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 West High Bay.

.2 System shall operate as follows:

.1 Maintenance & Repair Building West High Bay

.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. Tie into existing gas detection controller at grid line 2/H. Refer to Keynote 4 on M1.1.

.3 When all gas sensors are installed, provide gas sensor location map including gas sensor locations and ID numbers, controllers, etc.

.3 Heat Recovery Units, HRU-1/2

.1 HRU comes 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 supply and exhaust will operate continuously. Gas heating section shall modulate to maintain a space temperature of 70°F (adjustable).

.3 In the future to account for the on/off tailpipe exhaust systems, HRU exhaust will modulate to maintain space pressure differential setpoint to maintain a balance between exhaust air and outdoor air. HRU internal controls via differential pressure sensors across the cores will draw air through the unit bypass opening as required to prevent frosting on the cores. Provide provisions as required for this future arrangement.

.4 Provide the following DDC points to the control system:

.1 Supply Fan Status and Command

.2 Exhaust Fan Status and Command

.3 Supply Fan Speed

.4 Exhaust Fan Speed

.5 Supply Air Temperature

.6 Exhaust Air Temperature

.7 Pre Heat Air Temperature (ie Temperature before Gas Heating Section)

.8 Supply Air Low Limit Status (ie Freeze Stat)

.9 Free Cooling Command

.10 Filter Differential Sensor

.11 Space Temperature

.12 Core Differential Sensor

.13 Bypass Opening On/Off

.14 Bypass Airflow

.15 Control Cabinet Temperature

.5 Provide BMS alarm if space temperature falls below 50°F (adjustable).

.4 Infrared Heaters

.1 Infrared heaters shall modulate to maintain a space temperature of 70°F (adjustable).

.2 Provide BMS alarm if space temperature falls below 50°F (adjustable).

.3 Infrared heaters shall be enabled and disabled through BAS in the following zones:

.1 Maintenance & Repair Building West High Bay

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 01.

.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 American National Standards Institute/ International Electrical Testing Association (ANSI/NETA)

.1 ANSI/NETA Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems.

.3 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.

.4 Notify the Contract Administrator of any discrepancies or conflictions with any regulation seven (7) working days before bid opportunity close. Failing such notification, meet all such requirements without change to the contract price.

.5 In no instance shall the standard established by these specifications and drawings be reduced by any of the codes, rules or ordinances.

.6 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 General 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 General 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 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.

1.6 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. P.A., CCTV, Intercom, 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.

.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. Division 26 shall stamp shop drawings as evidence of review. Unreviewed shop drawings will be returned, marked revise and re-submit. Division 26 shall ensure the General Contractor and other affected sub-contractors review the shop drawings. Division 26 shall review other trades’ relevant shop drawings and stamp accordingly. 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 sub-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 Incomplete submissions will be returned for updating and re-submittal without Contract Administrator's review.

.18 Quality Control

- .1 Provide CSA or equivalent certified equipment and material.
- .2 Where CSA or equivalent 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.

.19 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.

1.7 QUALITY ASSURANCE

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

1.8 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.

1.9 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.

1.10 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 (including, but not limited to, all other disciplines' drawings and specs), 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. Check all other discipline plans, elevations and details for location of electrical devices, equipment and equipment to be connected.

.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.

1.11 COORDINATION OF EQUIPMENT AND SERVICES IN ABOVE-CEILING SPACES AND SERVICE ROOMS

.1 Coordinate installation of equipment and services in above-ceiling spaces and service rooms.

.2 Install equipment and services in such way to utilize spaces efficiently and to maximize accessibility for installations and maintenance of equipment and services of all trades. Review requirements of other trades. Consider required clearances for maintenance and repairs of equipment provided by other trades.

.3 Examine contract documents for ceiling space. Examine structural, architectural and mechanical obstructions. Examine manufacturer’s requirements for maintenance.

.4 Examine shop drawings of equipment of other trades.

.5 Where equipment or services are installed in existing above-ceiling spaces and service rooms.

.6 Assign space priorities and lay out equipment and route services so they can be installed efficiently in these spaces and provide code-compliant access to equipment and services for maintenance.

.7 The location of equipment in ceiling spaces shall be such that it can be accessed for maintenance from a location immediately below the equipment, by two hands at a time, by removal of a ceiling tile or an access panel.

.8 All above-ceiling installed equipment shall be located such that there is no interference with furniture and equipment in spaces below ceiling or above-ceiling mechanical and electrical systems.

.9 Where access to equipment or service is required for maintenance, removal or relocation of another equipment or service shall not be required.

1.12 PENETRATIONS IN STRUCTURAL MEMBERS

.1 Penetrations in existing structural members.

.1 Provide electrical services through structural members as shown on drawings.

.2 Penetrations in new structural members.

.1 Coordinate work with structural for penetrations through new structural members.

.2 Review structural drawings.

.3 Coordinate steel shop drawings to include for penetrations of electrical services through structural members. Review structural steel shop drawings prior to submission to Structural Contract Administrator for review.

.3 Installations that deviate from structural drawings are not acceptable.

.4 Submit proposals for deviations to Contract Administrator for review.

1.13 AS-BUILT DRAWINGS INDICATING CONDUIT/CABLE RUNS & EQUIPMENT LOCATIONS

.1 Produce as-built drawings in AutoCAD format describing the entire electrical as-built condition. Drawing shall indicate, but shall not be limited to:

.1 Record the horizontal and vertical routing of all electrical cables and conduits installed under this Contract. This includes the entire electrical distribution, all other Division’s electrical systems, and lighting.

.2 Record drawing information shall be organized and presented as follows. Each of the following groups of systems shall be recorded on separate record drawing sets. Do not 'crowd' drawings with as-built record information. Use additional drawing prints as required. In addition to the plan record drawings, provide supplemental riser schematics for clarity.

.1 Normal Power: Power and receptacles for all cable/wiring 120 Volts or greater excluding lighting.

.2 Normal Power: Distribution Equipment Feeders.

.3 Fire alarm and control systems.

.3 Record the location of the following: All power distribution equipment, cable splices, pull boxes, junction boxes, access fittings, power supplies and system control equipment, annunciators, terminal cabinets, etc.

.2 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.

1.14 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 Final copy of Short Circuit, Coordination and Arc Flash Study with all changes incorporated.
- .5 Names and addresses of local suppliers.
- .6 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, check lists, programming details 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.

1.15 TEMPORARY LIGHTING AND POWER

.1 All temporary and construction lighting and power work and costs for same are not included as part of the scope of the work of this section. Refer to such clauses in other sections of the specification.

1.16 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 Division 01.

2.2 MATERIALS AND EQUIPMENT

.1 Provide materials and equipment.

.2 Equipment and material to be CSA certified or certified by an equivalent recognized certifying agency to meet Canadian Standards. Electrical equipment consisting of individual certified components must also have a CSA or equivalent 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 General 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 on electrical drawings, or in this specification and related mechanical responsibility is indicated in Mechanical Equipment Schedule on 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.

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 LABELS, SIGNS AND MARKINGS

.1 Equipment identification labels, nameplates, signs and markings: in accordance with requirements of authority having jurisdiction and Contract Administrator.

.2 To match existing where applicable.

.3 Confirm with authority having jurisdiction, The City and Contract Administrator before ordering.

.4 Submit lamacoid sample of each type in PDF format to The City and Contract Administrator for review, before ordering.

.5 References:

.1 ANSI Z535.1 – Safety Colors

.2 ANSI Z535.2 – Environmental Facility and Safety Signs

.3 ANSI Z535.3 – Criteria for Safety Symbols

.4 ANSI Z535.4 – Product Safety Signs and Labels

.6 Equipment Identification

.1 Identify electrical equipment with nameplates and labels as follows, and as indicated in other specification sections:

.1 Nameplates: lamacoid 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.

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 pullboxes and junction boxes to indicate system and/or voltage characteristics.

.6 Panelboards: indicate name, amperage, voltage, phases, wiring configuration and equipment fed from.

.7 CDP type distributions, switchboards: indicate name, amperage, voltage, phases, wiring configuration and equipment fed from.

.8 Disconnects, and starters: indicate equipment being controlled and voltage.

.9 Transformers: indicate name, capacity, primary and secondary voltages.

.10 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.

.11 Co-ordinate names of equipment and systems with Mechanical section to ensure that identical names are used.

.12 Nameplates for control devices: indicate equipment controlled.

.13 Adjacent to each breaker in CDP type panelboards, and switchboards, provide and mount lamacoid nameplates identifying the respective load and location.

.14 End-of-line resistor: Indicate device with wording “END-OF-LINE RESISTOR, ZONE xx”. Include actual zone name/number. Provide white nameplate with black letters.

.7 Receptacle Identification

.1 All 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.

.8 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).

.2 Conductor marker identification shall correspond with panel or terminal board directory information.

.3 Wire in conduit #2 AWG and smaller shall have solid coloured insulation, colour coded as listed below.

.4 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. Neutral and ground conductors shall be identified. Paint or other means of colouring the insulation shall not be used.

.5 Colour code wire in conduit and single conductor cables as follows:
Phase A - red
Phase B - black
Phase C - blue
Neutral - white
Ground and bonding - green

.6 Maintain phase sequence and colour coding throughout project.

.7 Insulated bonding and grounding bonding conductors shall have a green finish and shall be used only as a bonding and grounding conductor.

.8 Identify control conductors in motor control equipment, contactors, fire alarm panels, etc. with wire markers.

.9 Use colour coded wires in communication cables, matched throughout system.

.10 Colour coding used shall be documented by individual systems in Maintenance Manuals.

.9 Conduit Identification

.1 Identify conduit as follows:

.1 At entry to and exit from equipment, within 300mm from equipment, including pull boxes and junction boxes.

.2 At penetrations through walls, ceilings, floors, at each side, within 300mm from penetration.

.3 At every 10m along the run.

.4 Label indoor and outdoor installation.

~~.5~~ Provide self adhesive vinyl labels, UV resistant, with following wording, as applicable:

.1 For normal power: “NORMAL POWER, 120/208V”, or with an appropriate voltage.

.2 Other communication systems, label as required

.3 FIRE ALARM

.4 CONTROLS

.5 Other systems, label as required.

.6 Label sizes per following table.

Outside Conduit/Cable Diameter		Minimum Length Label		Minimum Letter Height	
Inches	mm	Inches	mm	Inches	mm
.75-1.25	19-32	4	100	0.5	13
1.5-2	38-51	4	100	0.75	19
2.5-6	64-152	6	150	1.25	32

.7 Provide larger label to suit wording as required.

.8 Label colors

.1 Black letters on orange background. Wording shall be uppercase.

.9 Labels installed outdoors shall be rated for outdoor applications.

.10 Labels shall be manufactured in accordance to ANSI Z535.4 Product Safety Signs & Labels.

.11 Approved manufacturers

.1 GTS Sign Design

.2 Accent Striping & Lettering Co

.2 Branch circuit junction box identification

.1 Show circuit numbers in black felt marker on inside of covers.

.10 Identification Of Workplace Clearance

.1 Identification on equipment

.1 Provide adhesive-backed vinyl on equipment, 3.5 mil thick, minimum size 76mm x 127mm , yellow background with black letters, with wording: "WARNING - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 1 METER."

2.7 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 Color selection

.1 Indoor equipment, ASA61 (light grey).

.2 Outdoor equipment, “Equipment Green”

2.8 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 (or certified by an equivalent recognized certifying agency to meet Canadian Standards) 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.

2.9 REQUEST FOR EQUAL

.1 Refer to Bid Opportunity clause B7 for substitute requirements.

2.10 WIRING TERMINATIONS

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

2.11 SINGLE LINE ELECTRICAL DIAGRAMS

.1 Provide single line electrical diagrams under plexiglass as follows:

.1 Electrical distribution system: Locate in main electrical room or as designated by The City's representative.

.2 Drawings: 600 x 900mm minimum size.

2.12 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.

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 - GENERAL

.1 Install conduit and sleeves prior to pouring of concrete.

.2 Sleeves through concrete: schedule 40 steel pipe, sized for free passage of conduit, and protruding 50 mm.

.3 If plastic sleeves are used in fire rated walls or floors, remove before conduit installation.

.4 Install cables, conduits and fittings to be embedded or plastered over, neatly and close to building structure so furring can be kept to minimum.

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

.6 All conduits to be hidden in all locations except mechanical and electrical rooms.

.7 Redundant, unused or empty conduits, raceways, cable trays, supports, junction and pull boxes and other equipment, including associated cables and wiring, that was installed under this project but was not used shall be removed from the site unless otherwise noted. Where conduits, raceways, cable trays, supports, junction and pull boxes and other equipment, including associated cables and wiring, were required to be installed to facilitate construction work, such as temporary feeds these shall be removed from the site unless otherwise noted.

3.4 CONDUIT AND CABLE INSTALLATIONS ON ROOFS AND ROOF PENETRATIONS

.1 When conductors/cables are installed in conduits on roofs, EMT conduit to be provided c/w liquid tight couplings

.2 EMT conduits to be installed on roof top rubber supports. Unistrut channels to be provided as required.

.3 Roof penetrations to be provided with roof flashings specifically made for electrical cable and conduit penetrations.

.4 Roof flashings to be installed by a roofing contractor.

.5 Approved manufacturers:

.1 Rubber supports: Eaton – Dura-Block or approved equal in accordance with B6.

.2 Electrical roof flashings: Thaler or approved equal in accordance with B6.

.6 Provide shop drawings for review in accordance with specification section 26 05 00 Common Work Results – For Electrical.

.7 Install per manufacturer recommendations.

3.5 CABLE INSTALLATIONS DURING LOW AMBIENT TEMPERATURES

.1 When installing cables during low ambient temperatures, the installation shall be performed in accordance with the manufacturer's recommendations and the Canadian Electrical Code.

.2 Cables stored at temperatures below the minimum recommended installation temperature shall be warmed to temperatures above the minimum by keeping the cable in heated storage for at least 24 hours prior to installation.

3.6 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 Contractor prior to install.

.5 Install duplex receptacles and GFI receptacles as follows:

.1 Vertically mounted with grounding terminal facing down.

.2 Receptacles in mechanical rooms, coordinate locations and orientation with Mechanical Contractor.

.3 In existing areas, to match existing.

.6 Receptacles not mentioned above, coordinate location and orientation with Contract Administrator.

.7 Locate light switches on latch side of doors.

3.7 MOUNTING HEIGHTS

.1 Mounting height of equipment is from finished floor to centre line of equipment unless specified or indicated otherwise.

.2 Review all other discipline's drawings.

.3 If mounting height of equipment is not specified or indicated, verify with Contract Administrator before proceeding with installation.

.4 Install electrical equipment on wall at following heights unless indicated otherwise.

.1 Local switches: 1200mm.

.2 Wall receptacles:

.1 Confirm mounting heights with the City prior to rough in.

.2 General: 400mm.

.3 In mechanical rooms: 915mm.

.3 End-of-line resistors: 1800mm to the top edge of the device.

.4 On/off pushbuttons: 1200mm.

.5 Manual starters: 1200mm.

.6 Heights as above or at bottom of nearest block or brick course except where required to comply with Manitoba Building Code, other applicable codes, authorities having jurisdiction, etc.

.7 Heights and orientation to match existing where applicable except where required to comply with Manitoba Building Code, other applicable codes, authorities having jurisdiction, etc.

.8 Where multiple existing devices are present and are installed at different heights or orientations, confirm mounting height and orientation of new devices with Contract Administrator prior to rough in.

.9 All controls for the operation of building services or safety devices including electrical switches, dimmers, thermostats, intercom switches, card access readers, door security request to exit pushbuttons, etc. that are intended to be operated by the occupant, must be mounted between 400mm and 1200mm above the finished floor (to comply with the Manitoba Building Code for accessibility to a person in a wheelchair).

.10 Notify Contract Administrator for any discrepancies related to mounting heights and orientations.

3.8 SHORT CIRCUIT, PROTECTIVE DEVICE COORDINATION AND ARC FLASH STUDY

.1 General

.1 Submit a complete Short Circuit, Protective Device Coordination and Arc Flash Study for the equipment and the protective devices provided under this contract as well as for the existing upstream and downstream protective devices affecting the equipment in this contract. If any existing protective devices must be adjusted for proper coordination, other existing protective devices that are affected must be included in the study and adjusted as required for proper coordination.

.2 Consider all possible modes of operation and provide description for each (i.e. feeding from multiple utility sources, main-tie-main configuration, emergency generator, multiple emergency generators in parallel, co-generation, etc.)

.3 For new distributions include existing upstream overcurrent protection affected by new distribution. Where applicable, include protective devices owned by the utility.

.4 Obtain protective device and fault level information from utility.

.5 Drawings of existing distributions are available. Visit site to obtain information.

.6 The Contractor shall provide all information as required to his supplier of service to prepare this study. This shall include feeder sizes, feeder types, feeder lengths, transformer sizes and impedances, breaker catalogue numbers and tripping characteristics, equipment shop drawings, existing equipment nameplate data, etc.

.7 Feeder types, sizes and lengths shall be from the actual installation. Contractor to measure each feeder length after a feeder is installed. Estimated lengths from floor plans are not acceptable.

.8 Identification names of protective devices and distribution equipment in the study shall match the identification shown on the contract documents and names of existing devices where applicable.

.9 The study shall be done by a Professional Engineer licensed in the Province of Manitoba and the study shall be signed and sealed by the same Professional Engineer.

.10 The study shall be started immediately on award of contract and shall be submitted for review in advance of distribution equipment shop drawings. Minimum transformer impedance values from transformer specifications shall be used for the short circuit calculations.

.11 One PDF file of the study shall be submitted to Contract Administrator for review.

.12 Before completion of the project a final study shall be provided to Contract Administrator for review with all changes incorporated.

.13 The final study, after being reviewed by Contract Administrator, shall be included in the Operations and Maintenance Manuals, with all comments from Contract Administrator incorporated, and shall include:

.1 A title sheet listing the study name, project name, project number, date, engineering company that prepared the study (including address and phone number), the engineers seal and signature, etc.

.2 Table of Contents.

.3 Purpose of the study.

.4 Input data, including equipment nameplate data, cable sizes, cable lengths and cable configurations.

.5 All other requirements described below.

.14 All adjustable protective devices shall be set per final study.

.15 Qualifications

.1 The equipment manufacturer or approved engineering firm shall demonstrate experience with Arc Flash Hazard Studies by submitting names of at least ten actual arc flash hazard analysis it has performed in the past year.

.16 Acceptable Supplier of Service:

.1 Eaton

.2 Meg-A-Ron Engineering

.3 Shermco Industries

.4 Siemens

.5 SMS Engineering

.2 Short Circuit Study

.1 Determine the fault currents at critical points in the distribution system under the worst-case conditions in order to ensure the adequacy of the electrical equipment and the protective devices. Where applicable, contributions from all motors, capacitor banks, batteries, etc., shall be considered.

.2 Calculate maximum available short circuit currents for each equipment bus and compare calculated fault currents against equipment bus and protective device interrupting ratings.

.3 All locations shall be listed in table format with pass, marginal or fail mark. This listing shall also include the interrupting rating of the protective devices provided by this contract.

.1 Pass limit shall be set below 90%, marginal limit shall be set between 90% and 100% and fail limit above 100% of interrupting rating of respective bus/device.

.4 For the calculation of the available fault levels use infinite fault levels at utility transformer and actual transformer kVA and actual impedance values of the installed transformers. Typical or estimated values are not acceptable.

.5 In all cases use actual cable types, cable sizes and cable lengths.

.6 Describe the criteria used in the study and identify any areas of compromise, potential problems, marginal adequacies, etc.

.7 As applicable, provide summary of all equipment that marginally passed or failed the equipment evaluation or statement that all equipment ratings are satisfactory, and no corrective actions are required.

.3 Protective Device Coordination Study

.1 Select settings and characteristics for the protective devices in order to provide proper protection for all distribution equipment and wiring and achieve maximum selectivity between devices during fault conditions (ie. the device nearest the fault will operate first, thus minimizing the interruption).

