

# **PROJECT MANUAL VOL. 2**

Issued for Tender

Mechanical and Electrical

**YORK REGION**

**PARAMEDIC RESPONSE STATION #33**

**RFTC-397-21-18041**

2960 Teston Road,

City of Vaughan

DR - indicates entity responsible for preparation of listed documents (see Section 00 01 05)

**Document Identification**

**DR**

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## **PART 1 – GENERAL**

### **1.1 General**

- .1 Read and be governed by conditions of the *Contract Documents*, including sections of Division 01.
- .2 This specification section forms part of the Contract Documents and is to be read, interpreted, and coordinated with all other sections.
- .3 The general conditions and instructions to bidders as outlined in the general contract specification and all associated addenda shall govern this Division. This section covers items common to all sections of Division 20, 21, 22, 23, and 25 and is intended to supplement requirements of Divisions 00 and 01.
- .4 Where requirements of this section contradict requirements of Divisions 00 or 01, the most stringent of the conditions shall take precedence.

### **1.2 Definitions**

- .1 Where not specifically defined in the general contract specifications, the following terms shall apply to Divisions 20, 21, 22, 23, and 25.
  - .1 "Provide" means "supply and install" products and services as specified.
  - .2 "Work" means the total construction required by the Contract Documents and includes all labour, products, and services.
  - .3 "Products" means all material, equipment, machinery, and fixtures forming the completed work.
  - .4 "Concealed" means normally hidden from sight in ceiling spaces, within walls, within furred spaces.
  - .5 "Exposed" means normally visible, including work in equipment rooms and similar spaces.
  - .6 "Install" means to secure in place, make all necessary connections, test, adjust, and verify.
  - .7 "Authority Having Jurisdiction" and/or "Governing Authority" and/or "Regulatory Authority" means government agencies, standards, and regulations that govern work and to which work must adhere.

### **1.3 Scope Of Work**

- .1 Provide all material and equipment as shown on the drawings and/or specifications, required to provide complete, properly functioning and fully tested mechanical systems fit to the intended use. Provide fittings or materials not herein listed necessary for the proper operation of the systems. All materials shall be new, the best of their respective kinds, and installed to the highest industry standards.
- .2 Where a product manufacturer is not specified, contractor shall provide products of quality consistent these specifications. All products must have CSA certification or equivalent. Contractor shall obtain approval of the inspection authority having jurisdiction for every

product lacking CSA certification. Provide products by the same manufacturer for like applications unless noted otherwise. All products shall comply with the National Energy Code for Buildings (NECB) / ASHRAE 90.1 standards.

#### **1.4 Examination of Site and Contract Documents**

- .1 Contractor shall carefully examine Documents and visit the site of the building to determine and review existing site conditions that will or may affect work, and include for such conditions in Bid Price. This specification is to be read in conjunction with all other Sections and Divisions of the specification. In the event of conflict between documents, this specification shall govern.
- .2 Upon finding discrepancies in, or omissions from Documents, or having any uncertainty as to their intent, the Contractor shall notify Consultant in writing prior to the close of tenders. Failure to notify the Consultant of any discrepancies will not relieve the Contractor of responsibility for completing the work as intended, nor will it be grounds for additional costs. The Contractor shall not proceed if uncertain as to the intent of any aspect of the Documents.
- .3 Unless exceptions are specifically noted by the Contractor to the Consultant at the time of tender, the submission of a bid confirms that the Contractor has accepted all specifications, drawings, contract documents, and conditions without qualification.
- .4 Read and be governed by the noise control instructions in Section 23 05 48.

#### **1.5 Interpretation of Drawings**

- .1 The Specifications are to be read in conjunction with the Drawings and neither shall be used alone. Any item shown, noted, specified, or implied in either the Drawings or the Specifications shall be provided by the Contractor, even if it does not appear in both the Drawings and the Specifications. Where there is conflict between Codes, Specifications, and Drawings, the maximum condition shall govern.
- .2 Drawings are diagrammatic in nature, showing the layout, general design, proposed path, and extent of the completed systems. Contractor shall be responsible for laying out all equipment and services on site and making all necessary connections to leave equipment and systems in good working order. All piping and ductwork shall be concealed unless otherwise noted.
- .3 Where the location of any system components and/or equipment is indicated by dimensions on the drawings, Contractor shall be checked and verified these dimensions in the field. Where any services and/or equipment cannot be installed in the location indicated on the drawings, the Contractor shall notify Consultant immediately and secure written approval for such revisions before proceeding with the work. Each Division shall make any necessary changes to equipment and/or service locations to accommodate structural elements without additional cost to the Owner.
- .4 It is the responsibility of the Contractor to coordinate the location of fixtures, fittings, and equipment which may interfere with the work of other trades with said trades and with the Project Manager / General Contractor.