.2 The coordination of the protective devices and protection of equipment shall govern (shall have priority over possible reductions of high arc flash levels). Revision of the settings for the purpose of reduction of high arc flash levels shall be considered only after proper coordination is achieved.

.3 Mis-coordination should be checked among all devices within each branch containing the immediate protective device upstream and downstream, and settings shall be adjusted to prevent mis-coordination.

.4 Where possible, turn the instantaneous pickup off or set it to a higher value and/or apply delay time to prevent overlapping with downstream device's instantaneous curve, while maintaining coordination with upstream device.

.5 Consider zone selective interlocking schemes between protective devices, where applicable.

.6 Consider protection settings of arc reduction switches, where applicable, and provide comments on coordination/mis-coordination with equipment protection, start-up of motors, transformer inrush currents. Identify potential issues, related to nuisance tripping and provide summary in table format identifying devices that may trip on start-up/energization of respective equipment with arc reduction feature in use.

.1 Provide separate set of settings (in addition to the normal operation settings) for protective relays provided with arc reduction switches and identify these settings respectively.

.7 Set the protective device operating curves below the corresponding cable and equipment damage curves.

.8 Include time current diagrams showing proper selective coordination and equipment protection.

.9 On each time-current diagram, include a box showing a single line diagram of the respective distribution equipment.

.10 On each time-current diagram include maximum available short circuit currents at each bus.

.11 In addition to the curves of the protective devices, each time current drawing shall show and include, as applicable, proper protection and coordination for:

.1 Transformer damage curves (single phase and three phase fault).

.2 Transformer inrush points.

.3 Transformer full load currents.

.4 Transformer kVA rating.

.5 Generator damage curve.

.6 Generator 3-phase and single-phase fault decrement curves.

.7 Generator full load current

.8 Cable damage curves.

.9 Motor starting curves.

.10 Automatic transfer switch short circuit rating (i.e. fault current at 3 cycles or as applicable)

.12 Avoid overlap between transformer inrush current and intended protection curve.

.13 Transformer inrush point shall be as follows:

.1 For normal operation: 12 x full load current @ 0.1 Sec

.2 For hot-load pickup:

.1 13 x full load current @ 0.1 Sec for 120% loading

.2 14 x full load current @ 0.1 Sec for 160% loading

.3 15 full load current @ 0.1 Sec for 200% loading

.3 For cold-load pickup:

.1 6 x full load current @ 1 Sec

.2 3 x full load current @ 10 Sec

.3 2 x full load current @ 15 Min

.14 Curves shall be plotted on a standard log-log scale as time versus current values on a common 600 Volt base, or other standard voltage levels as applicable.

.15 Ground fault curves shall be plotted on same drawings as overcurrent curves to ensure proper coordination. Do not overcrowd drawings, provide additional drawings as required.

.16 In the cases when main breakers in distribution equipment have ground fault protection and branch feeder breakers don't have ground fault protection, set the ground fault protection curve of main breakers on the right side of the phase protection of the branch breakers.

.17 Show protection curves of all protective devices that are mis-coordinated with downstream or upstream protective devices. When there are multiple protective devices of same size and type, protecting same equipment, (i.e. multiple identical branch breakers in a CDP type distribution feeding multiple identical panelboards) only one branch device may be shown (one protective device with the respective equipment that is protecting may be shown), but all mis-coordinated devices shall be listed in the summary (as mis-coordinated).

.18 All protective device settings shall be listed in table form including details such as model, type, voltage and current rating, rating plug and sensor rating, settings for each segment, etc.

.19 Settings of long time, short time and instantaneous elements shall be shown in amperes. Settings of delay time elements shall be in seconds. Showing only position on rotary switch is not acceptable, but may be shown in addition to corresponding ampere and time values.

.20 Where there is equipment such as but not limited to the following: uninterrupted power supply units, harmonic filters, power factor correction equipment, motor control centres, variable frequency drives, rectifiers, control panels and other equipment, provided with main protective devices, also include those main protective devices in the study. Obtain main protective device information from equipment manufacturers.

.21 Describe the criteria for determining proper selective coordination, protection, adequacy, etc. (eg. describe when coordination is achieved, minimum/maximum tripping times and current values, separation between curves, safety margins, damage curves, etc.).

.22 Provide comments for each time current diagram where mis-coordination is present with summary recommendation for improvement.

.23 Identify any areas of compromise, potential problems, marginal adequacies, etc.

.24 When proper selective coordination and proper protection are achieved provide such statement (i.e. "Proper coordination is achieved and no corrective actions are required")

.25 Where settings of existing protective devices are required to be revised provide summary table with recommended new settings. Provide "before" and "after" settings and identify areas of improvements.

.26 When miscoordination is identified between new and existing protective devices and when the mis-coordination cannot be improved by adjusting the settings of the existing protective devices, provide summary table of existing devices that need to be replaced with new and provide general recommendations (i.e. change thermal magnetic breaker with fully adjustable electronic breaker, etc.).

.27 As applicable, provide summary of all devices that need to be replaced to improve coordination, or statement that all protective devices are well coordinated and no corrective action is required.

.4 Arc Flash Study

.1 References

.1 IEEE 141 - Recommended Practice for Electrical Power Distribution and Coordination of Industrial and Commercial Power Systems.

.2 IEEE 242 - Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems.

.3 IEEE 399 - Recommended Practice for Industrial and Commercial Power System Analysis.

.4 IEEE 241 - Recommended Practice for Electric Power Systems in Commercial Buildings.

.5 IEEE 1015 - Recommended Practice for Applying Low-Voltage Circuit Breakers Used in Industrial and Commercial Power Systems.

.6 IEEE 1584 - Guide for Performing Arc-Flash Hazard Calculations.

.7 IEEE 1584.1- Guide for the Specification of Scope and Deliverable Requirements for an Arc-Flash Hazard Calculation Study.

.8 CSA Z462 - Workplace Electrical Safety.

.9 ANSI Z535.4 - Product Safety Signs and Labels.

.2 Submittals For Construction

.1 Arc flash labels shall be provided in hard copy only and affixed to the relevant equipment.

.3 Provide all information as required to the supplier of service to prepare this study. This shall include feeder sizes, feeder types, feeder lengths, transformer impedances, breaker catalogue numbers and tripping characteristics, equipment shop drawings, etc.

.1 Feeder types, sizes and lengths to be from the actual installation.

.2 Contractor to measure each feeder length after the feeder is installed.

.3 Estimated lengths from floor plans are not acceptable.

.4 Actual transformer impedances shall be used. Estimated values or minimum or maximum values from transformer specifications shall not be used.

.4 Arc Flash Hazard Analysis

.1 The arc flash hazard study shall be performed according to the equations that are presented in Z462 - Workplace Electrical Safety, Annex D.

.2 The flash protection boundary and the incident energy shall be calculated for the following: switchboards, switchgear, motor-control centers, CDP’s, panelboards, disconnect switches, transformers, motor

control centres, variable frequency drives, capacitor banks, busway termination boxes, UPS's, harmonic filters, splitters.

.3 In addition, the Arc-Flash Hazard study shall include all significant locations where work could be performed on energized parts. If uncertain, confirm such locations with the City and Contract Administrator.

.4 Safe working distances shall be based upon the calculated arc flash boundary considering an incident energy of 1.2 cal/cm^2.

.5 The short circuit calculations and the clearing times of the phase overcurrent devices shall be retrieved from the short-circuit and coordination study model.

.6 The short-circuit calculations and the corresponding incident energy calculations for multiple system scenarios must be compared and the greatest incident energy must be uniquely reported for each location. Calculations must be performed to represent the maximum and minimum contributions of fault current magnitude for all normal operating conditions. The minimum calculations will assume that the utility contribution is at a minimum and will assume a minimum motor contribution (all motors off). Conversely, the maximum calculation will assume a maximum contribution from the utility and will assume the maximum amount of motors to be operating. Calculations shall take into consideration the parallel operation of synchronous generators with the electric utility, where applicable.

.7 In the case where maximum and minimum grid fault current are not provided by utility, consider 80% and 120% of normal fault level as minimum and maximum fault, respectively.

.8 Infinite utility fault levels shall not be used.

.9 The incident energy calculations must consider the accumulation of energy over time when performing arc flash calculation on buses with multiple sources. Iterative calculations must take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators should be decremented as follows:

.1 Fault contribution from synchronous motors and generators should be decayed to match the actual decrement of each as closely as possible. Use the sequence impedance and transient parameters provided by manufacturer in the equipment cutsheet of the model actual decrement curve. Do not use typical parameters.

.10 For each equipment location with a separately enclosed main device (where there is adequate separation between the line side terminals of the main protective device and the work location), calculations for incident energy and flash protection boundary shall include both the line and load side of the main breaker.

.11 When performing incident energy calculations on the line side of a main breaker (as required per above), the line side and load side contributions must be included in the fault calculations.

.12 Mis-coordination should be checked amongst all devices within the branch containing the immediate protective device upstream of the

calculation location and the calculation should utilize the fastest device to compute the incident energy for the corresponding location.

.13 Arc reduction switches shall be considered where applicable. Two arc flash labels shall be provided, one for normal operation and one for arc reduction switches in operation. Each mode of operation shall be shown on respective arc flash label.

.14 Arc Flash calculations shall be based on actual overcurrent protective device clearing time. Maximum clearing time shall be capped at 2 seconds based on IEEE 1584, section B.1.2. Where it is not physically possible to move outside of the flash protection boundary in less than 2 seconds during an arch flash event, a maximum clearing time based on the specific location shall be utilized.

.15 The protective devices with adjustable settings shall be adjusted to minimize the respective arc flash energy as much as possible without sacrificing the protective device coordination or the protection of the equipment. The coordination of the protective devices and protection of equipment shall govern. Revision of the settings for the purpose of reduction of high arc flash levels shall be considered only after proper protective device coordination and proper equipment protection is achieved.

.16 If revision of the settings is performed for reduction of high arc flash energy while coordination and equipment protection is still satisfactory, the study shall reflect and include these final changes.

.1 Incident energy and flash protection boundary calculations

.2 Arcing fault magnitude

.3 Protective device clearing time

.4 Duration of arc

.5 Arc flash boundary

.6 Working distance

.7 Incident energy

.8 Hazard Risk Category

.9 Recommendations for arc flash energy reduction

.5 Field Adjustment

.1 Arc Flash Warning Labels

.1 The contractor of the Arc Flash Hazard Analysis shall provide a 4in. x 6in. thermal transfer type label of high adhesion polyester for each work location analyzed.

.2 All labels will be based on recommended overcurrent device settings and shall be provided after the results of the analysis have been presented to Contract Administrator and after any system changes, upgrades or modifications have been incorporated in the system.

.3 The label shall be as specified in Figure Q.3 of CSA Z462, Workplace Electrical Safety.

.4 In addition to the requirements specified in Figure Q.3:

.1 Provide information on the equipment location (i.e. Room Name and Number) following after "Equipment Name".

.2 In cases when arc reduction switches are utilized, provide two arc flash labels, one for normal operation and one for arc reduction switches in operation. Each mode of operation shall be shown on respective arc flash label.

.5 Label Colours:

.6 Danger labels need to have the word "DANGER" in safety white letters on a safety red background;

.7 Warning labels need to have the word "WARNING" in safety black letters on a safety orange background; and

.8 If a safety alert symbol is used, it needs to be the same colour as the signal word lettering and the exclamation mark needs to be the same colour as the signal word panel background.

.9 Labels shall be machine printed, with no field markings.

.10 Arc flash labels shall be provided in the following manner and all labels shall be based on recommended overcurrent device settings. For additions to existing distribution system, all existing electrical distributions upstream of the new panels up to point of common coupling with utility shall be labelled.

.1 For each 600 Volt CDP type panelboard, one arc flash label shall be provided. For double tub 600V CDP's, one arc flash label shall be provided.

.2 For each motor control centre, one arc flash label shall be provided. Do not label each individual starter.

.3 For each 120/208V panelboard, one arc flash label shall be provided. For double and or multiple section panelboards, one arc flash label shall be provided.

.4 For each disconnect switch, splitter, transformer, etc., one arc flash label shall be provided.

.5 For each switchgear, one arc flash label shall be provided. Do not label each individual section or breaker cell.

.6 For medium voltage switchgear, one arc flash label shall be provided. Do not label each individual section, switch or breaker.

.7 Labels shall be field installed by Electrical Contractor. A label needs to be readily visible to the worker and alert the worker to the potential hazard in time to make appropriate action.

.8 The labels shall not cover equipment nameplates, names, warning labels, and any other labels on equipment. Provide additional brackets/plates on or near equipment for application of labels if there is no sufficient space on the surface of the equipment.

.9 NOTE: Persons who will be producing and/or installing arc flash and shock warning labels should consult ANSI Z535.4 to ensure that all applicable requirements of ANSI Z535.4 are met.

.6 Arc Flash Training

.1 The contractor of the Arc Flash Hazard Analysis shall train the City's qualified electrical personnel of the potential arc flash hazards associated with working on energized equipment (minimum of 4 hours). The training shall be certified for continuing education units (CEUs) by the International Association for Continuing Education Training (IACET) or equivalent.]

3.9 EQUIPMENT FAULT INTERRUPTING RATINGS

.1 Review and evaluate equipment fault interrupting ratings provided in contract documents against the calculated fault levels in the short circuit study.

.2 Identify all equipment and protective devices that failed the evaluation of the interrupting ratings.

.3 Immediately notify Consultant, listing all equipment and devices that failed, using RFI forms, before the submittal of the respective shop drawings to the Consultant. Incorporate all changes in the respective shop drawings.

.4 If no notification is provided, it is assumed that all interrupting ratings are satisfactory.

.5 If no notification is provided and it is discovered during the review of the shop drawings that interrupting ratings need to be revised to match the short circuit study, the costs associated with the re-production, re-submission, including delays, and the Engineer's re-review of the shop drawings and the short circuit study, shall be the responsibility of the Contractor.

3.10 NEW BREAKERS IN EXISTING EQUIPMENT

.1 New breaker kA rating to match existing equipment bus kA rating.

.2 Where existing equipment bus kA rating is not available, obtain kA ratings of all existing breakers within equipment and match the breaker with highest kA rating.

.3 Provide breaker mounting hardware.

.4 If modifications to existing equipment are required for the installation of new breaker, re-certify equipment to maintain CSA certification or obtain approval from local Electrical Inspection Department or Authority Having Jurisdiction. Cover all costs for inspections and re-certifications.

.5 Program breaker trip unit per protective device coordination study.

3.11 EXISTING CIRCUIT BREAKER INSPECTION AND TESTING

.1 Where existing circuit breakers are re-used, prior to connecting new wiring to existing breakers, they shall be tested as noted below.

.2 Testing and maintenance (if required) should be performed by the breaker manufacturer. Third party testing companies are not allowed unless approved by Contract Administrator.

.3 Testing should be performed in accordance with ANSI/NETA Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems.

.4 The tests below are minimum recommended. If, in opinion of breaker manufacturer, additional tests are required, include the cost for additional testing.

.5 Review recommended testing, confirm testing procedures, pass/fail limits and testing equipment with breaker manufacturer prior to testing.

.1 Panelboard type, thermal magnetic trip, circuit breakers

.1 Clean breaker.

.2 Operate circuit breaker to ensure smooth operation.

.3 Inspect overall physical and mechanical condition.

.4 Check line side connections to bus.

.1 Check torque levels against manufacturer's recommendations.

.2 Use torque wrench to adjust torque levels if required.

.2 CDP type, thermal magnetic trip, moulded case circuit breakers

.1 Clean breaker.

.2 Perform contact resistance testing, each phase.

.3 Operate circuit breaker to ensure smooth operation.

.4 Inspect overall physical and mechanical condition.

.5 Inspect anchorage and alignment.

.6 Inspect bolted connections at breaker and at bus.

.7 Check line side connections to bus.

.1 Check torque levels against manufacturer's recommendations.

.2 Use torque wrench to adjust torque levels if required.

.3 CDP and switchboard type, electronic trip, moulded case circuit breakers

.1 Clean breaker.

.2 Lubricate breaker.

.3 Operate circuit breaker to ensure smooth operation.

.4 Perform contact resistance testing, each phase.

.5 Inspect overall physical and mechanical condition.

.6 Inspect anchorage and alignment.

.7 Inspect bolted connections at breaker and at bus.

.8 Check line side connections to bus.

.1 Check torque levels against manufacturer's recommendations.

.2 Use torque wrench to adjust torque levels if required.

.9 Inspect trip unit operation and ensure trip unit is functional.

.1 Perform primary injection test. Confirm test current with breaker manufacturer before proceeding.

.2 Check trip unit date and time for accuracy (where available), adjust if necessary.

.10 Test operation of all existing features that are present and are going to be re-used for the new load, such as shunt trip, external power for trip unit, zone selective interlocking, remote alarms, etc. Features that are existing and are not going to be re-used to be disconnected or disabled and recorded in test report.

.4 Test report

.1 In addition to requirements outlined in "Contractor's and Manufacturer's Reports", in this specification section, include the following in the test report.

.1 Summary of all breaker features that are used, such as shunt trip, external power for trip unit, zone selective interlocking, remote alarms, arc flash reduction switch, etc., and summary of all disconnected/disabled features.

.2 All test results.

.3 The test report to be submitted to Contract Administrator for review prior to feeder connections.

.4 Obtain written approval from Contract Administrator to connect feeder to existing breaker.

3.12 FIELD QUALITY CONTROL

.1 General

.1 This Section specifies general requirements common to all starting and testing of electrical equipment and systems. Read this Section in conjunction with related Sections which specify specific portions of electrical starting and testing work.

.2 Except where otherwise specified, arrange and pay for the testing and related requirements specified in this and related Sections.

.3 If test results do not conform with applicable requirements, repair, replace, or adjust or balance equipment and systems. Repeat testing as necessary until acceptable results are achieved.

.1 Prior to testing ensure all electrical equipment is cleaned and free of dust.

.2 After testing, protect equipment subject to dust from construction activities.

.3 Do not conceal or cover equipment until observed and approved by Contract Administrator.

.4 Assume all liabilities associated with starting, testing and balancing procedures.

.5 Assume all costs associated with starting, testing, adjusting and balancing, including supply of testing equipment and witnessing.

.4 Provide instruments, meters, equipment and personnel required to conduct tests during and at conclusion of project.

.5 Coordinate starting of electrical equipment and systems with other Divisions.

.6 Notify Contract Administrator when starting and testing of all systems has been completed.

.7 Upon completion of the work and adjustments of all equipment, all systems shall be operated in the presence of the Contract Administrator and the City to demonstrate that all equipment furnished and installed or connected as part of this section of the contract shall function in the required manner as determined by the Contract Administrator. The City or Contract Administrator may elect to not attend demonstration.

.2 Reference Documents

.1 Perform tests in accordance with:

.1 These Contract Documents

.2 Requirements of authorities having jurisdiction

.3 Manufacturer's published instructions

.4 CAN/ULC S537 - Verification of Fire Alarm Systems

.5 NETA Standard For Acceptance Testing Specifications for Electrical Power Equipment and Systems

.6 Other applicable standards

.2 If requirements of any of the foregoing are in conflict, notify Contract Administrator before proceeding with tests and obtain clarification.

.3 Witnessing of starting and testing on site

.1 Where any equipment or systems requires testing prior to starting, ensure that such work has been completed prior to starting of electrical equipment and systems.

.2 Prior to starting and testing of electrical equipment or systems, prepare a start-up and testing schedule of all tests specified.

.3 Review schedules with Contract Administrator and the City. Provide a complete schedule to the Contract Administrator and the City a minimum 2 weeks prior to commencement of testing.

.4 Advise Contract Administrator and the City of dates and times for all testing with sufficient advance notice (minimum three days) to allow Contract Administrator to make arrangements to attend.

.5 Contract Administrator or the City may witness all or any portion of testing and starting procedures performed by Contractor or Contractor's Testing Agent.

.6 Contractor shall be present for all tests specified, even where test is being performed by a supplier or sub-contractor.

.4 Manufacturer's Starting Recommendations

.1 Prior to starting equipment or systems, obtain and review manufacturer's installation, operation and starting instructions.

.2 Use manufacturer's and supplier's starting personnel where required to maintain validity of manufacturer's warranty. Confirm with manufacturer that all testing specified in this Section will not void any warranties.

.3 Compare installation to manufacturer's published data and record discrepancies. Modify procedures detrimental to equipment performance prior to starting equipment.

.5 Manufacturer's Field Services

.1 Arrange and pay for qualified manufacturer's representatives to supervise starting and testing of equipment and systems when in the opinion of the manufacturer such representatives are necessary for the supervision of the starting and the testing.

.2 Manufacturer's personnel shall be experienced in design and operation of equipment and systems being started and have ability to interpret results of readings, and tests and report results in a logical fashion.

.3 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 SUBMITTALS.

.4 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.

.6 Contractor’s and Manufacturer’s Reports

.1 Submit for Contract Administrator’s review completed test report forms in PDF file format immediately after each test is completed.

.2 After a test has been successfully completed, each test report shall contain a summary which clearly states that all results were satisfactory.

.3 Record all data gathered on site on test report forms.

.4 Obtain test report forms from equipment manufacturers. When test report forms are not available of specific tests are requested in this specification create your own test report forms based on those requirements. Where applicable, create test report forms based on samples provided in this specification.

.5 Provide testing personnel names and signatures and date and time of testing.

.6 Note any damage, missing parts or incomplete work on test form.

.7 Record date of corrected deficiencies on form.

.8 Maintain one copy on site of all data taken during starting and testing period.

.9 Maintain one copy of all final starting, testing, balancing and adjusting reports on site up to interim acceptance of the work for reference purposes.

.10 Arrange for manufacturer to submit copies of all production test records for production tests required by EEMAC and CSA standards for manufactured electrical equipment to the Contract Administrator prior to shipping.

.11 Arrange for manufacturer to submit certificate or letter confirming that entire installation as it pertains to each system has been installed to manufacturer's instructions.

.12 Insert final test results, check lists, programming details and certifications in Maintenance Manuals.

.13 Provide calibration certificates for each test equipment.

.7 Test Equipment

.1 Provide all required test equipment.

.2 Test equipment must be calibrated within one year of testing.

.8 Contract Administrator's/the City’s Performance Testing Agent(s)

.1 The Contract Administrator or the City, at his option, may arrange for services of a performance testing agent to separately test or re-test electrical equipment or systems.

.2 Performance testing agent may witness any or all tests or start-ups which are the responsibility of the Contractor.

.3 Performance testing of any system by the Contract Administrator or the City does not reduce the Contractors obligations for complete testing and start-up of systems as specified.

.9 Starting Motors

.1 Prior To Starting Motors:

.1 Confirm motor nameplate data with motor starter heater overloads, setting of MCP's and sizing of fuses.

.2 Verify rotation.

.3 Ensure disconnects are installed.

.4 Confirm labeling of motors, disconnects and starters.

.2 Measure and record operating load amp readings for all three phase motors.

.10 Correction Of Deficiencies

.1 Correct all contract deficiencies found during electrical starting and testing of equipment and systems and Contract Administrator's performance verification.

.11 Testing After Project Completion

.1 Return to site three (3) months after completion to perform load balance, power factor and voltage testing.

.2 Provide test reports and provide corrective actions as required by this specification.

.12 Basic Testing

.1 Perform the following testing:

.2 Bolted Conductor Terminations Testing

.1 Bolted conductor terminations shall be tightened to manufacturer’s published torque values using torque tools.

.2 Torque tools shall be calibrated not more than one year before the date of use.

.3 Obtain torque values from equipment manufacturer.

.4 In absence of manufacturer’s published torque values, use recommended tightening torque values from Canadian Electrical Code.

.5 For equipment rated 400A and above record torque values and provide report to Contract Administrator for review.

.6 Report to include following:

.1 Project name _____

.2 Project # _____

.3 Provide completed form as sample below.

.4 After all terminations have been completed, provide summary in the report to clearly state that all terminations are completed per manufacturer's (or Code) recommendations.

.5 Provide details if torque values deviate from manufacturer's or Code recommended values.

.6 Submit tool calibration certificate with report.

.7 Table 1. Sample form

Equipment name and rating	Phase	Busbar	Terminal Block	Conductor Lug	Bolt Size	Torque Value	Date	Technician Name
CDP-1B 1200A/600V/3ph/3W	A			X	½" x 2"	50ft/lbs	Nov 2/14	John Smith
	B			X	½" x 2"	50ft/lbs	Nov 2/14	
	C			X	½" x 2"	50ft/lbs	Nov 2/14	
All terminations are completed per manufacturer's recommendations.								John Smith

.3 Phase Rotation Testing

.1 Phase rotation testing shall be conducted using a phase rotation meter, after cables are terminated, but before loads are energized.

.2 Where the new cables or new equipment replace existing, verify phase rotation prior to disconnecting the existing. Where counter-clockwise rotation is found, resolve new and existing installations.

.4 Load Balance and Adjusting

.1 Test load balance on all feeders for distribution centres (CDP's), motor control centres and panelboards.

.2 Perform load tests with as many loads on as possible 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.

.3 Revise equipment directories and wiring identification accordingly.

.4 Record all changes on Record Drawings.

.5 Submit, at completion of work, report listing phase and neutral currents on CDP's, panelboards, dry-core transformers and motor control centres, operating under normal load. State hour and date on which each load was measured, and voltage at time of test.

.5 Voltage Testing and Adjusting

.1 Test and record voltage at service entry point, switchgear, switchboards, CDP's, panelboards, motor control centres, loads, secondary lugs of transformers, operating under normal load.

.2 Adjust transformer taps to within 2% of rated voltage of equipment/load.

.3 Record all changes on Record Drawings.

.4 Submit, at completion of work, report listing phase and neutral voltages at each location tested. State hour and date on which each load was measured, and voltage at time of test.

.6 Verification of protective device settings

.1 A certified testing agency normally engaged in field service equipment testing shall be engaged and shall test all circuit breaker settings as follows (to include new and existing breakers that require adjustment of settings):

.1 Verification of settings 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 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.

.7 Insulation resistance testing:

.1 Branch circuits and feeders rated 1000V and less:

.1 Rated up to 350V with a 500V instrument.

.2 Rated 350V - 600V with a 1000V instrument.

.2 Branch circuits and feeders rated above 1000V shall be tested with “Very Low Frequency” test method.

.8 Test all circuits and wires for continuity and high impedance grounds.

.9 Those circuits which test non-continuous, with an insulation resistance less than minimum recommended resistance or with high impedance grounds shall be replaced.

.10 All circuits shall be tested to ensure that the circuit numbers are correct and that the proper neutral conductors have been provided and installed.

.11 Low Voltage Switchgear

.1 Carry out on-site testing and commissioning of all low voltage switchgear including:

.1 Visual observation

.2 Operational tests

.3 Megger tests

.4 Contact resistance tests

.5 Phasing checks
.6 Metering
.7 Relay operation
.8 Hi-voltage tests

.12 Customer metering
.1 Set date and time on customer meters.
.2 Program CT and PT inputs.

.13 Fire Alarm System Testing And Verification

.1 The Contractor is responsible for appointing a testing and verification agent of fire alarm system in accordance with:
.1 CAN/ULC-S537, "Verification of Fire Alarm System Installations", and
.2 Requirements of authority having jurisdiction.

.2 Submit testing and verification report to Contract Administrator for review.

3.13 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.

3.14 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.

3.15 CLEANLINESS AND CLEANING

.1 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 lighting fixtures, lamps, lens, 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.

3.16 MODIFICATIONS

.1 Locations of all light fixtures, convenience receptacles, outlets, switches, voice/data or similar outlets, fire alarm stations, bells, 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.

3.17 ENGINEERING OBSERVATIONS

.1 The term "Contract Administrator" in all electrical sections of specification shall mean:

SMS Engineering Ltd.
770 Bradford Street
Winnipeg, Manitoba
R3H ON3

.2 Contractors work will be observed periodically, solely for purpose of determining general quality of work, and not for any other purpose. Guidance will be offered to Contractor in interpretation of plans and specifications to assist Contractor to carry out work. Observation and directives given to Contractor does not relieve Contractor and his agents, servants and employees of their responsibility to erect and install work in all its parts in a safe and workmanlike manner, and in accordance with all relevant Codes, Standards, plans and specifications, nor does it impose upon the City, and/or Contract Administrator or their representatives, any responsibility to supervise or oversee erection or installation of any work.

.3 The Contract Administrator is not responsible for inspection of the Contractor’s work. The Contract Administrator maintains the right to observe the work at its sole discretion. In addition to the above, Contractor's work may be observed periodically by the City, and/or Contract Administrator or their representatives, without notice or without request from Contractor.

.4 Contractor shall notify Contract Administrator of completion of work at various stages. Notification shall be made as a minimum as noted below (provide minimum 5 working day’s notice), whereupon the Contract Administrator may visit site to periodically observe the work:

.1 After distribution equipment is installed into final location, but before energization. All distribution equipment shall be left with covers removed to allow for an internal review of distribution.

.2 After main feeders and grounding and bonding conductors are installed and terminated.

.3 Before closing walls and ceilings,

.4 At first energization of equipment,

.5 At commissioning,

.6 At final completion of project,

.7 At demonstration of operation of equipment.

.5 Where observation reports are submitted, the Contractor is responsible for rectifying issues noted in the Observation Reports in a timely manner and before covering up the work or affecting access to it.

3.18 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.

3.19 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 in bid opportunity price. Employ and pay appropriate sub-contractor whose work is involved, for carrying out work described above.

3.20 FIRE ALARM INSTALLATIONS

.1 Install fire alarm systems in accordance with CAN/ULC S524, local Codes, manufacturer recommendations and requirements of Authority Having Jurisdiction.

.2 Keep copy of latest edition of CAN/ULC-S524, Installation of Fire Alarm Systems, all time during the construction of the fire alarm system.

.3 The above standard may be referenced and reviewed during the engineering observations.

.4 It is highly recommended the Contractor to be familiar with the above standard.

.5 Newly installed or altered fire alarm systems to be verified in accordance with CAN/ULC-S537, Verification of Fire Alarm Systems and local Codes.

.1 Provide verification report to Contract Administrator for review.

3.21 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 or equivalent, 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.

Pentrating 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

3.22 FASTENERS, SECURITY FASTENERS AND HARDWARE

.1 Install security fasteners as required.

.1 This shall also include security tamperproof screws that are exposed such as in coverplates, system devices, outlet covers, etc.

.2 Minimum requirements for materials:

.1 Zinc plated for indoor applications.

.2 18-8 Stainless steel or hot dip galvanized steel where exposed to weather or moisture.

.3 316 Stainless steel where exposed to salt spray or corrosive environments.

.4 Silicon bronze alloy for grounding connections where exposed to weather or moisture.

.3 Shall be of type and material that will minimize deterioration from galvanic action due to dissimilar metals.

.4 Grade of fasteners shall be suitable strength to meet the requirements of the application.

3.23 EQUIPMENT SECURITY

.1 Provide temporary locking system, comprising of padlocks, equipment door locks, keys, etc. during construction period, to prevent unauthorized access to components within equipment.

.2 Equipment doors shall be kept locked (with keys removed from padlocks and locks) at all times, except when work is performed on actual equipment.

.3 At completion of work, remove temporary locking system from equipment.

.4 Equipment door locks and keys provided by equipment manufacturers to remain. Hand over to the City such keys, tagged with equipment names.

.5 New locking system, after completion of work, shall be provided by the City.

.6 In cases where the City enters into maintenance agreement with utility, typically the utility provides own locking system for that equipment. Coordinate work with utility and the City.

.7 No equipment shall remain without means for locking at any time.

3.24 PROTECTION

.1 Protect exposed live equipment during construction for personnel safety.

.2 Shield and mark live parts "LIVE 120 VOLTS", or with an appropriate voltage in English.

3.25 SCHEDULING OF WORK

.1 Existing buildings will remain in use during construction. Arrange work so that interruption of services is kept to a minimum. Obtain permission from The City prior to cutting into electrical services. Where deemed necessary by Contract Administrator, temporary electrical shall be installed and/or work shall be carried out at night and on weekends.

.2 Contractor to maintain continuous and adequate all existing electrical systems and other services during entire time of this contract. Provide temporary conduit, wire, equipment, etc. where necessary to meet this requirement.

3.26 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 Architectural plans for demolition areas/phasing.

.2 Drawings do not show all electrical requiring removal to accommodate renovations such as receptacles, switches, lights, starters, motors, nurse call systems, components, heaters, etc. Visit site and refer to drawings and include all costs for demolition.

.3 Refer to Specification Section 26 05 05 - Work in Existing Building.

3.27 MAINTENANCE PLAN

.1 Provide maintenance plan, in accordance to CSA Z463 – Maintenance of Electrical Systems, for major pieces of electrical equipment, for new and existing, including but not limited to the following: distribution panels, motor control centres, variable speed drives, disconnects, circuit breakers, feeders, controls, etc.

.2 Provide two (2) hard copies of maintenance plan in hard-backed, D-ring loose leaf binders and one DVD with PDF files of the maintenance plan.

.3 Maintenance plan shall include:

.1 General maintenance instructions

.2 Details on frequency of maintenance

.3 Specific details on maintenance procedures at each maintenance interval

.4 Duration of each maintenance procedure.

.5 Required equipment shutdown.

.6 Look-ahead schedule in a task based, time scaled GANNT chart (one bar per activity).

.7 Identify requirements for shutdown on GANNT chart.

.8 Test forms and test equipment calibration requirements.

3.28 INTERIM AND FINAL OCCUPANCY CERTIFICATION BY CONTRACT ADMINISTRATOR

.1 Interim Occupancy Certification

.1 When final occupancy is not practical due to project phasing or the City's requirements an interim occupancy may be granted for a finished portion of the site.

.2 A Certification letter for Interim Occupancy, will be issued to the Authority Having Jurisdiction (AHJ), by the Contract Administrator, under seal of a Professional Engineer solely for the purpose of applying for Interim Building Occupancy Permit, under following conditions:

.1 The construction was carried out in substantial compliance with the applicable provisions of the Electrical By-laws, the Manitoba Building Code and the Manitoba Energy Code for Buildings and the plans and specifications submitted in support of the application for the building permit. This shall include any additional plans, documents and design decisions that have been part of the contract that were not detailed as part of the submitted permit application.

.2 Life safety systems for the entire structure (occupied and non occupied areas) must be completed entirely. This shall include but not limited to the following (all systems may not apply):

.1 Fire Alarm System

.1 Fire alarm control panel and associated devices and auxiliaries

.2 Central monitoring

.3 Sprinkler system monitoring

.4 Fan shutdowns
.5 Smoke removal system
.6 Magnetic lock door release
.7 Homing of elevator
.8 A certified fire alarm verification report shall be submitted 3 working days before the date the Letter of Certification is required. Including Schedule A where applicable.

.2 Emergency Power
.1 Emergency generator
.2 Automatic transfer switch
.3 Emergency cables
.4 MI cable test reports.
.5 Signals to the Fire Alarm panel when generator is running.

.3 Emergency Lighting
.1 Emergency AC lights
.2 Emergency DC lights
.3 Exit signs
.4 Emergency battery packs
.5 General lighting
.6 Lighting controls

.3 Distribution breakers shall be set to the approved coordination study.
.4 No open wiring shall be present, all terminations shall be installed in a box with cover.
.5 A successful ‘dry-run’ of the Life Safety Test shall be completed.
.6 All electrical installations shall be made safe.
.7 All applicable life safety systems shall be fully commissioned, tested and certified by respective testing agencies.
.8 Certification sheets and test reports shall be submitted to Contract Administrator with no deficiencies.
.9 Electrical and Building permit numbers, project name and address shall be submitted to Contract Administrator.
.10 All Observation Reports shall be submitted to the Contract Administrator, clearly indicating that all deficiencies relating to any of the above are complete. Any items not completed shall be clearly indicated, and the Contractor shall provide a date indicating when the work will be complete.

.2 The interim occupancy certification letter will not be issued until all information required above, including final certification sheets and test reports are received by Contract Administrator, with no deficiencies.

.3 The interim occupancy certification letter will state the applicable non-life-safety exceptions and points of non-compliance with the Electrical By-laws, the Manitoba Building Code and the Manitoba Energy Code for Buildings.

.4 The letter will also state how long the building may be occupied under these conditions, without compromising the health or safety of occupants.

.5 The decision as to whether the Letter of Certification for Interim Occupancy is to be issued lies entirely with the Engineer of Record, and it is incumbent on the Contractor to successfully demonstrate to the satisfaction of the Engineer of Record that the building is ready for Interim Occupancy. Ultimately, once the Letter of Certification for Interim Occupancy is provided to the AHJ, the decision as to whether an Interim Building Occupancy Permit is to be granted lies with the AHJ.

.6 Final Occupancy Certification

.1 A Certification letter for Final Occupancy, shall be issued to the Authority Having Jurisdiction (AHJ), by the Contract Administrator, under seal of a Professional Engineer solely for the purpose of applying for Final Building Occupancy Permit, under following conditions:

.1 The building is to be complete. As such, all items noted in the Interim Occupancy Certification Letter and any correspondence with the AHJ shall be complete including but not limited to the following (all systems may not apply):

.1 All receptacles and switches are installed

.2 All device covers are installed

.3 All panel covers are installed

.4 Arc flash labels are installed to electrical equipment

.5 Electrical equipment is identified with name plates

.6 Panel directories are completed and installed.

.7 A certified fire alarm verification report shall be submitted 3 working days before the date the Letter of Certification is required.

.8 All non-life-safety exceptions and points of non-compliance noted under Interim Occupancy Certification, including all deficiencies noted on Contract Administrator's Observation Reports are completed in compliance with all applicable codes and standards and the plans and specifications submitted a minimum of 3 working days ahead of the date required for the Letter of Certification, in support of the application for the building permit. This shall include any additional plans, documents and design decisions that have been part of the contract that were not detailed as part of the submitted permit application.

.9 All electrical installations are made safe.

.7 Certification letter will not be issued until all information required above, including final certification sheets and test reports are received by Contract Administrator, with no deficiencies.

.8 The decision as to whether the Letter of Certification for Final Occupancy is to be issued lies entirely with the Engineer of Record, and it is incumbent on the Contractor to successfully demonstrate to the satisfaction of the Engineer of Record that the building is ready for Final Occupancy. Ultimately, once the Letter of Certification for Final

Occupancy is provided to the AHJ, the decision as to whether a Final Building Occupancy Permit is to be granted lies with the AHJ.

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).

.3 Section 26 05 32 – Outlet Boxes, Conduit Boxes and Fittings.

.4 Section 26 05 34 – Conduits, Conduit Fastenings and Conduit Fittings.

1.2 WASTE MANAGEMENT AND DISPOSAL

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

1.3 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, sound 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. Submit for approval a written, concise schedule of each disruption at least 120 hours in advance of performing work and obtain The 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 The 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.

1.4 EXISTING DEVICES IN NEW CONSTRUCTION

.1 Where existing devices (receptacles, switches, etc.) presently mounted on a wall which will be covered with a new finish, provide an extension ring, coverplate, etc. or relocate as required to mount the device to the new wall.

.2 Where existing conduits pass vertically through a floor area, relocate those conduits to be installed concealed in a new wall or surface mounted in a service area. Extend conduit, wiring, etc. as required.

.3 Existing junction boxes in walls and ceiling spaces required to maintain existing circuits shall remain accessible.

.4 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.

1.5 SCHEDULE OF WORK

.1 Carefully note and refer to the 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 into 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, and reprogram 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.

.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.

1.4 CLOSEOUT SUBMITTALS

.1 Provide operation and maintenance data for power cables for incorporation into Operation and Maintenance Manual.

.2 Include in Operation and Maintenance Manual instructions for particular unit supplied and not general description of units manufactured by supplier and

.1 Operation and maintenance instructions for cable, connectors, splices, terminations kits, etc. to permit effective operation, maintenance and repair.

.2 Technical data:

.1 Illustrated parts lists with parts catalogue numbers.

.2 Certified copy of factory test results.