- .5 Contractor shall not scale Mechanical Drawings. Refer to Architectural Drawings for all dimensions. Unless otherwise indicated on the drawings, dimensions shown on Mechanical Drawings are indicated in millimetres (mm).

#### **1.6 Permits, Certificates, Approvals, and Fees**

- .1 Obtain and pay for all permits and approvals required to complete the Work from local authorities having jurisdiction and utility providers. Submit applications requiring Owner's signature before commencing Work. Do Work in compliance with laws, rules, and regulations having jurisdiction.
- .2 The following deposits and fees required for the completion of the Work shall be included in the tender price, unless otherwise indicated:
- .3 fees required for the approval and inspection of any portion of the mechanical system by government agency, department, or authority;
- .4 fees for the building gas and water services, complete with meters;
- .5 fees required for the approval and inspection of the sprinkler system(s) shall be included in the tender price except that all fees required for the review of the system(s) by the insurance underwriters.
- .6 Contractor shall be responsible for notifying authorities having jurisdiction when work is ready for inspection in a timeframe consistent with the authority's policy for inspection notice, and with sufficient time to correct deficiencies such that the schedule of completion of Work will not be impacted. Inspection certificates, as follows, shall be submitted before requesting final review:
  - .1 Gas Inspection
  - .2 Electrical Inspection
  - .3 Plumbing Inspection
  - .4 Fire Protection Inspection
  - .5 HVAC Inspection
- .7 Submit to Consultant all approval and inspection certificates issued by authorities having jurisdiction to confirm that Work as installed complies with all relevant rules and regulations. Include copies of these approval and inspection certificates in each copy of the operating and maintenance instruction manuals.

#### **1.7 Standards of Material and Equipment**

- .1 Material and equipment are described in this specification using the following terms.
  - .1 "Acceptable products" means the bid may be based on any of the listed acceptable products, provided they meet all the specifications. Listing of a manufacturer or product as "acceptable" does not automatically grant acceptance of the product by the Consultant and/or the Owner, nor does it alleviate the Contractor of the responsibility to ensure that any product included in their bid and/or submitted for

approval at the shop drawing stage meets or exceeds the requirements of the drawings and specifications.

- .2 "Or approved equal" means the bid may be based on any product that meets all the specifications, including but not limited to space, power, energy consumption, sound levels, and all other specified requirements of base specified product. Products supplied by a manufacturer/supplier other than a manufacturer listed as acceptable or approved equal may be considered for acceptance by Consultant if requested in writing with full product documentation submitted a minimum of five working days prior to Bid closing date. Contractor shall certify in writing that product to be used meets or exceeds base specified product in every specified parameter. Acceptance of approved equal products is at sole discretion of Consultant. Do not order such products until approved in writing by Consultant. No increases in Contract Price will be allowed based on changes to associated equipment, mechanically, electrically, structurally or architecturally, required by acceptance of approved equal product, nor will any increase in Contract price be allowed due to Consultant's rejection of proposed equivalent products.
  - .3 "Base specified" means the product and manufacturer listed in equipment schedules included in the Drawing set, or, if none is listed in the Drawing schedules, then the first name listed in a list of acceptable manufacturers in the Specifications. Bid price may be based on any of the listed "acceptable products".
  - .4 "Base bid" means the Contractor's bid shall be based on the specified equipment. Any equipment proposed by the bidding Contractor other than the "base bid" equipment shall be considered "alternative equipment" (see next point).
  - .5 "Alternative equipment" means any equipment proposed by the bidding Contractor other than the base bid equipment. The bidding Contractor shall list all alternative equipment on the Tender Form with the cost saving, and the Owner shall have sole discretion in accepting or rejecting the proposed alternative equipment. The cost saving identified by the contractor shall include all associated architectural, structural, or electrical changes required to accommodate the alternative equipment, as well as redesign time by architectural, structural or electrical consultants. Said changes shall be at the expense of this Division. Contractor shall be responsible for ensuring that alternative equipment meets all the specifications, including but not limited to space, power, energy consumption, sound levels, and all other specified requirements of base bid product. Contractor shall certify in writing that product to be used meets or exceeds "base bid" product in every specified parameter. Contractor shall prepare and submit for review detailed dimensioned drawings of all rooms affected by alternative equipment. These drawings shall identify architectural and structural elements and demonstrate that the alternative equipment and associated systems will not create interferences and will properly meet the design intent. Owner will not accept any increase in Contract Price for revisions associated with alternative equipment.
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- .2 Contractor shall bear the cost, if any, of any proposed changes to equipment and systems initiated by Contractor after award of Contract, if changes are approved by Consultant.
  - .3 Order equipment and materials and confirm all delivery dates with suppliers to meet project scheduling timelines. Failure to order said materials with sufficient production and delivery time shall not be considered grounds to request substitutions.
  - .4 Provide equipment and materials manufactured in Canada when the cost of said equipment and materials is cost competitive and of equivalent performance and quality.