.3 Certified copy of site test results.

.4 Maintenance and overhaul instructions.

.5 Spare parts list.

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.

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: 600V, cross-linked polyethylene (XLPE), 90 deg. 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 LOW VOLTAGE CONTROL CABLES (BELOW 30VAC)

.1 Type LVT.

.2 Manufactured in accordance with CSA C22.2 N°35.

.3 Sizes, 18 and 16 AWG solid copper, insulated, color coded conductors.

.4 Insulation voltage rating: 30VAC

.5 Insulation temperature rating: -20 to +60 deg. C.

.6 Green colored conductor for bonding.

.7 Aluminum/mylar shield with tinned copper drain wire.

.8 Outer jacket over conductors and shield, sunlight resistant PVC.

.9 Rip cord under jacket for jacket stripping.

.10 Interlocked aluminum armour (when installed in steel stud walls).

Part 3 Execution

3.1 GENERAL

.1 To Minimize Voltage Drop

.1 All circuits including lighting circuits shall be minimum #10 AWG for all circuits longer than 21 metres and shall be minimum #8 for all circuits longer than 35 metres.

.2 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 cabletrays (only where noted on drawings).

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 diam. 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 diam. and bends shall not damage or distort the outer sheath.

.3 Do not install PVC jacketted cables in circulating air plenums.

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.

.2 Type AC90 armoured cable (BX) shall be used for connections from conduit systems to wiring devices in steel stud partitions and for interconnection of wiring devices within steel stud partitions, cable to be clipped before entering junction or outlet boxes. Cable to be clamped within partitioning with steel galvanized tie-wire.

3.5 INSTALLATION OF LOW VOLTAGE CONTROL CABLES (BELOW 30VAC)

.1 Type LVT without interlocked aluminum armour shall be installed in conduit.

.2 Armoured LVT in steel stud walls.

.3 All connections shall be in a junction box.

.4 Confirm cable configuration with equipment manufacturer wiring requirements.

.5 Bond cable shield to ground.

.6 Indoor installations only.

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 INSTALLATION IN STEEL STUD WALLS

.1 CAT6 and control cables shall not be fished in steel stud walls. Install in conduit inside steel stud walls.

.2 Building wires and PVC, polyethylene or similar jacketed power cables shall not be fished in steel stud walls.

3.9 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.

3.10 IDENTIFICATION

.1 Provide identification of wires and cables as noted in specification section 26 05 00 – Common Work results – For Electrical.

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 (0-1000 V)

1.2 REFERENCES

.1 Canadian Standards Association (CSA International)

.1 CAN/CSA-C22.2 No. 18, Outlet Boxes, Conduit Boxes, Fittings and Associated Hardware.

.2 CAN/CSA C22.2 No. 41, Grounding and Bonding Equipment.

.3 CAN/CSA C22.2 No. 65, Wire Connectors.

.4 CAN/CSA-C22.2 No. 188, Splicing Wire Connectors

1.3 PRODUCT DATA

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

Part 2 Products

2.1 MATERIALS

.1 In accordance with referenced standards, suitable for: conductor sizes and types, conductor materials, respective equipment and respective environment.

.2 Compression (crimp-on) type connectors for control wiring.

.3 Twist-on spring type (wire nuts) connectors with insulated caps or mechanical pressure type connectors for wire splicing or taps inside junction boxes.

.4 Mechanical pressure type connectors for termination of wires onto busses or breakers inside panelboards.

.5 Mechanical pressure type connectors for termination of wires inside splitters.

.6 Mechanical pressure type or compression (crimp-on) type connectors for termination of feeders onto busses or breakers inside CDP type distributions or switchboards, per manufacturer’s requirements.

.7 Dual hole long barrel compression (crimp-on) type connectors for termination of feeders onto busses or breakers inside switchgear.

.8 All other equipment connections in accordance with equipment manufacturer’s recommendations.

□

.9 Push-in and soldering type connectors are not acceptable.

Part 3 Execution

3.1 INSTALLATION

.1 Remove insulation carefully from ends of conductors.

.2 Clean conductor surfaces before installing connectors.

.3 Do not cut conductor strands to fit into connectors.

.4 Do not place bare control conductors directly under terminal screws that are not intended to secure bare conductors.

.5 Make connections to equipment and conductor splices to carry full ampacity of conductors with no temperature rise above the conductor/connector temperature rating.

.6 Use appropriate connector type, sized to respective conductor size(s), number of conductors and types of conductors, according to manufacturer's recommendations.

.7 Install twist-on type (wire nuts) connectors and tighten according to manufacturer's recommendations.

.8 Install mechanical pressure type connectors and tighten screws with appropriate tool to torque values to manufacturer's recommendations.

.9 Install compression (crimp-on) type connectors using manufacturer's recommended tools and dies and tighten screws with appropriate tool to torque values to manufacturer's 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 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 CAN/CSA B72, Installation Code for Lightning Protective Systems

.4 CAN/CSA T527, Grounding and Bonding for Telecommunications in Commercial Buildings

.5 CAN/CSA Z32, Electrical Safety and Essential Electrical Systems in Health Care Facilities

.6 IEEE 142, Recommended Practice for Grounding of Industrial and Commercial Power Systems

.7 IEEE 837, Qualifying Permanent Connections Used in Substation Grounding

1.3 SHOP DRAWINGS

.1 Submit shop drawings in accordance with Section 26 05 00 – Common Work Results – For Electrical.

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 Grounding for control power shall be separated from power grounding and shall only be bonded to power grounding at only one point.

.7 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 Cadweld type conductor connectors.
.5 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, grounding 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, grounding 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 Cadwelded, welded, brazed, 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 Connections to structural steel shall be Cadwelded.

.10 Where connections will be inaccessible after construction, connections shall be made by the cadweld process (Erico Products 'Cadweld' or Burndy 'Thermoweld').

.11 Soldered connections shall not be used.

.12 Install conductor connectors in accordance with manufacturer's instructions.

.13 Make connections in radial configuration only, with connections terminating at single point. Avoid loop connections.

.14 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 The main metallic water and gas services to a building shall be bonded to ground.

.3 Fuel tanks shall be bonded to ground.

.4 Install bonding conductor for flexible conduit, connected at both ends to conduit by using grounding bushing, solderless lug or grounding clamp.

.5 In wet or damp areas and near tanks containing liquids, all equipment frames, tanks, boxes, outlets, etc., shall be bonded to ground.

.6 Bond building structural steel and metal siding to ground by cadwelding to steel. The location of such connections shall be at points where they will not be subject to mechanical damage, but if possible will be accessible for observation.

.7 Bond single conductor, metallic armoured cables to ground at supply end, and provide non-metallic entry plate at load end.

.8 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.

.9 Bonding conductors shall be sized according to the Canadian Electrical Code, but shall be minimum #12 AWG.

.10 Conduit expansion joints and telescoping sections of metal raceways and cable trays not thoroughly bonded otherwise, shall be provided with approved bonding jumpers.

.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-metalic entry plate at load end for cables with metal armor.

.2 When partial discharge sensing current transformers are used, metal armor, tape shields or concentric neutral conductors of the single conductor cables shall be bonded to ground at the conductor end at the location of the CT for partial discharge sensing. Bonding conductor to run through the CT for partial discharge sensing.

.3 Bond metal armor, tape shields or concentric neutral conductors to ground by #2/0 green insulated copper conductor at starting end of cable.

.4 For cables that shall have their metal armor, tape shields or concentric neutral conductors bonded to ground at both ends, refer to drawings.

.5 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: switchgear, panelboards, transformers, frames of motors, motor control centres, starters, control panels, building steel work, etc.

.2 Make bonding connections in radial configurations only.

3.4 CABLE TRAY BONDING (CABLE TRAY FOR POWER CABLES)

.1 Install bonding conductor, #3/0 green insulated stranded copper, in each cable tray.

.2 Each cable tray section shall be bonded to the bonding conductor with cable tray ground clamps at maximum 3 meters (10 feet) intervals.

.3 Provide expansion joints with bonding jumpers, at building expansion joints and where recommended by the manufacturer in long runs. Bonding conductor shall be utilized as a bonding jumper at the expansion joints given that sufficient slack is provided.

.4 For double or multiple stacked cable trays the bonding conductor shall be laid in the upper tray. Additional bonding conductors to each section in the lower tray(s) shall be installed from the upper cable tray down to the lowest cable tray at each interval. Bonding intervals to lower tray sections shall not exceed 3 meters (10 feet).

.5 Bonding conductors between different cable trays shall be #3/0 green insulated stranded copper.

.6 Provide bonding jumpers to take-off raceways.

3.5 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, or set in poured concrete walls and ceilings.

Part 3 Execution

3.1 INSTALLATION

.1 Secure equipment to concrete, masonry, tile and plaster surfaces with fasteners suitable for the installation.

.2 When equipment is supported by T-bar ceiling, ensure that T-bars are adequately supported to carry weight of equipment specified before installation.

.3 Support equipment, conduit or cables using clips, spring loaded bolts, cable clamps designed as accessories to basic channel members.

.4 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.

.5 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.

.6 For surface mounting of two or more conduits use channels.

.7 Provide metal brackets, frames, hangers, clamps and related types of support structures where indicated or as required to support conduit and cable runs.

.8 Ensure adequate support for raceways and cables dropped vertically to equipment where there is no wall support.

.9 Do not use wire lashing or perforated strap to support or secure raceways or cables.

.10 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.

.11 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 gasketted covers where exposed to moisture or weather or where specified.

2.2 JUNCTION, AND PULL BOX INSTALLATION

.1 Install pull boxes in inconspicuous but accessible locations.

.2 Install pull boxes so as not to exceed 30 m of conduit run between pull boxes.

.3 Install junction and pull boxes clear of all mechanical ductwork and piping.

.4 Support junction and pull boxes, greater than 4-11/16 x 4-11/16 inches, with independent threaded rod from structure, independent from the conduit support system. Junction and pull boxes sizes 6 x 6 inches and larger to have two supports.

2.3 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 Device box extenders shall not be used.

.8 In finished area ceilings, junction and pull box covers shall be solid covers, painted to match the finish of the adjacent surface.

.9 In moist or dusty areas, gasketted 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 ring, adjustable depth ring 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 Where outlet boxes are shown on the drawings as being "back-to-back" shall have a minimum offset of 200 mm (8") between boxes to reduce sound transmission. In no case shall "thru-wall" boxes be used.

.8 Install pull boxes, or fittings, in conduit runs where more than four bends are necessary.

.9 Install pull boxes where run exceeds 23.0 (75 feet) in length.

.10 All junction, outlets and pull boxes shall be so installed that they are always readily accessible.

.11 No power driven pins (Ramset) shall be utilized to secure boxes without specific approval from Contract Administrator.

.12 Check opening provided for each recessed outlet box and if it is not completely covered by cover plate, report discrepancy to the division responsible and ensure that it is rectified.

.13 All concealed junction boxes, conduit fittings, etc. to be c/w galv. steel covers, secured with two bolts.

.14 Apply acoustic sealant to seal wires penetrating moulded vapour barrier boxes.

.15 No more than two extension rings shall be used in sequence.

.16 Where standard size raised device cover can't provide the required clearance, adjustable depth cover shall be provided.

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.

Part 2 Products

2.1 CONDUITS

.1 Electrical metallic tubing (EMT): to CSA C22.2 No. 83, with couplings.

.2 Flexible metal conduit: to CSA C22.2 No. 56, and liquid tight flexible metal conduit.

.3 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 Steel set screw connectors and couplings. Insulated throat liners on connectors.

.3 Raintight connectors and fittings c/w O-rings for use on weatherproof or sprinklerproof enclosures.

.4 Raintight couplings to be used for conduit installations exposed to moisture or sprinkler heads.

2.4 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 Conceal conduits except in mechanical and electrical service rooms.

.5 Use electrical metallic tubing (EMT) except where specified otherwise.

.6 Use liquid tight flexible metal conduit for connection to motors or vibrating equipment in damp, wet or corrosive locations.

.7 Minimum conduit size: 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 dia.

.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.

3.3 CONCEALED CONDUITS

.1 Run parallel or perpendicular to building lines.

.2 Do not install horizontal runs in masonry walls.

.3 Do not install conduits in terrazzo or concrete toppings.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 The work covered under this section consists of the furnishing of all necessary labor, supervision, materials, equipment, tests and services to install complete cable tray systems as shown on the drawings.

.2 Cable tray systems are defined to include, but are not limited to straight sections of cable trays, tees, crosses, risers, dropouts, turns, offsets, reducers, elbows, barrier strips, covers and accessories.

1.2 RELATED SECTIONS

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

.2 Section 26 05 26 – Grounding and Bonding for Electrical Systems.

.3 Section 26 05 29 – Hangers and Supports for Electrical Systems.

1.3 REFERENCES

.1 ASTM International:

.1 ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

.2 Canadian Standard Association:

.1 CSA C22.2 No. 126.1 – Metal Cable Tray Systems

.3 National Electrical Manufacturers Association:

.1 NEMA VE 1 - Metal Cable Tray Systems.

.2 NEMA VE 2 - Cable Tray Installation Guidelines.

1.4 DRAWINGS

.1 The drawings, which constitute a part of these specifications, indicate the general route of the cable runway systems. Accuracy is not guaranteed and field verification of all dimensions, routing, etc., is required.

.2 Specifications and drawings are for assistance and guidance, but exact routing, locations, distances and levels will be governed by actual field conditions. Contractor shall make field surveys as part of his work.

1.5 QUALITY ASSURANCE

.1 Manufacturers: Firms regularly engaged in manufacture of cable trays and fittings of types and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years.

.2 Comply with applicable CSA and NEMA standards.

.3 Products shall be CSA-classified and labeled.

1.6 DELIVERY, STORAGE AND HANDLING

.1 Deliver cable tray systems and components carefully to avoid breakage, denting and scoring finishes. Do not install damaged equipment.

.2 Store cable trays and accessories in original cartons and in clean dry space; protect from weather and construction traffic. Wet materials should be unpacked and dried before storage.

1.7 SUBMITTALS

.1 Shop Drawings: Indicate tray type, dimensions, support points, tees, crosses, risers, dropouts, turns, offsets, reducers, elbows, barrier strips, covers and finishes.

.2 Product Data: Submit fittings and accessories.

.3 Manufacturer's Installation Instructions: Submit application conditions and limitations of use. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

.4 Test Reports: Provide results of tests performed or witnessed by an independent testing laboratory of the "worst case" loading conditions outlined in this specification and performed in accordance with the latest revision of NEMA VE-1; including test reports verifying rung load capacity in accordance with NEMA VE-1 Section 5.4.

1.8 CLOSEOUT SUBMITTALS

.1 Project Record Documents: Record actual routing of cable tray and locations of supports.

Part 2 Products

2.1 ACCEPTABLE MANUFACTURERS

.1 Manufacturers: Subject to compliance with these specifications, cable tray and cable channel systems shall be as manufactured by Cooper B-Line, Thomas & Betts, MP Husky, Mono-Systems and Cablofil.

2.2 CABLE TRAY SECTIONS AND COMPONENTS

.1 Except as otherwise indicated, provide metal cable trays, of types, classes, and sizes indicated; with splice plates, bolts, nuts and washers for connecting units. Construct units with rounded edges and smooth surfaces; in compliance with applicable standards; and with the following additional construction features.

.2 Material and finish:

.1 Indoor Installations: Straight section, fitting side rails, rungs and splice plates shall be extruded from Aluminum Association Alloy 6063. All fabricated parts shall be made from Aluminum Association Alloy 5052.

2.3 TYPE OF TRAY SYSTEM

.1 Ladder Cable Trays shall consist of two longitudinal members (side rails) with transverse members (rungs) mechanically fastened to the side rails.

.1 Rungs shall be spaced 150 mm on center. Rung spacing in radiused fittings shall be industry standard 225mm and measured at the center of the tray's width. Each rung must be capable of supporting 90.9 kg concentrated load at the center of a 450mm wide cable tray with a safety factor of 1.5. Tangents on radiused fittings shall be minimum 76mm.

.2 Cable tray loading depth shall be 102 mm.

.3 Straight sections shall be supplied in standard (3.048m) lengths.

.4 Cable tray widths shall be as shown on drawings.

.5 Splice plates shall have maximum (4) four nuts and bolts per plate. The resistance of fixed splice connections between adjacent sections of tray shall not exceed 0.00033 ohms. Splice plates shall be furnished with straight sections and fittings.

.6 Fittings: Tees, crosses, risers, dropouts, turns, reducers, elbows, barrier strips, covers and other fittings of same materials and finishes as cable tray.

.7 Minimum bending radius: 600 mm.

.8 Barrier Strips: Same materials and finishes as for cable tray.

2.4 LOADING CAPACITIES

.1 Select cable trays loading class per CSA C22.2 No. 126.1, for 3.0m span, with safety factor of 1.5.

.2 Maximum distance between support points: 3.048m.

Part 3 Execution

3.1 INSTALLATION

.1 Cable tray installation

.1 Install cable trays as indicated: Installation shall be in accordance with equipment manufacturer's instructions, and with recognized industry practices to ensure that cable tray equipment comply with requirements of applicable CSA and NEMA Standards. Reference NEMA-VE2 for general cable tray installation guidelines, confirm with equipment manufacturer.

.2 Coordinate cable tray installation with other electrical work as necessary to properly integrate installation of cable tray work with other work.

.3 Remove burrs and sharp edges from cable trays.

.4 Provide sufficient space encompassing cable trays to permit access for installing and maintaining cables.

.5 Support cable tray assembly to prevent twisting from eccentric loading.

.6 Cable tray fitting supports shall be located such that they meet the strength requirements of straight sections.

.7 Make connections to equipment with flanged fittings fastened to cable trays and to equipment. Support cable trays independent of equipment. Do not carry weight of cable trays on equipment enclosure.

.8 Install expansion connectors where cable trays cross building expansion joints and in cable tray runs that exceed dimensions recommended in NEMA VE-2. Space connectors and set gaps according to applicable standard. Provide flexible bonding jumpers.

.9 Install barrier strips to separate cables of different insulation levels, such as 600, 5000, and 15 000 V.

.1 Install covers, if used, after cables are installed.

.2 Install fitting supports per NEMA VE-2 guidelines, or in accordance with manufacturer's instructions.

.10 Cable Installation

.1 Install cables only when each cable tray run has been completed and inspected.

.2 Fasten cables to cable tray. Fasten only enough to secure the cable, without indenting the cable jacket. When cable ties are used, install cable ties with a tool that includes an automatic pressure-limiting device.

.3 Fasten and support cables that pass from one cable tray to another or drop from cable trays to equipment enclosures. Fasten cables to the cable tray at the point of exit and support cables independent of the enclosure.

.4 Remove abandoned cables from cable trays.

.5 Install temporary protection for cables in open trays to safeguard exposed cables against falling objects or debris during construction. Temporary protection for cables and cable tray can be constructed of wood or metal materials and shall remain in place until the risk of damage is over.

3.2 FIRE BARRIERS

.1 Arrange for opening in fire rated walls, for cables to pass through in sleeves.

.2 Install capped metal sleeves for future cables through firestop-sealed cable tray penetrations of fire and smoke barriers.

.3 Provide fire proofing of floors or walls after cables have been installed in accordance with Section 26 05 00.

3.3 BONDING TO GROUND

.1 Bond cable tray in accordance with section 26 05 26 – Grounding.

3.4 FIELD QUALITY CONTROL

.1 After installing cable trays and before electrical circuitry has been energized, inspect for compliance with requirements.

.2 Visually inspect cable insulation for damage. Correct sharp corners, protuberances in cable trays, vibrations, and thermal expansion and contraction conditions, which may cause or have caused damage.

.3 Verify that the number, size, and voltage of cables are correct.

.4 Verify that cables of different voltage levels are separated by barriers or are installed in separate cable trays.

.5 Verify that there are no intruding items such as pipes, hangers, or other equipment in the cable tray.

.6 Remove dust deposits, industrial process materials, trash of any description, and any blockage of tray ventilation.

.7 Visually inspect each cable tray joint and each ground connection for mechanical continuity. Check bolted connections between sections for corrosion. Clean and re-torque in suspect areas.

.8 Check for improperly sized or installed bonding jumpers.

.9 Check for missing, incorrect, or damaged bolts, bolt heads, or nuts. When found, replace with specified hardware.

.10 Perform visual and mechanical checks for adequacy of cable tray grounding; verify that all take-off raceways are bonded to cable trays.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 This Section includes a CSA Certified and FM Approved heat tracing system for freeze protection of aboveground water lines consisting of self-regulating heating cable, connection kits and electronic controller.

1.2 RELATED SECTIONS

.1 Section 26 05 00 – Common Work Results for Electrical.

1.3 SYSTEM DESCRIPTION

.1 System for freeze protection of aboveground water lines with Proportional Ambient Sensing Control (PASC), monitoring, integrated ground-fault circuit protection and Building Management System (BMS) communication capabilities.

1.4 SUBMITTALS

.1 Product Data

.1 Heating cable data sheet
.2 CSA, FM approval certificates for freeze protection for aboveground water lines
.3 Pipe freeze protection design guide
.4 System installation and operation manual
.5 System installation details
.6 Connection kits and accessories data sheet
.7 Controller data sheet
.8 Controller wiring diagram

1.5 QUALITY ASSURANCE

.1 Manufacturers Qualifications

.1 Manufacturer to show minimum of thirty (30) years experience in manufacturing electric self-regulating heating cables.
.2 Manufacturer shall be ISO-9001 registered.
.3 Manufacturer to provide products consistent with CSA 22.2 No 130-03 and IEEE 515.1 requirements.

.2 Installer Qualifications

.1 System installer shall have complete understanding of product and product literature from manufacturer or authorized representative prior to installation. Electrical connections shall be performed by a licensed electrician.

.3 Regulatory Requirements and Approvals

.1 The system (heating cable, connection kits, and controller) shall be CSA Certified and FM Approved for freeze protection of aboveground water lines.

.2 Electrical Components, Devices, and Accessories: Listed and labelled as defined in NFPA 70, Article 100, by a Nationally Recognized Testing Laboratory (NRTL), and marked for intended use.

1.6 DELIVERY, STORAGE AND HANDLING

.1 General Requirements: Deliver, store and handle products to prevent their deterioration or damage due to moisture, temperature changes, contaminates or other causes.

.2 Delivery and Acceptance Requirements: Deliver products to site in original, unopened containers or packages with intact and legible manufacturers' labels identifying the following:

.1 Product and Manufacturer
.2 Length/Quantity
.3 Lot Number
.4 Installation and Operation Manual
.5 MSDS (if applicable)

.3 Storage and Handling Requirements

.1 Store the heating cable in a clean, dry location with a temperature range 0 deg. F (-18 deg.C) to 140 deg. F (60 deg. C).
.2 Protect the heating cable from mechanical damage.

1.7 WARRANTY

.1 Extended Warranty

.1 Manufacturer shall provide ten (10) year warranty for all heating cables and components.
.2 Provide one (1) year warranty for all heat trace controllers from date of acceptance of submitted declaration of Substantial Performance.
.3 Contractor shall submit to City results of installation tests required by the manufacturer.

Part 2 Products

2.1 MANUFACTURERS AND PRODUCTS

.1 Contract Documents are based on manufacturer and products named below to establish a standard of quality.

.2 Basis of Design

.1 Basis of Design Product Selections
.1 Manufacturer
.1 Manufacturers shall have more than thirty (30) years experience with manufacture & installation self-regulating heating cables.
.2 Manufacturer shall provide CSA, FM approval certificates for freeze protection of aboveground water lines.

.3 Manufacturer shall be Raychem heat tracing products of Pentair Thermal Building Solutions, Redwood City 94063, 800-545-6258;

.4 Email: thermal.info@pentair.com Website: www.pentairthermal.com

.2 Pipe Freeze Protection System

.1 Raychem® GM-2XT self-regulating heating cable with fluoropolymer jacket (-XT).

.2 Raychem RayClic®

.3 Raychem® ECW-GF controller

2.2 PRODUCTS, GENERAL

.1 Single Source Responsibility: Furnish heat tracing system for the freeze protection of aboveground water lines from a single manufacturer.

.2 The system (heating cable, connection kits, and controller) shall be CSA Certified and FM Approved for freeze protection of aboveground water lines. No parts of the system may be substituted or exchanged.

2.3 PRODUCTS

.1 Self-Regulating Heating Cable

.1 Heating cable shall be Raychem self-regulating heating cable manufactured by Pentair Thermal Building Solutions.

.1 Model Numbers

.1 GM-2XT

.2 The heating cable shall consist of a continuous core of conductive polymer that is radiation cross-linked, extruded between two (2) 16 AWG nickel-plated copper bus wires that varies its power output in response to pipe temperature changes.

.3 The heating cable shall have a modified polyolefin inner jacket and a tinned-copper braid to provide a ground path and enhance the cables ruggedness.

.4 The heating cable shall have a fluoropolymer jacket (-XT).

.5 The heating cable shall have a self-regulating factor of at least 90 percent. The self-regulating factor is defined as the percent reduction of the heating cable power output going from a 40 deg. F pipe temperature to 150 deg. F pipe temperature.

.6 The heating cable shall operate on line voltages of 208 volts without the use of transformers.

.7 The heating cable shall be CSA Certified and FM Approved system.

.8 The outer jacket of the heating cable shall have the following markings:

.1 Heating cable model number

.2 Agency listings

.3 Meter mark

.4 Lot/Batch ID

.2 Heating Cable Connection Kits

.1 Heating cable connection kits shall be Raychem RayClic.

.2 Manufacturer shall provide power connection, splice/tee and end seal kits compatible with selected heating cable.

.3 Installation shall not require the installing contractor to cut into the heating-cable core to expose the bus wires.

.4 Connection kits shall be rated NEMA 4X to prevent water ingress and corrosion. All components shall be UV stabilized.

.5 Connection kits shall be CSA Certified and FM Approved.

.3 Heating Cable Installation Accessories

.1 High temperature, glass filament tape for attachment of heating cable to water lines. Cable ties are not permitted. (PTM Catalog Number: GT-66)

.2 Plastic Piping – provide an aluminium self-adhesive tape over the heating cable on all plastic piping if required. (PTM Catalog Number: AT-180)

.3 Labels – Provide warning labels every 10 feet on exterior of insulation, opposite sides of pipe. (PTM Catalog Number: ETL)

.4 Digital Temperature Controller with built-in Ground-Fault Protection Device (GFPD)

.1 Single Circuit Local Digital Controller

.1 Local digital controller shall be Raychem ECW-GF.

.2 Heating cable manufacturer shall provide a local digital controller with built-in GFPD compatible with selected heating cable.

.3 Digital controller shall be capable of supporting up to two (2) RTD temperature sensors per control point. Leads can be extended using 18 AWG, 3-wire, shielded cable.

.4 Enclosure type shall be NEMA 4X fiberglass reinforced plastic (FRP).

.5 Digital controller shall have an integrated adjustable GFPD (10 – 200 mA).

.6 Digital control system can be configured for line-sensing, ambient sensing and PASC modes. PASC control proportionally energizes the power to the heating cable to minimize energy based on ambient sensed conditions.

.7 Digital controller shall be capable of operating with supply voltages from 100 V to 277 V.

.8 Digital controller will have a built-in self-test feature to verify proper functionality of heating cable system.

.9 Digital controller will also be able to communicate with BMS by one of the following protocols using the Raychem ProtoNode multi-protocol gateway.

.1 BACnet®

.10 Digital controller will also supply an isolated triac alarm relay and a dry contact relay for alarm annunciation back to the BMS.

.11 The following variables will be monitored by the digital controller and reported back to the BMS.

.1 Temperature

.2 Ground-fault

.3 Current draw

.4 Power consumption

.5 Associated alarms

.12 Digital controller shall have c-CSA-us approvals.

.5 Thermal Pipe Insulation

.1 Pipes must be thermally insulated in accordance with the GM-2XT design guide requirements.

.2 Thermal insulation must be a type that is flame retardant (closed-cell or fiberglass) with waterproof covering.

2.4 SYSTEM LISTING

.1 The system (heating cable, connection kits, and controller) shall be CSA Certified and FM Approved for freeze protection of aboveground water lines.

.2 The freeze protection system shall have a design, installation and operating manual specific to aboveground water lines.

Part 3 Execution

3.1 INSTALLERS

.1 Acceptable Installers

.1 Subject to compliance with requirements of Contract Documents, installer shall be familiar with installing heat-trace cable and equipment.

3.2 INSTALLATION

.1 Comply with manufacturer's recommendations in the GM-2XT Installation and Operation Manual.

.2 Apply the heating cable linearly on the pipe after piping has successfully completed any pressure tests. Secure the heating cable to piping with fiberglass tape.

.3 Install electric heating cable according to the drawings and the manufacturer's instructions. The installer shall be responsible for providing a complete functional system, installed in accordance with applicable national and local requirements.

3.3 FIELD QUALITY CONTROL

.1 Start-up of system shall be performed by factory technician or factory representative per the City's requirements.

.2 Field Testing and Inspections

.1 The system shall be commissioned in accordance to the GM-2XT Installation and Operation manual.

.2 The heating cable circuit integrity shall be tested using a 2500 Vdc megohmmeter at the following intervals below. Minimum acceptable insulation resistance shall be 1000 megohms or greater.

.1 Before installing the heating cable

.2 After heating cable has been installed onto the pipe

.3 After installing connection kits

.4 After the thermal insulation is installed onto the pipe

.5 Prior to initial start-up (commissioning)

.6 As part of the regular system maintenance

.3 The technician shall verify that the ECW-GF control parameters are set to the application requirements.

.4 The technician shall verify that the ECW-GF alarm contacts are corrected connected to the BMS.

.5 The technician shall verify that the ECW-GF and ProtoNode-RER are configured correctly with the BMS.

.6 All commissioning results will be recorded and presented to the City.

3.4 MAINTENANCE

.1 Maintenance Service

.1 Comply with manufacturer's recommendations in GM-2XT System Installation and Operation Manual.

END OF SECTION

Part 1 General

1.1 RELATED SPECIFICATIONS

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

.2 Section 26 28 21 – Moulded Case Circuit Breakers.

1.2 SECTION INCLUDES

.1 Utilize existing switchgear to install new breakers as indicated on drawings.

.1 Ratings as indicated on single line diagram. Where ratings are not shown confirm on site prior to ordering breakers.

1.3 REFERENCES

.1 The switchboard(s) and overcurrent protection device(s) referenced herein are designed and manufactured according to the latest revision of the following specifications.

.1 CSA C22.2 No.31, Switchgear assemblies

.2 CSA C22.2 No.29, Switchboards

.3 CSA C22.2 No. 5, Molded Case Circuit Breakers

.4 CSA C22.2 No. 4, Enclosed Switches

.5 CSA C22.2No.0.4, Bonding and Grounding of Electrical Equipment (Protective Grounding)

1.4 DELIVERY, STORAGE, AND HANDLING

1.5 OPERATIONS AND MAINTENANCE MATERIALS

.1 Provide maintenance data for incorporation into maintenance manuals.

1.6 WARRANTY

.1 Manufacturer shall warrant specified equipment free from defects in materials and workmanship for the lesser of one (1) year from the date of installation or eighteen (18) months from the date of purchase.

1.7 APPROVED MANUFACTURERS

.1 Eaton existing 1600A 347/600V 3ph. 4W Switchgear unit.

Part 2 Products

.1 Not Applicable.

Part 3 Execution

3.1 INSTALLATION

.1 Install breakers in accordance with manufacturer's written instructions, and applicable standards and safety codes.

.2 Connect breakers in switchboard to feeders.

.3 Connect controls, customer metering alarms and communications.

.4 Check factory made connections for mechanical security and electrical continuity.

.5 Program all trip units per coordination study.

.6 Test all breakers after trip units are programmed.

.7 Provide test report to Contract Administrator for review.

.8 Incorporate test report in maintenance manuals.

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 ANSI/IEEE 837, Qualifying Permanent Connections Used in Substation Grounding.

.2 ASTM - American Society of Testing Materials.

.3 CAN/CSA - C22.2, No. 31 – Switchgear Assemblies.

.4 CSA C22.2No.0.4, Bonding and Grounding of Electrical Equipment (Protective Grounding).

.5 CSA Standard C22.2 No. 29 - Panelboards and Enclosed Panelboards.

.6 CSA Standard C22.2 No. 5 - Molded Case Circuit Breakers.

.7 NEMA AB 1 - Molded Case Circuit Breakers.

.8 NEMA PB 1 - Panelboards.

.9 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.
- .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 (to match existing).

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.

.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 Provide a pad lockable provision for main breaker or switch. Breaker or switch is to be lockable in either the open or closed position. The locking device is to be attached to the breaker or switch.

.5 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.

.6 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.

.7 Breakers with 400A frames and smaller shall utilize twin breaker hardware mounting kits. Breakers shall be mounted double wide to save space.

.8 All current carrying components such as buswork, interconnecting components, etc. shall be tin plated copper. No aluminum components are allowed.

.9 If wire size exceeds the breaker terminal wire range, use compression wire reducer to terminate feeder onto breaker terminal.

.10 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.

.11 Distribution enclosure shall be treated to inhibit rusting and painted with a primer and two (2) coats of ASA61 grey enamel.

.12 Enclosure shall be protected from spray from sprinkler heads as outlined in Canadian Electrical Code NEMA 3R.

.13 All breakers shall have individual lamacoid nameplates securely fastened with rivets on panel cover adjacent to respective breaker.

.14 Interrupting capacity of main breaker or switch and feeder circuit breakers shall be RMS symmetrical at applied voltage as shown on the single line diagram.

.15 All devices must be fully rated. Series rated devices are not acceptable.

.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.

.19 Distribution is to contain surge protective devices (SPD's). SPD's are to be bus connected. SPD's to meet requirements of 26 43 13 – Surge Protective Devices (SPD's).

2.2 PROVISIONS FOR FUTURE ENERGY CONSUMPTION MONITORING

.1 New Distribution shall have provisions for installation of energy meters for feeders for

.1 HVAC systems

.2 Distributions of any load carrying capacity shall have provisions for installation of energy meters to separately monitor the energy consumption of the total load and of each branch circuit.

.3 Provide provisions for installation of metering class current and voltage transformers and digital energy meters.

.1 Include metering compartments, wireways, wiring, back mounting panels, terminal blocks, power supply modules, etc. as required.

.4 Metering compartments to be provided with lockable doors.

2.3 CUSTOMER OWNED DIGITAL METERING SYSTEM

.1 Provide customer owned digital metering system (DMS) c/w potential and current transformers in switchgear as indicated on drawings. Meter to be installed at 5'-6" above finished floor. Refer to Section 26 24 06.

.2 Potential Transformers

.1 Potential transformers: to CAN3-C13, dry type for indoor use, with following characteristics:

.1 Voltage class: to match switchgear.

.2 Rated frequency: 60 Hz.

.3 Basic impulse level: standard

.4 Secondary voltage: 120V

.5 Metering accuracy rating: 1%.

.6 Three individual transformers shall be provided, installed in dedicated compartment, wired in delta-wye grounded configuration.

.7 Provide primary fuses and fuse blocks as required.

.3 Current Transformers

.1 Current transformers: to CAN3-C13, dry type for indoor use with following characteristics:

.1 Voltage class: As required.

.2 Rated frequency: 60 Hz.

.3 Basic impulse level: Standard.

.4 Metering accuracy rating: 1%.

.5 Rated primary current: To match switchgear bus.

.6 Rated secondary current: 5 Amps.

.7 Continuous-current rating factor: Standard.

.8 Shorting blocks in secondary terminals, provided in low voltage compartment.

2.4 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 mounted on wall with strut channel between pad and enclosure wall.

.3 Connect breakers in distribution to feeders.

.4 Connect control and communication wiring.

.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 SECTION INCLUDES

.1 Materials and installation for standard and custom breaker type panelboards.

1.2 RELATED SECTIONS

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

.2 Section 26 28 21 – Moulded Case Circuit Breakers.

1.3 REFERENCES

.1 Canadian Standards Association (CSA International)

.1 CSA C22.2No.29, Panelboards and enclosed Panelboards.

Part 2 Products

2.1 PANELBOARDS

.1 Install new circuit breakers in existing panelboards as indicated on drawings.

2.2 BREAKERS

.1 Breakers: to Section 26 28 21 – Moulded Case Circuit Breakers.

.2 Breakers with thermal and magnetic tripping in panelboards except as indicated otherwise.

.3 Provide lock-on devices on breakers for, fire alarm equipment.

2.3 EQUIPMENT IDENTIFICATION

.1 Provide equipment identification in accordance with Section 26 05 00 – Common Work Results – For Electrical.

.2 Complete circuit directory with typewritten legend showing location and load of each circuit.

2.4 APPROVED MANUFACTURERS

.1 Match existing.

Part 3 Execution

3.1 INSTALLATION

.1 Connect loads to circuits.

.2 Breakers feeding fire alarm equipment shall not be painted with red color paint. Instead, provide lamacoid label near breaker, white letters on red background, with wording: "FIRE ALARM". Lamacoid label shall be fastened to panel with self tapping screws or rivets.

.3 Connect branch circuit neutral conductors to common neutral bus. Common neutrals shall be shared by vertically adjacent breakers except for GFI protected branch circuits and dimmer circuits which shall not share neutrals with other circuits. Neutral conductors shall be identified with wire markers showing the circuit numbers of the circuits sharing the neutral.

.4 Wiring in panelboards shall be neat and set in as if laced. All neutral conductors shall be identified in the panel with their associated circuit numbers by means of Brady Markers.

.5 All panelboards throughout the building shall be phased together such that the left-hand, centre and right-hand panelboard busses represent phases A, B and C respectively. All indicating meters shall be identified to this sequence.

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.

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.

1.4 COORDINATION

.1 Review mechanical shop drawings prior to submittal to the Contract Administrator. Resolve internal conflicts prior to submission.

.2 Verify electrical supply characteristics of 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.

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.

.2 Include pushbutton stations, motor protective switches, interlocks, conduit, wire, devices and fittings required to provide controls for mechanical equipment.

Part 3 Execution

3.1 POWER WIRING

.1 Provide feeder wiring to equipment, but not limited to the following: starters, disconnects, heaters and make connections to associated mechanical equipment.

.2 Provide branch circuit wiring to equipment, but not limited to the following: control panels, timers, control transformers.

3.2 CONTROL WIRING

.1 Provide wiring to equipment, including but not limited to the following: control panels, alarm panels, etc. for new mechanical equipment.

.2 Provide power and control wiring for fully functional controlled system.

.3 Control wiring shall be installed in conduit.

3.3 COORDINATION

.1 Confirm exact location of control devices and other equipment requiring an electrical connection.

.2 Obtain wire sizes and quantities from equipment manufacturers.

.3 Coordinate wiring requirements with other Divisions and provide control wiring and connections as required to make the control systems operate as specified.

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.42.1, Cover Plates for Flush-Mounted Wiring Devices (Bi-national standard, with UL 514D).
- .3 CSA-C22.2 No.55, Special Use Switches.
- .4 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 COMMERCIAL GRADE RECEPTACLES

.1 Duplex receptacles, CSA type 5-15 R (15A), 5-20R (20A), 125 Vac, U ground, with following features:

- .1 Nylon face, white color for normal 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 riveted grounding contacts.

.2 Receptacles of one manufacturer throughout project.

.3 Approved manufacturers for duplex receptacles:

- .1 Eaton/Cooper: 5262 Series (15A) and 5362 Series (20A)
- .2 Hubbell: BR15, DR15, CR15 (15A) and BR20, DR20, CR20 (20A)
- .3 Leviton: BR15 Series (15A) and BR20 Series (20A)
- .4 Pass & Seymour: 5262 Series 915A) and 5362 Series (20A)

.4 Approved manufacturers for ground fault receptacles:

- .1 Eaton/Arrow-Hart – SGF15 Series (15A), SGF20 Series (20A)
- .2 Hubbell - GFRST15 (15A), GFRST20 (20A)

.3 Leviton – GFNT1 Series (15A), GFNT2 Series (20A)

.4 Pass & Seymour - 1597 Series (15A), 2097 Series (20A)

2.2 COVER PLATES

.1 Cover plates from one manufacturer throughout project.