- .5 Provide only new products. Where a manufacturer is not specified provide products of high commercial standard and quality consistent with the standards of these specifications. Provide products of same manufacture for like applications unless noted otherwise.
- .6 All products must bear the approval of the CSA or have special approval of the inspection authority having jurisdiction for their respective functions and environments.
- .7 When part of equipment does not bear the required UL label, the Contractor shall obtain UL approval on site, when that part of the equipment is an electric component, a special approval shall be obtained and the Contractor shall pay the applicable fees.
- .8 Drawings and Specifications have been prepared based on product available at time of Bidding. If the specified manufacturer can no longer supply a product that meets base specifications after the contract is awarded, notify Consultant immediately. Contractor shall be responsible for obtaining other manufacturers' products that comply with base specified performance and meets project timelines. Proposed products shall be treated as "alternative equipment" and subject to the same review and credit process.
- .9 Systems and equipment shall be the newest current production series/version of product available at time of the shop drawing review process. Non-current models will not be accepted.
- .10 Provide a weatherproof on-site storage container for the protection of materials and equipment. Seal all openings in products with plastic sheeting or other mechanical means to prevent dust, dirt, and moisture from entering the equipment. Any materials or equipment damaged by water or deemed by the Consultant to be unfit for installation as a result of dirt accumulation shall be replaced at no additional cost

### **1.8 Standards of Workmanship**

- .1 Where regulations, codes, and standards conflict with drawings and specifications, the more stringent requirement shall apply unless otherwise directed by the consultant.
- .2 Where any code, standard, regulation, bylaw and/or manual is referenced, it means the latest published edition that has been adopted by the local authorities having jurisdiction at the time of submission of bids, unless otherwise specifically noted.
- .3 All mechanical Work shall be in accordance with the regulations of the following:
  - .1 Ontario Building Code (OBC);
  - .2 Canadian Gas Association (CGA);
  - .3 Natural Gas and Propane Installation Code;
  - .4 National Fire Protection Association (NFPA);
  - .5 Canadian Standards Association (CSA);
  - .6 Ontario Fire Code;
  - .7 Mechanical Refrigeration Code;
  - .8 Ontario Electrical Safety Code (OESC);
  - .9 National Energy Code for Buildings (NECB) 2015;



- .10 American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE);
- .11 American Society of Mechanical Engineers (ASME);
- .12 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA);
- .13 Technical Standards and Safety Authority (TSSA);
- .14 All Municipal regulations and any authorities having jurisdiction;
  - a. Owner's standards.
- .4 Where any governing Code, Standard, or Regulation requires preparation and submission of drawings for review, they are the responsibility of the contractor to prepare and submit. The contractor shall pay all associated costs

### **1.9 Site Superintendence**

- .1 Provide at all times qualified personnel and supervisory staff to undertake administration, meet schedules, ensure performance and coordination of all labour for satisfactory completion of the Work. Any individual deemed by the Consultant to be unsatisfactory at these duties shall be replaced.