.2 Stainless steel cover plates for wiring devices mounted in flush-mounted receptacle boxes to be minimum plate thickness of 1.0mm.

.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 Receptacles of configurations 5-15R, 5-20R, 5-20RA, 6-15K, 6-20R and 6-20RA where exposed to weather or moisture, shall be provided with cover plates suitable for wet locations whether or not a plug is inserted into receptacle. Approved Manufacturers:

.1 Eaton/Cooper WIU-1X (1 gang), WIU-2X (2 gang).

.2 Appleton WCDIU1 (1 gang), WCIU2 (2 gang).

.3 Hubbell MM420 (1 gang), MM2420 (2 gang).

.4 Leviton 5980-UCL (1 gang), Leviton 5981-UCL (2 gang).

.5 Pass & Seymour WIUC10 (1 gang), WIUC20 (2 gang),

.6 Weatherproof cover for switch with gaskets as indicated.

Part 3 Execution

3.1 INSTALLATION

.1 Receptacles:

.1 In general, mount receptacles vertically, with the ground terminal at the bottom, at heights specified in Section 26 05 00 or as indicated.

.2 Bond to ground all receptacles with #12 green insulated wire to outlet box. Provide additional separate ground conductor to isolated ground receptacles.

.2 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.

.2 Identify switches 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.

.2 Section 26 24 17 – Panelboards Breaker Type.

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 GROUND FAULT PROTECTOR UNIT

.1 Self-contained with 15A or 20A, 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 and co-ordinate with Section 01 45 00 – Quality Control if required.

.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 26 05 00 – Common Work Results - For Electrical.

.2 Section 26 24 13 – Switchboards (Above 1200A).

.3 Section 26 24 16 – CDP Type Distribution (1200A and Below).

.4 Section 26 24 17 – Panelboards Breaker Type.

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.

Part 2 Products

2.1 BREAKERS GENERAL

.1 Moulded-case circuit breakers, Circuit breakers.

.2 Bolt-on moulded case circuit breaker: quick- make, quick-break type, for manual and automatic operation with temperature compensation for 40 deg. 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 of 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, match the kA from the breaker with the highest kA rating.

.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 SOLID STATE TRIP BREAKERS

.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)

2.4 APPROVED MANUFACTURERS

.1 Match existing.

2.5 REQUIRED FEATURES

.1 Include:

.1 Under-voltage release.
.2 On-off locking device.
.3 Handle mechanism.
.4 Handle accessories.

.1 Circuit breaker handle accessories shall provide provisions for locking handle in the on and off position.

.5 Real time metering

.1 Trip units shall be available to provide real time metering. Metering functions shall include, but shall not be limited to, the following:

.1 Current (phases, neutral, average, maximum).
.2 Voltage (phase-to-phase, phase-to-neutral, average, unbalance).
.3 Power (active [kW], reactive [kVAR], apparent [kVA], power factor).
.4 Energy (active [kW h], reactive [kVAR], apparent [kVA]).
.5 Frequency.
.6 Total harmonic distortion (current, voltage).
.7 Metering accuracy shall be 1.5 percent current (above 600A), 1.0 percent current (600A and below), 0.5 percent voltage, and 2 percent energy. These accuracy's shall be total system, including, but not limited to, CT and meter.

.2 Measurement chain shall be independent from the protection chain.
.3 The measurements shall be displayed on the breaker itself.

.4 Displays mounted on breakers or remote displays

.1 Shall operate continuously and independently of measured load size (shall display values at any load current).

.2 If powering of displays cannot be supported by breaker/trip unit itself, provide additional power supply module inside distribution c/w blue LED pilot light.

.3 Pilot light shall be mounted on the trim, indicating “Control power”.

.4 The power module shall be provided with form “C” alarm contact and shall be fed from a breaker or fuse block within the distribution.

.5 Connections from circuit breaker to remote display and/or communication module shall be plug-n-play via RJ45 connector. No special tools or programming shall be required.

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 switchboards.

.2 Breakers in CDP’s.

.3 Main breakers in panelboards.

.4 Breakers in panelboards that are sub-feeding panelboards.

.5 Programmable/adjustable breakers.

.6 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 Enclosures indoors shall be NEMA 3R.

.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 Fuseholders: suitable without adaptors, for type and size of fuse indicated.

.7 Quick-make, quick-break action, heavy duty industrial grade.

.8 ON-OFF switch position indication on switch enclosure cover.

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 Eaton (to match existing).

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 When arc flash labels are installed on disconnect switches, the arc flash labels shall not cover nameplates or other labels. Provide additional brackets/plates on or near disconnect switches for application of arc flash labels, if there is no sufficient space on the front of the switches.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

.1 Section 26 24 16 – CDP Type Distribution (Up to 1200A).

1.2 REFERENCES

.1 SPD units and all components shall be designed, manufactured, and tested in accordance with the latest applicable UL standard (ANSI/UL 1449 3rd Edition).

1.3 SUBMITTALS

.1 Submit shop drawings and product data in accordance with Section 26 05 00 – Common Work Results – For Electrical.

.2 The following information shall be submitted to the Contract Administrator:

.1 Provide verification that the SPD complies with the required ANSI/UL 1449 3rd Edition listing by Underwriters Laboratories (UL) or other Nationally Recognized Testing Laboratory (NRTL). Compliance may be in the form of a file number that can be verified on UL's website or on any other NRTL's website, as long as the website contains the following information at a minimum: model number, SPD Type, system voltage, phases, modes of protection, Voltage Protection Rating (VPR), and Nominal Discharge Current (I_n).

.2 For sidemount mounting applications (SPD mounted external to electrical assembly), electrical/mechanical drawings showing unit dimensions, weights, installation instruction details, and wiring configuration.

.3 Where applicable the following additional information shall be submitted:

.1 Descriptive bulletins

.2 Product sheets

1.4 SCOPE

.1 The Contractor shall furnish and install the Surge Protective Device (SPD) equipment having the electrical characteristics, ratings, and modifications as specified herein or as shown on the contract drawings. To maximize performance and reliability and to obtain the lowest possible let-through voltages, the ac surge protection shall be integrated into electrical distribution equipment such as panelboards.

1.5 QUALIFICATIONS

.1 The manufacturer of the assembly shall be the manufacturer of the major components within the assembly.

.2 For the equipment specified herein, the manufacturer shall be ISO 9001 or 9002 certified.

.3 The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of five (5) years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

.4 The SPD shall be compliant with the Restriction of Hazardous Substances (RoHS) Directive 2002/95/EC.

1.6 DELIVERY, STORAGE AND HANDLING

.1 Equipment shall be handled and stored in accordance with manufacturer's instructions. One (1) copy of manufacturer's instructions shall be included with the equipment at time of shipment.

1.7 OPERATION AND MAINTENANCE MANUALS

.1 Operation and maintenance manuals shall be provided with each SPD shipped.

Part 2 Products

2.1 VOLTAGE SURGE SUPPRESSION – GENERAL

.1 Electrical Requirements

.1 Unit Operating Voltage – Refer to drawings for operating voltage and unit configuration.

.2 Maximum Continuous Operating Voltage (MCOV) – The MCOV shall not be less than 115% of the nominal system operating voltage.

.3 The suppression system shall incorporate thermally protected metal-oxide varistors (MOVs) as the core surge suppression component for the service entrance and all other distribution levels. The system shall not utilize silicon avalanche diodes, selenium cells, air gaps, or other components that may crowbar the system voltage leading to system upset or create any environmental hazards.

.4 Protection Modes – The SPD must protect all modes of the electrical system being utilized. The required protection modes are indicated by bullets in the following table:

	Protection Modes			
Configuration	L-N	L-G	L-L	N-G
Wye	●	●	●	●
Delta	N/A	●	●	N/A
Single Split Phase	●	●	●	●
High Leg Delta	●	●	●	●

.5 Nominal Discharge Current (I_n) – All SPDs applied to the distribution system shall have a 20kA I_n rating regardless of their SPD Type (includes Types 1 and 2) or operating voltage. SPDs having an I_n less than 20kA shall be rejected.

.6 ANSI/UL 1449 3rd Edition Voltage Protection Rating (VPR) – The maximum ANSI/UL 1449 3rd Edition VPR for the device shall not exceed the following:

MODES	208Y/120	480Y/277	600Y/347
L-N; L-G; N-G	700	1200	1500
L-L	1200	2000	3000

.2 SPD Design

.1 Maintenance Free Design – The SPD shall be maintenance free and shall not require any user intervention throughout its life. SPDs containing items such as replaceable modules, replaceable fuses, or replaceable batteries shall not be accepted. SPDs requiring any maintenance of any sort such as periodic tightening of connections shall not be accepted. SPDs requiring user intervention to test the unit via a diagnostic test kit or similar device shall not be accepted.

.2 Balanced Suppression Platform – The surge current shall be equally distributed to all MOV components to ensure equal stressing and maximum performance. The surge suppression platform must provide equal impedance paths to each matched MOV. Designs incorporating replaceable SPD modules shall not be accepted.

.3 Electrical Noise Filter – Each unit shall include a high-performance EMI/RFI noise rejection filter. Noise attenuation for electric line noise shall be up to 50 dB from 10 kHz to 100 MHz using the MIL-STD-220A insertion loss test method. Products unable able to meet this specification shall not be accepted.

.4 Internal Connections – No plug-in component modules or printed circuit boards shall be used as surge current conductors. All internal components shall be soldered, hardwired with connections utilizing low impedance conductors.

.5 Monitoring Diagnostics – Each SPD shall provide the following integral monitoring options:

.1 Protection Status Indicators - Each unit shall have a green / red solid-state indicator light that reports the status of the protection on each phase.

.1 For wye configured units, the indicator lights must report the status of all protection elements and circuitry in the L-N and L-G modes. Wye configured units shall also contain an additional green / red solid-state indicator light that reports the status of the protection elements and circuitry in the N-G mode. SPDs that indicate only the status of the L-N and L-G modes shall not be accepted.

.2 For delta configured units, the indicator lights must report the status of all protection elements and circuitry in the L-G and L-L modes.

.3 The absence of a green light and the presence of a red light shall indicate that damage has occurred on the respective phase or mode. All protection status indicators must indicate the actual status of the protection on each phase or mode. If power is removed from any one phase, the indicator lights must continue to indicate the status of the protection on all other phases and protection modes. Diagnostics packages that simply indicate whether power is present on a particular phase shall not be accepted.

.2 Remote Status Monitor – The SPD must include Form C dry contacts (one NO and one NC) for remote annunciation of its status. Both the NO and NC contacts shall change state under any fault condition.

.3 Audible Alarm and Silence Button – The SPD shall contain an audible alarm that will be activated under any fault condition. There shall also be an audible alarm silence button used to silence the audible alarm after it has been activated.

.4 Surge Counter – The SPD shall be equipped with an LCD display that indicates to the user how many surges have occurred at the location. The surge counter shall trigger each time a surge event with a peak current magnitude of a minimum of 50 ± 20A occurs. A reset pushbutton shall also be standard, allowing the surge counter to be zeroed. The reset button shall contain a mechanism to prevent accidental resetting of the counter via a single, short-duration button press. In order to prevent accidental resetting, the surge counter reset button shall be depressed for a minimum of 2 seconds in order to clear the surge count total.

.1 The ongoing surge count shall be stored in non-volatile memory. If power to the SPD is completely interrupted, the ongoing count indicated on the surge counter's display prior to the interruption shall be stored in non-volatile memory and displayed after power is restored. The surge counter's memory shall not require a backup battery in order to achieve this functionality.

.6 Overcurrent Protection

.1 The unit shall contain thermally protected MOVs. These thermally protected MOVs shall have a thermal protection element packaged together with the MOV in order to achieve overcurrent protection of the MOV. The thermal protection element shall disconnect the MOV(s) from the system in a fail-safe manner should a condition occur that would cause them to enter a thermal runaway condition.

.7 Fully Integrated Component Design – All of the SPD's components and diagnostics shall be contained within one discrete assembly. SPDs or individual SPD modules that must be ganged together in order to achieve higher surge current ratings or other functionality shall not be accepted.

.8 Safety Requirements

.1 The SPD shall minimize potential arc flash hazards by containing no user serviceable / replaceable parts and shall be maintenance free. SPDs

containing items such as replaceable modules, replaceable fuses, or replaceable batteries shall not be accepted. SPDs requiring any maintenance of any sort such as periodic tightening of connections shall not be accepted. SPDs requiring user intervention to test the unit via a diagnostic test kit or similar device shall not be accepted.

.2 SPDs designed to interface with the electrical assembly via conductors shall require no user contact with the inside of the unit. Such units shall have any required conductors be factory installed.

.3 Sidemount SPDs shall be factory sealed in order to prevent access to the inside of the unit.

2.2 SYSTEM APPLICATION

.1 The SPD applications covered under this section include distribution and branch panel locations. All SPDs shall be tested and demonstrate suitability for application within ANSI/IEEE C62.41 Category C, B, and A environments.

.2 Surge Current Capacity – The minimum surge current capacity the device is capable of withstanding shall be as shown in the following table:

Minimum surge current capacity based on ANSI / IEEE C62.41 location category			
CATEGORY	Application	Per Phase	Per Mode
C	Service Entrance Locations (Switchboards, Switchgear, MCC, Main Entrance)	250 kA	125 kA
B	High Exposure Roof Top Locations (Distribution Panelboards)	160 kA	80 kA
A	Branch Locations (Panelboards, MCCs, Busway)	120 kA	60 kA

2.3 DISTRIBUTION PANELBOARD REQUIREMENTS

.1 The SPD application covered under this section includes distribution panelboards. The SPD units shall be tested and demonstrate suitability for application within ANSI/IEEE C62.41 Category B environments.

.1 The SPD shall not limit the use of through-feed lugs, sub-feed lugs, and sub-feed breaker options.

.2 SPDs shall be installed immediately following the load side of the main breaker. SPDs installed in main lug only panelboards shall be installed immediately following the incoming main lugs.

.3 The panelboard shall be capable of re-energizing upon removal of the SPD.

.4 The SPD shall be interfaced to the panelboard via a direct bus bar connection. Alternately, an SPD connected to a 30A circuit breaker for disconnecting purposes may be installed using short lengths of conductors as long as the

conductors originate integrally to the SPD. The SPD shall be located directly adjacent to the 30A circuit breaker.

.5 The SPD shall be included and mounted within the panelboard by the manufacturer of the panelboard.

.6 The SPD shall be of the same manufacturer as the panelboard.

.7 The complete panelboard including the SPD shall be UL67 listed.

.2 Sidemount Mounting Applications Installation (SPD mounted external to electrical assembly)

.1 Lead length between the breaker and suppressor shall be kept as short as possible to ensure optimum performance. Any excess conductor length shall be trimmed in order to minimize let-through voltage. The installer shall comply with the manufacturer's recommended installation and wiring practices.

2.4 ENCLOSURES

.1 All enclosed equipment shall have NEMA 3R general purpose enclosures, unless otherwise noted.

2.5 ACCEPTABLE MANUFACTURERS

.1 Acceptable Manufacturers: Eaton.

Part 3 Execution

3.1 FACTORY TESTING

.1 Standard factory tests shall be performed on the equipment under this section. All tests shall be in accordance with the latest version of NEMA and UL standards.

3.2 INSTALLATION

.1 The Contractor shall install all equipment per the manufacturer's recommendations and the contract drawings.

3.3 WARRANTY

.1 Warranty all equipment, materials, peripherals, installation, workmanship, etc. for one (1) year from the date of acceptance of submitted declaration of Substantial Performance.

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 21 - Wires and Cable.

.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 CAN/ULC-S524 Installation of Fire Alarm Systems

.2 CAN/ULC-S525 Audible Signal Appliances for Fire Alarm

.3 CAN/ULC-S526 Visual Signal Appliances for Fire Alarm Systems

.4 CAN/ULC-S527 Control Units, Fire Alarm

.5 CAN/ULC-S528 Manual Pull Stations

.6 CAN/ULC-S529 Smoke Detectors, Fire Alarm

.7 CAN/ULC-S530 Heat Actuated Fire Detectors, Fire Alarm

.8 CAN/ULC-S531 Smoke Alarms

.9 CAN/ULC-S536 Inspection and Testing of Fire Alarm Systems

.10 CAN/ULC-S537 Verification of Fire Alarm Systems

.11 DFC No. 310(M) Computer Systems

.12 Manitoba Building Code

.13 CSA 22.1 Canadian Electrical Code

1.3 DESCRIPTION OF SYSTEM

.1 This specification provides the requirements for the supply and installation, programming, testing, commissioning and verification of new fire alarm devices connected to the existing Addressable Fire alarm system.

.2 Existing system to accept monitoring points for Carbon Monoxide detection control panels as shown on drawings. Provide additional modules and include for all re-programming of existing system as required so that the existing system integrity and new additions are fully operational.

.3 System Includes:

- .1 Microprocessor based addressable control panel to carry out fire alarm and protection functions including receiving alarm signals, initiating general alarm, supervising system continuously, actuating zone annunciators, initiating trouble signals, performing fire control functions, etc.
- .2 Trouble signal devices.
- .3 Power supply facilities.
- .4 Manual alarm stations.
- .5 Automatic alarm initiating devices.

.6 Audible alarm signal devices.
.7 Visual alarm signal devices.
.8 End-of-line devices.
.9 Ancillary devices.
.10 Standby batteries.
.11 Auxiliary control.
.12 Intelligent environmental compensation.

.4 The loading of device loops shall be based on approximately 80% load. Provide additional loops to comply with this loading where required or directed.

1.4 REQUIREMENTS OF REGULATORY AGENCIES

.1 The equipment and installation shall comply with the current ULC and Building Code requirements.

.2 Manitoba Building Code.

.3 Local and Municipal By-Laws.

.4 Authorities having jurisdiction.

1.5 SHOP DRAWINGS

.1 Submit shop drawings in accordance with Section 26 05 00 for the complete Fire Alarm system including:
.1 All devices.
.2 Programming of the Fire Alarm System.
.3 All other components of the fire alarm system.
.4 Description of the operational sequences of the system.
.5 Pictorial drawings of control equipment indicating the location of the components and parts and their respective catalogue number and electrical characteristics.
.6 Maintenance instructions.
.7 Recommended spare parts list.
.8 Provide name, address and telephone number of the manufacturer's service representative to be contacted during the warranty period.
.9 Complete wiring diagram, including:
.1 Connections to devices
.2 Schematics of modules

.2 This information is to be revised to "as-built" after construction is completed. Insert as part of the Operating and Maintenance Manuals.

1.6 OPERATION AND MAINTENANCE DATA

.1 Provide operation and maintenance data for Fire Alarm System for incorporation into Operation and Maintenance Manual specified in Section 26 05 00.

.2 Include:
.1 Operation and maintenance instructions for complete fire alarm system to permit effective operation and maintenance.
.2 Technical data - illustrated parts lists with parts catalogue numbers.
.3 Copy of as-built shop drawings.

1.7 WARRANTY

.1 Warranty all equipment, materials, peripherals, installation, workmanship, etc. for one (1) year from the date of acceptance of submitted declaration of Substantial Performance.

.2 Provide all programming of system as directed during the warranty period at no cost to The City.

Part 2 Products

2.1 MANUFACTURER

.1 Being listed as an acceptable Manufacturer in no way relieves obligation to provide all equipment and features in accordance with these specifications.

.2 Manufacturers

.1 Approved Manufacturers:

.1 Notifier by Vipond (to match existing)

.3 All equipment and components shall be the manufacturer's current models, unless noted otherwise. The system and components must be supplied by one manufacturer. The materials, appliances, equipment and devices shall be tested and listed to ULC standards for use as part of a protective signaling (fire alarm) system. The Contractor shall provide, from the acceptable manufacturer's current product lines, equipment and components that comply, with the requirements of these Specifications. Equipment or components, which do not provide the performance and features, required by these specifications are not acceptable, regardless of manufacturer.

2.2 MATERIALS

.1 Equipment and devices: ULC listed and labelled and supplied by single manufacturer.

.2 All equipment furnished for this project shall be new and unused. All equipment, materials, accessories, devices, and other facilities covered by this specification or noted on contract drawings and installation specifications shall be the best suited for the intended use and shall be the product of a single manufacturer.

2.3 FIRE ALARM CONTROL PANEL (FACP)

.1 The existing fire alarm control panels consist of:

.1 Notifier NFS-640ND W/NCA single stage fire alarm system.

.2 The Fire Alarm System shall consist of all necessary hardware equipment and software programming to perform the following additions to the existing fire alarm system:

.1 Fire alarm and detection operations as indicted on the drawings and speciation for interconnection of new Carbon monoxide gas detection panels.

2.4 AUTOMATIC ALARM INITIATING DEVICES

.1 Carbon Monoxide Detection.

.1 The CO detection element shall indicate a trouble condition at the FACP signaling end of life and the CO element of the detector shall be field replaceable. It shall be programmed at the main control panel as a supervisory indication and transmit a separate supervisory signal to the central station. The CO detector shall be ULC-S529 and CSA-6.19 as CO alarm device.

.2 Addressable Carbon Monoxide (CO) Detector supervisory signals are to be monitored by an off site central station (separate monitoring for CO detection).

.3 Self-diagnostics and History Log - Each Signature Series detector are to run self-checks to provide important maintenance information. The results of the self-check are to be automatically updated and permanently stored in the detector's non-volatile memory.

.4 Automatic Device Mapping - The loop controller is to learn where each device's serial number address is installed relative to other devices on the circuit. The mapping feature is to provide supervision of each device's installed location to prevent a detector from being reinstalled (after cleaning etc.) in a different location from where it was originally.

.5 Stand-alone Operation - A decentralized alarm decision by the detector is to be guaranteed. On-board intelligence is to permit the detector to operate in stand-alone mode. If loop controller CPU communications fail for more than four seconds, all devices on that circuit go into stand-alone mode. The circuit is to act like a conventional alarm receiving circuit.

.6 Fast Stable Communication - On-board intelligence equates to less information being sent between the detector and the loop controller. Other than regular supervisory polling response, the detector is to communicate with the loop controller when it has something new to report.

2.5 DETECTOR BASES

.1 General

.1 Detector Bases shall be suitable for mounting on octagon box, or 4" square box.

.2 Isolator Base

.1 The isolator base shall support all detector types and have the following minimum requirements:

.1 The operation of the isolator base shall be controlled by its respective detector processor. Isolators which are not controlled by a detector processor shall not be accepted.

.2 The isolator shall operate within a minimum of 23 msec. of a short circuit condition on the communication line.

.3 Following a short circuit condition, each isolator/detector shall be capable of performing an internal self-test procedure to re-establish normal operation. Isolator/detectors not capable of performing independent self tests shall not be acceptable.

.2 When connected in Class A configuration the Loop Controller shall identify an isolated circuit condition and provide communications to all non isolated analog devices. Loop wiring shall be Class 'A'. Isolator bases to be provided when a loop is used between floors, between areas which have fire separations. Do not exceed 12 devices on a branch without an isolator.

.3 Terminal connections shall be made on the room side of the base. Bases which must be removed to gain access to the terminals shall not be acceptable.

2.6 MODULES

.1 Single Input Module

.1 The intelligent Single Input Module shall be capable of a minimum of 4 personalities, each with a distinct operation.

.2 The personality of the module shall be programmable at site to suit conditions and may be changed at any time using a personality code downloaded from the Analog Loop Controller. Single function modules or modules requiring Eprom, ROM or PROM changes or DIP switch/jumper changes shall not be acceptable.

.3 The single input module shall support the following circuit types:

.1 Alarm Latching, Manual Station, Conventional Heat, Waterflow

.2 Delayed Waterflow

.3 Non-Latching Monitor

.4 Supervisory

.4 Input circuit wiring shall be supervised for open and ground faults.

.5 The input module shall be suitable for operation in the following environment:

.1 Temperature: 32F to 120F (0C to 49C)

.2 Humidity: 0-93% RH, non-condensing

.2 Single Input Signal Module

.1 The intelligent Single Input Riser/Signal Module shall provide one supervised output circuit. The output circuit shall be suitable for any of the following operations:

.1 24 vdc, polarized audible and visible signal appliances

.2 Circuit wiring shall be supervised for open and ground faults.

.3 The signal module shall have a minimum of 2 diagnostic LEDs mounted behind finished cover plate. A green LED shall flash to confirm communication with the loop controller. A red LED shall flash to display alarm status. The module shall be capable of storing up to 24 diagnostic codes.

.4 Terminal connections shall be accessible from the room side of the assembly. Devices which must be removed to gain access to the wiring terminals shall not be acceptable.

.5 The signal module shall be suitable for operation in the following environment:

.1 Temperature: 32F to 120F (0C to 49C)

.2 Humidity: 0-93% RH, non-condensing

2.7 ISOLATOR MODULE

.1 Isolator modules shall be provided to automatically isolate wire to wire short circuits on a DCL Class A or Class B branch. The isolator module shall limit the number of modules or detectors that may be rendered inoperative by a short circuit fault on the DCL loop segment or branch.

.2 If a circuit fault occurs; open, short or ground, or destructive fault caused by a fire occurs, the isolator module shall automatically open circuit (disconnect) the DCL / disconnect the bad segment of the link and allow data communication on all of the remaining segments through an alternate path until the fault is cleared. When the circuit fault or destructive fault condition is corrected, the isolator module shall automatically reconnect the isolated section.

.3 The isolator module and its operations shall be totally automatic. It shall not be necessary to replace or reset an isolator module after its normal operation.

.4 The isolator module shall provide a single LED that shall flash to indicate that the isolator is operational and shall illuminate steadily to indicate that a short circuit condition has been detected and isolated.

2.8 CONDUIT AND WIRE

.1 Conduit:

.1 Conduit shall be in accordance with Canadian Electrical Code, local and provincial requirements.

.2 Where possible, all wiring shall be installed in conduit or raceway. Conduit fill shall not exceed 40 percent of interior cross sectional area where three or more cables are contained within a single conduit.

.3 Cable must be separated from any open conductors of Power, or Class 1 circuits, and shall not be placed in any conduit, junction box or raceway containing these conductors.

.4 Wiring for 24 volt control, alarm notification, emergency communication and similar power limited auxiliary functions may be run in the same conduit as initiating and signalling line circuits. All circuits shall be provided with transient suppression devices and the system shall be designed to permit simultaneous operation of all circuits without interference or loss of signals.

.5 Conduit shall not enter the fire alarm control panel or any other remotely mounted control panel equipment or back boxes, except where conduit entry is specified by the FACP manufacturer.

.2 Wire:

.1 All fire alarm system wiring must be new.

.2 Wiring shall be in accordance with local, provincial and national codes and as recommended by the manufacturer of the fire alarm system. Number and size of conductors shall be as recommended by the fire alarm system manufacturer, but not less than 18 AWG (1.02 mm) for initiating device circuits and signalling line circuits, and 14 AWG (1.63 mm) for notification appliance circuits.

.3 All wire and cable shall be listed and/or approved by a recognized testing agency for use with a protective signalling system.

.4 Wiring used for the multiplex communication circuit (DCL) shall be twisted and unshielded and support a minimum wiring distance of 12,500 feet. The design of the system shall permit use of IDC and NAC wiring in the same conduit with the DCL communication circuit.

.5 The system shall permit the use of IDC and NAC wiring in the same conduit with the multiplex communication loop.

.6 All field wiring shall be completely supervised. In the event of a primary power failure, disconnected standby battery, removal of any internal modules, or any open circuits in the field wiring, a trouble signal will be activated until the system and its associated field wiring are restored to normal condition.

.3 Terminal Boxes, Junction Boxes and Cabinets:

.1 All boxes and cabinets shall be CSA listed for their intended purpose.

.2 Initiating circuits shall be arranged to serve like categories (manual, smoke, waterflow). Mixed category circuitry shall not be permitted except on Data Communication Link connected to intelligent reporting devices.

.4 .

Part 3 Execution

3.1 INSTALLATION, GENERAL

.1 Install system components and all associated devices in accordance with applicable building code requirements, ULC Standards and manufacturer's recommendations.

.2 Installation personnel shall be supervised by persons who are qualified and experienced in the installation, inspection, and testing of fire alarm systems. Examples of qualified personnel shall include, but not be limited to, the following:

.1 Factory trained and certified personnel.

.2 Canadian Fire Alarm Association (CFAA) personnel.

.3 Personnel licensed or certified by provincial or local authority.

.3 Locate and install detectors and connect to alarm circuit wiring. Do not mount detectors within 1 m of air outlets. Maintain at least 600 mm radius clear space on ceiling, below and around detectors. Locate duct type detectors in straight portions of ducts (co-ordinate with Division 25 Heating & Ventilation as per codes and standards and the manufacturer's instructions).

3.2 EQUIPMENT INSTALLATION

.1 Furnish and install a complete Fire Alarm System as described herein and as shown on the plans. Include sufficient automatic fire detectors, wiring, terminations, electrical boxes, and all other necessary material for a complete operating system.

.2 Existing Fire Alarm Equipment shall be maintained fully operational until the new equipment has been tested and accepted.

3.3 ISOLATOR MODULE INSTALLATION

.1 Provide fault isolation modules as per CAN/ULC-S524 (current adopted version). Fault isolation modules shall be utilized when entering and leaving each fire alarm zone, as required by the National Building Code of Canada (current adopted version). Where a fire separation is provided, fault isolation modules shall be installed on each side of that fire separation.

3.4 WIRING INSTALLATION

.1 System Wiring: Wire and cable shall be a type listed for its intended use by an approval agency acceptable to the Authority Having Jurisdiction (AHJ) and shall be installed in accordance with the appropriate articles from the current approved edition of the Canadian Electric Code (CEC).

.2 Contractor shall obtain from the Fire Alarm System Manufacturer written instruction regarding the appropriate wire/cable to be used for this installation. No deviation from the written instruction shall be made by the Contractor without the prior written approval of the Fire Alarm System Manufacturer.

.3 Color Coding: Color-code fire alarm conductors differently from the normal building power wiring. Use one color code for alarm initiating device circuits wiring and a different color code for supervisory circuits. Color-code notification appliance circuits differently from alarm-initiating circuits. Paint fire alarm system junction boxes and covers red.

3.5 VERIFICATION, DATA AND TESTING

.1 System Verification

.1 Upon completion of all wiring and installation of all equipment, devices, etc., do complete verification of the fire alarm system. Verification shall be in accordance with current edition of Standard CAN/ULC-S537 "The Verification of Fire Alarm Systems" and following requirements. Even if permitted by Code and recognized standards and regulations, grade of work shall in no case be lower than specified in the project specifications. Verify all new initiating and signal/ zones and circuits, etc. Verify that every component installed, is working and functions as intended.

.2 Manufacturer with assistance of electrical contractor shall do a complete verification of system to ULC S-537 to ensure:

.1 That system is installed as per plans and specifications and is operative and acceptable to all authorities having jurisdiction.

.2 That system is installed as per recommendations of manufacturer.

.3 That system is electrically supervised, including all zone lamps. To accomplish this, manufacturer with assistance of electrical contractor shall:

.1 Remove each and every device from its applicable circuit by disconnecting circuit wiring

.2 Verify presence of the applicable trouble signal and indications at control panel and remote annunciators.

.4 That all devices are operative. Check each switch, device, ancillary device, etc. for proper operation.

.5 That all system functions are operating as intended, including:

.1 All main control circuits,

.2 All remote annunciator circuits,

.3 All manual and automatic initiating devices,

.4 All audible and visual alarm signals,

.5 All ancillary controls, including fan shutdown, door release, fire dampers, maglock release, smoke evacuation sequence, monitor modules, etc.

.1 Verification report shall include the actual operational test of all ancillary devices.

.6 All existing systems functions (such as alarm signals, ancillary controls, etc.) that are not modified, but are required to operate from any new zones added, shall be verified for correct operation.

.7 When fire alarm system is verified, Contractor shall measure and record all loop or circuit resistance values at the fire alarm panel when end-of-line resistor is shorted. Contractor shall highlight all values which exceed the manufacturer's recommendations and report them to the Contract Administrator for action to correct this deficiency.

.3 Any necessary changes required to conform to the above shall be completed by the electrical contractor with technical assistance provided by the system manufacturer.

.4 Upon completion of the above inspection, including any changes required, the manufacturer shall submit the following documentation to the Contract Administrator.

.1 Certification of Verification

.2 A complete report of all equipment verified, including:

.1 automatic detectors

.2 alarm signals

.3 the number and type of devices connected to each circuit

.5 For each piece of equipment verified, the following information shall be included in the report:

.1 Catalogue number and type of device

.2 Location of device

.3 Zoning or circuit devices including ancillary devices

.4 Supervision test results

.5 Operation of device

.6 Inspection date

.7 Serial number of every smoke detector

.8 Sensitivity reading of every smoke detector, including duct detectors

.9 Record the time delay of all sprinkler flow switches

.10 Zone circuit loop resistance

.11 Fire alarm system supplier shall verify that alarm descriptions match and are consistent at each of following reporting locations:

.1 Fire alarm control panel

.2 Fire alarm remote annunciators

.6 Report shall also indicate operation of ancillary functions such as remote alarm indicators, door release, fan shutdown, etc. which are required to be activated. Operation shall be verified by actual observation of the entire function (e.g. bells ringing, checking to ensure proper fans shut down, etc.). Observing a change of state in the fire alarm control panel (e.g. observing relay function) is not considered complete verification of the entire function. Verification shall include actual field checking of proper operation of ancillary devices and equipment. Complete fire alarm system verification report shall be submitted to Contract Administrator.

.7 All costs necessary for this verification shall be included in electrical trade's Bid Opportunity price.

.8 Upon completion of this inspection, manufacturer shall demonstrate the operation of system to the City.

.9 Manitoba Fire Alarm Technician ‘M’ License:

.1 A Manitoba Fire Alarm Technician ‘M’ License is required to perform fire alarm verifications. The scope of this license allows holders to maintain, service, repair and verify fire alarm systems. Installations of fire alarm systems must still be performed by a licensed electrician. Fire

alarm verifications shall be conducted by a qualified person other than the installing contractor or contract administrator.

.2 In addition to the name and contact information of the verifying organization, the verification report must include the printed name, the signature, the 'M' license number and the CFAA (Canadian Fire Alarm Association) certificate number of the primary technician conducting the verification.

3.6 FIELD QUALITY CONTROL

.1 Manufacturer's Field Services: Provide services of a factory-authorized service representative to supervise the field assembly and connection of components and the pre-testing, testing, and adjustment of the system.

.2 Service personnel shall be qualified and experienced in the inspection, testing, and maintenance of fire alarm systems. Examples of qualified personnel shall be permitted to include, but shall not be limited to, individuals with the following qualifications:

.1 Factory trained, and certified and authorized.

.2 Canadian Fire Alarm Association (CFAA) fire alarm certified.

.3 Certified by a provincial or local authority.

.4 Trained and qualified personnel employed by an organization listed by a national testing laboratory for the servicing of fire alarm systems.

.3 Pre-testing: Determine, through pre-testing, the conformance of the system to the requirements of the Drawings and Specifications. Correct deficiencies observed in pre-testing. Replace malfunctioning or damaged items with new and retest until satisfactory performance and conditions are achieved.

.4 Final Test Notice: Provide a 10-day minimum notice in writing when the system is ready for final acceptance testing.

.5 Minimum System Tests: Test the system according to the procedures outlined in CAN/ULC-S537.

.6 Retesting: Correct deficiencies indicated by tests and completely retest work affected by such deficiencies. Verify by the system test that the total system meets the Specifications and complies with applicable standards.

.7 Report of Tests and Inspections: Provide a written record of inspections, tests, and detailed test results in the form of a test log.

.8 Final Test, Certificate of Completion, and Certificate of Occupancy:

.1 Test the system as required by the Authority Having Jurisdiction in order to obtain a certificate of occupancy. Refer to Life Safety Testing in Section 26 05 00.

3.7 TRAINING

.1 Provide the services of a factory-authorized service representative to demonstrate the system and train the City's maintenance personnel as specified below.

.1 Train the City's maintenance personnel in the procedures and schedules involved in operating, troubleshooting, servicing, and preventive maintaining of the system. Provide a minimum of 4 hours' training.

.2 Schedule training with the City at least seven days in advance.

END OF SECTION

Heat Recovery Units

AIR HANDLING UNIT No.	**HRU-1 & 2**			
SERVICE AREA	Maintenance and Repair Building - West High Bay			
MANUFACTURER	Tempeff			
MODEL	RG 15000			
SUPPLY FILTER TYPE	**2" Merv-10**			
EXHAUST FILTER TYPE	**None**			
BALANCED AIRFLOW CONDITION				
SUPPLY FAN - SIZE/TYPE	ANPA 22			
AIRFLOW RATE (cfm) (l/s)	**18190**		8585	
TOTAL STATIC REQUIRED (in.H_2O) (Pa)	**2.85**		712.50	
EXTERNAL STATIC REQUIRED (in.H2O) (Pa)	**1.50**		375.00	
MOTOR (Bhp/Hp) (bkW/kW)	**7.31**	**10.00**	5.45	7.46
SPEED (rpm)	1617			
EXHAUST FAN - SIZE/TYPE	ANPA 22			
AIRFLOW RATE (cfm) (l/s)	**18051**		8519	
TOTAL STATIC REQUIRED (in.H_2O) (Pa)	**2.80**		700.00	
EXTERNAL STATIC REQUIRED (in.H2O) (Pa)	**2.00**		500.00	
MOTOR (Bhp/Hp) (bkW/kW)	**7.19**	**10.00**	5.36	7.46
SPEED (rpm)	1604			
HEAT RECOVERY SECTION				
SUPPLY AIRFLOW (cfm) (l/s)	**18051**		8519	
EXHAUST AIRFLOW (cfm) (l/s)	**18051**		8519	
WINTER ENERGY RECOVERY (MBH) (kW)	**1682.71**		493.2	
WINTER RECOVERY FACTOR (%)	**86.30**			
WINTER SUPPLY AIR TEMP. AFTER UNIT (°F) (°C)	**56.31**		13.51	
HEATING EXCHANGER				
MAX GAS HEATING INPUT (MBH)	**1200**			
MAX GAS HEATING OUTPUT (MBH)	**960**			
ENTERING AIR TEMP (°F) (°C)	**55.70**		13.17	
LEAVING AIR TEMP (°F) (°C)	**104.30**		40.17	
INBALANCED AIRFLOW CONDITION (TAILPIPE EXHAUST SYSTEM FULL OPERATION)				
SUPPLY FAN - SIZE/TYPE	ANPA 22			
AIRFLOW RATE (cfm) (l/s)	**18190**		8585	
TOTAL STATIC REQUIRED (in.H_2O) (Pa)	**2.65**		662.50	
EXTERNAL STATIC REQUIRED (in.H2O) (Pa)	**1.50**		375.00	
MOTOR (Bhp/Hp) (bkW/kW)	**7.31**	**10.00**	5.45	7.46
SPEED (rpm)	1617			
EXHAUST FAN - SIZE/TYPE	ANPA 22			
AIRFLOW RATE (cfm) (l/s)	**11731**		5536	
TOTAL STATIC REQUIRED (in.H_2O) (Pa)	**2.42**		605.00	
EXTERNAL STATIC REQUIRED (in.H2O) (Pa)	**2.00**		500.00	
MOTOR (Bhp/Hp) (bkW/kW)	**7.19**	**10.00**	5.36	7.46
SPEED (rpm)	1604			
HEAT RECOVERY SECTION				
SUPPLY AIRFLOW (cfm) (l/s)	**14650**		6914	

EXHAUST AIRFLOW (cfm) (l/s)	**11731**	5536
WINTER ENERGY RECOVERY (MBH) (kW)	**1200.31**	351.8
WINTER RECOVERY FACTOR (%)	**75.90**	
WINTER SUPPLY AIR TEMP. AFTER UNIT (°F) (°C)	**45.86**	7.70
BYPASS AIRFLOW (cfm) (l/s)	**3540**	1671
HEATING EXCHANGER		
MAX GAS HEATING INPUT (MBH)	**1200**	
MAX GAS HEATING OUTPUT (MBH)	**960**	
ENTERING AIR TEMP (°F) (°C)	**28.30**	-2.06
LEAVING AIR TEMP (°F) (°C)	**76.30**	24.61
UNIT TOTAL LENGTH (in.) (mm)	**357.25**	9074.15
UNIT TOTAL WIDTH (in.) (mm)	**114.13**	2898.78
UNIT TOTAL HEIGHT (in.) (mm)	**106.25**	2698.75
UNIT WEIGHT (lbs) (kg)	**21930**	9947

Notes:	**2" Foam Injected Panels**
	All Sections c/w Hinged Access Doors and Locking Latches
	Multi-Damper Switchover Section c/w Actuators
	SS Drain Pans under Heat Exchanger(s) w/ 1" NPT Connections
	Galvanized Heat Exchanger Frames
	Galvanized Damper Blades, Damper Rods and Axles
	Exterior/ Interior Casing: 24 Ga G90 Galv
	10 HP WEG ODP Premium Eff. 4 Pole 215T Frame
	SA Drive: ACH580-022A-6; RA Drive: ACH580-01-022A-6
	1in. Seismic Spring Isolation; Single Point Power; Low Limit;
	SA Pre-Filter: Dafco Merv 10 (2") 400 HC; Quick Connect;
	Heatco HDB-HPP-400-1200 Indirect Gas Burner 15:1 Turndown;
	8" 10 Ga Baseframe; Dwyer DH3 Digihelic
	Dwyer Magnehelic 605 Series (4-20mA Out)
	External Enclosure w/ Hood; Enclosure Dampers w/ Actuators
	Enclosure Temperature Controls; Enclosure Transformer
	Enclosure Cooler; Enclosure Heater
	SA Insulated Bypass Dampers with Modulate Belimo Actuator

SMS Engineering

Heat Recovery Unit Schedule

Project:	**Transit Maintenance and Repair Building Mechanical Upgrade - West High Bay**		
File:	20-349-01	Designer:	JTRH
Date:	Jun-22	Sheet:	**MS-1**

Grilles, Registers and Diffusers

TYPE	MANUFAC-TURER	MODEL	BOR-DER	CORE	VOLUME CONT.	FRAME	FASTNG.	FINISH	REMARKS
S-1	EH Price	920D	-	-	-	Std	A	Silver/ Gray #01	Sidewall Double Deflection Heavy Duty Grille

SMS Engineering™

Grille, Register and Diffuser Schedule

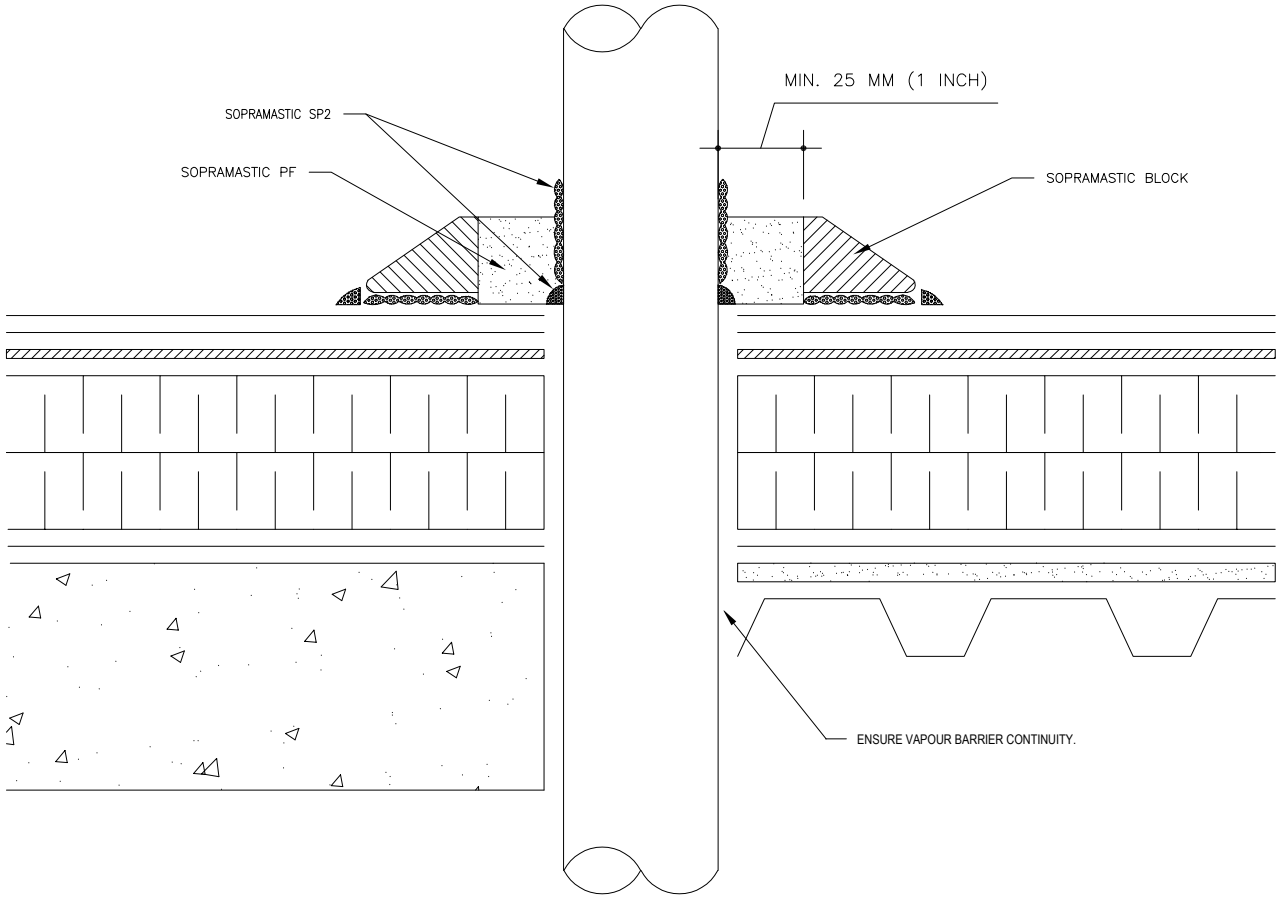
Project: **Transit Maintenance and Repair Building**
Mechanical Upgrade - West High Bay

File: 20-349-01 Designer: JTRH

Date: Jun-22 Sheet: **MS-2**

Gas Fired Radiant Heaters

NO.	LOCATION	MANUFACTURER	MODEL	LENGTH Feet	INPUT (MBH)	OPTIONS
IH 39	Maintenan & Repair Building - West High Bay	Superior Radiant	UA	50 ft long	150	c/w lower radiant shield for coverage distance on tube. Provide thermostat and relay kits to complete the control. Mount thermostat to meet AHJ's requirements.
IH 42	Maintenan & Repair Building - West High Bay	Superior Radiant	UA	50 ft long	150	c/w lower radiant shield for coverage distance on tube. Provide thermostat and relay kits to complete the control. Mount thermostat to meet AHJ's requirements.
IH 43	Maintenan & Repair Building - West High Bay	Superior Radiant	UA	50 ft long	150	c/w lower radiant shield for coverage distance on tube. Provide thermostat and relay kits to complete the control. Mount thermostat to meet AHJ's requirements.
IH 44	Maintenan & Repair Building - West High Bay	Superior Radiant	UA	50 ft long	150	c/w lower radiant shield for coverage distance on tube. Provide thermostat and relay kits to complete the control. Mount thermostat to meet AHJ's requirements.
IH 45	Maintenan & Repair Building - West High Bay	Superior Radiant	UA	50 ft long	150	c/w lower radiant shield for coverage distance on tube. Provide thermostat and relay kits to complete the control. Mount thermostat to meet AHJ's requirements.
IH 46	Maintenan & Repair Building - West High Bay	Superior Radiant	UA	50 ft long	150	c/w lower radiant shield for coverage distance on tube. Provide thermostat and relay kits to complete the control. Mount thermostat to meet AHJ's requirements.
IH 47	Maintenan & Repair Building - West High Bay	Superior Radiant	UA	50 ft long	150	c/w lower radiant shield for coverage distance on tube. Provide thermostat and relay kits to complete the control. Mount thermostat to meet AHJ's requirements.
IH 48	Maintenan & Repair Building - West High Bay	Superior Radiant	UA	50 ft long	150	c/w lower radiant shield for coverage distance on tube. Provide thermostat and relay kits to complete the control. Mount thermostat to meet AHJ's requirements.
IH 49	Maintenan & Repair Building - West High Bay	Superior Radiant	UA	40 ft long	150	c/w lower radiant shield for coverage distance on tube. Provide thermostat and relay kits to complete the control. Mount thermostat to meet AHJ's requirements.
IH 50	Maintenan & Repair Building - West High Bay	Superior Radiant	UA	50 ft long	150	c/w lower radiant shield for coverage distance on tube. Provide thermostat and relay kits to complete the control. Mount thermostat to meet AHJ's requirements.
IH 51	Maintenan & Repair Building - West High Bay	Superior Radiant	UA	50 ft long	150	c/w lower radiant shield for coverage distance on tube. Provide thermostat and relay kits to complete the control. Mount thermostat to meet AHJ's requirements.
IH 52	Maintenan & Repair Building - West High Bay	Superior Radiant	UA	50 ft long	150	c/w lower radiant shield for coverage distance on tube. Provide thermostat and relay kits to complete the control. Mount thermostat to meet AHJ's requirements.



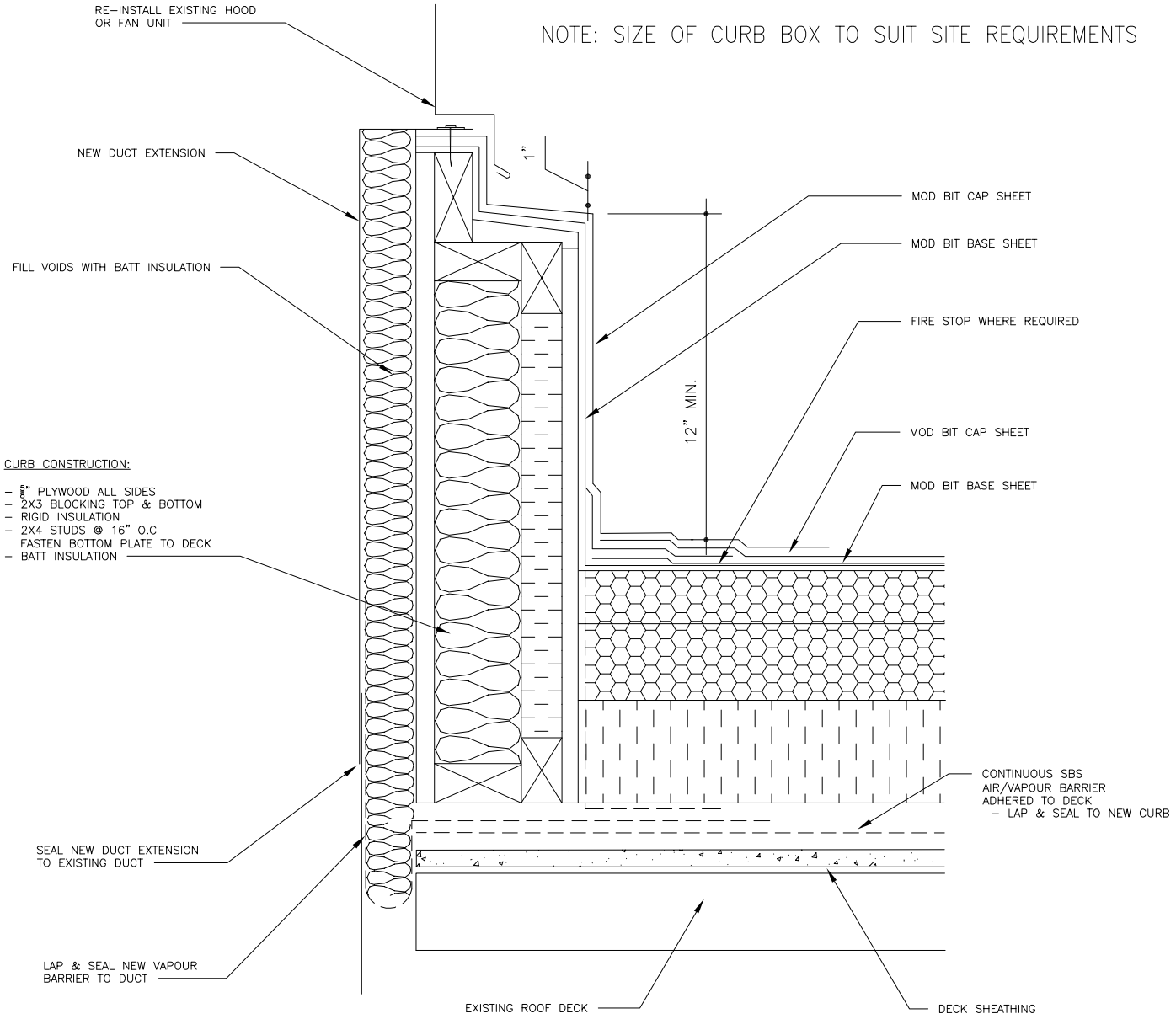
GENERAL NOTES:

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

JDB.
BUILDING ENVELOPE SPECIALISTS

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

NOTE: SIZE OF CURB BOX TO SUIT SITE REQUIREMENTS



JDB.
BUILDING ENVELOPE SPECIALISTS

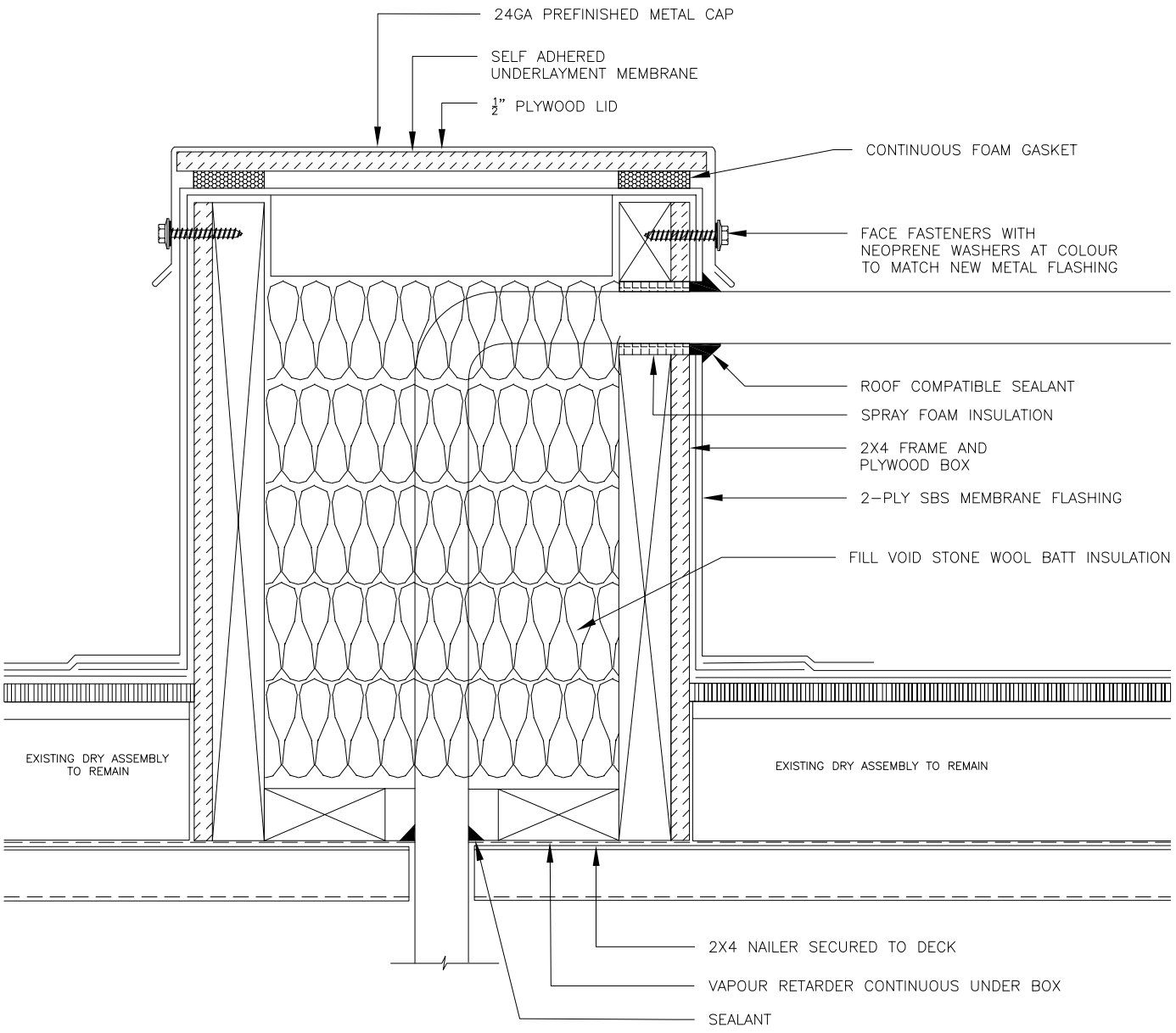
DRAWING: ROOF CURB @ DUCT DETAIL

CLIENT: –

PROJECT: 1005–2016

SCALE: N.T.S

SHEET NO: RD–2



JDB.
BUILDING ENVELOPE SPECIALISTS

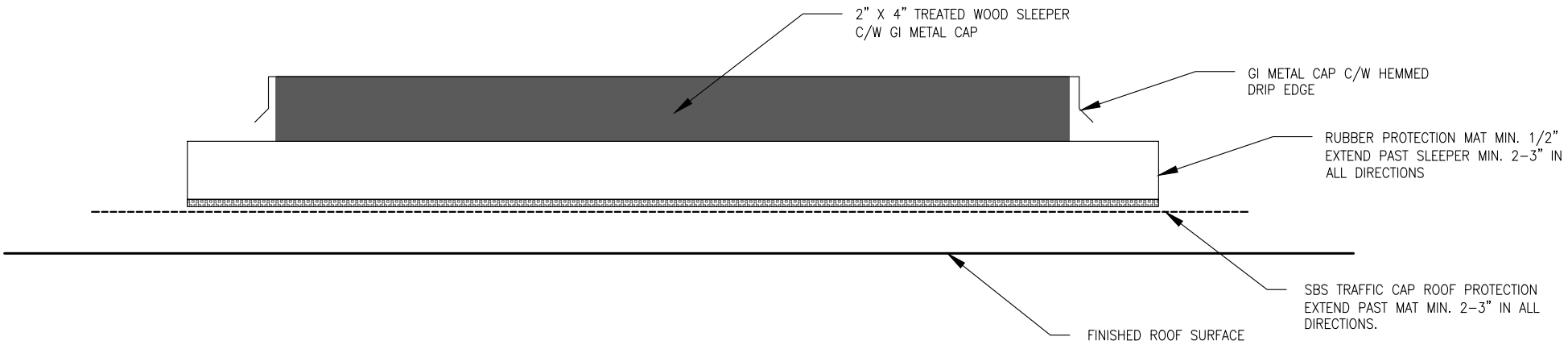
DRAWING: CONDUIT BOX DETAIL

CLIENT: –

PROJECT: 1005-2016

SCALE: N.T.S

SHEET NO: RD-3



TYPICAL SLEEPER SUPPORT DETAIL

JDB.
BUILDING ENVELOPE SPECIALISTS

PROJECT NAME:
PROVISION OF ROOF REPLACEMENT

CLIENT:
–

eFile:
1005-2016_Drawing_RD-4

SCALE:
N.T.S

SHEET NO:
RD-4