### **1.10 Progress Payments**

- .1 Submit a detailed breakdown of work cost prior to submitting first progress payment draw. Breakdown shall itemize one-time project milestones, including site mobilization, insurance and bonds, shop drawings, commissioning, testing, adjusting and balancing, and closeout submittals. Indicate site services costs, including equipment, material and labour. Progress payments will not be processed until Consultant has approved the breakdown in writing.
- .2 Progress draws shall follow the same format as the breakdown approved by the Consultant

### **1.11 Planning and Layout of Work**

- .1 The Consultant's drawings and instructions, properly coordinated with shop drawings that have been reviewed by the Consultant, shall govern the location of all items.
- .2 Install all equipment and services in a neat and orderly manner, to the satisfaction of the Consultant.
  - .1 Equipment and services located in ceiling spaces shall be laid out in a compact manner that maximizes headroom without compromising access to the equipment and services for future maintenance and replacement.
  - .2 Services shall follow building lines unless otherwise instructed by the Consultant in writing or indicated on the drawings.
  - .3 Located concealed pipes and ducts as close as possible to building structure to minimize the size of the furred chase.
  - .4 Conceal all work in finished areas unless otherwise indicated. All exposed ductwork and piping shall be neatly installed, following the lines of the building structure and centered in spaces such as hallways.

- .3 Valves, fittings, cleanouts, balancing devices, air vents, and similar elements requiring access for service and adjustment shall be located in easily accessible spaces.
- .4 Provide all supports, hangers, saddles, and fasteners required to support all equipment and services in a manner that prevents undue stresses on the structure and systems. Ensure that the load onto building structure does not exceed the allowable loading as shown on structural drawings or directed by the Consultant.
- .5 Verify all measurements on site prior to fabricating ductwork, piping systems, and other such services. Do not use Contract Drawing measurements for this purpose.
- .6 Confirm inverts on site and make allowances for work of other trades. Where site measured inverts or dimensions conflict with Contract Drawings, notify Consultant prior to proceeding with work.
- .7 Prepare plan and interference drawings of the work at 1:50 drawing scale, including detailed section drawings cross referenced with plan drawings. Section drawings shall be prepared for congested areas, including corridor ceiling spaces, and shall indicate dimensions of mechanical work and structural elements. Submit drawings to Consultant for review.
- .8 Install metering devices at a height that is easily read. Install meters and sensors in a location that allows accurate and reliable sampling.
- .9 Provide appropriate physical protection or jacketing for all exposed equipment and services.
- .10 Install all products and services in accordance with the manufacturer's requirements and /or recommendations.
- .11 Install all piping in a location or manner that will prevent freezing.
- .12 Provide sleeves and inserts as required for piping and ductwork.
- .13 Failure to comply with these requirements or to coordinate the location of services with structural elements or the work of other trades will render the Contractor responsible for the cost of all extra work required to remedy the deficiencies

#### **1.12 Co-ordination of Work**

- .1 Review the specifications and drawings of all Divisions to develop a thorough understanding of the building structure and systems.
- .2 Co-ordinate the work with all other Divisions, including but not limited to equipment locations, connections, electrical data and wiring, supports, opening locations, sleeve locations, piping and duct locations, housekeeping pads, and sump pits. Re-work required due to improper coordination between trades shall be at the Contractor's expense.
- .3 Co-ordinate equipment delivery schedule with General Contractor to ensure equipment is on site and ready for installation in its final location prior to the close-in of building openings required for access.
- .4 Ensure the work of this Division and all other Divisions does not impinge upon the clearances required for each piece of equipment. Similarly, ensure proper clearances are

maintained for future removal of equipment. Co-ordinate work prior to and during installation.

- .5 Exposed mechanical elements to be installed including but not limited to wall and ceiling diffusers, grilles, sprinkler heads, and ceiling cassettes shall be located in exact accordance with dimensions provided by the Architect, masonry contractor, and installers of ceiling and wall finishes. Contractor shall adjust duct and piping branches as necessary to allow these mechanical elements to align exactly with ceiling and wall patterns.

### **1.13 Shop Drawings**

- .1 Submit shop drawings and data sheets for all equipment listed as requiring shop drawings prior to ordering and/or fabricating. Products and equipment requiring shop drawings are listed in their respective specification section under Submittals. Consultant's final review is required prior to ordering and/or fabricating equipment.
- .2 Contractor shall consult with Construction Manager and Consultant at time of start-up meeting to determine shop drawing submittal process.
- .3 Do not bundle dissimilar equipment or large packages of equipment. Shop drawings may be bundled in small packages for like equipment (e.g. air handlers).
- .4 Shop drawings must contain adequate technical information to verify all specified parameters. Non-specific data sheets, brochures, and advertising sheets shall not be considered acceptable.
- .5 Every shop drawing shall contain the following information: project name, equipment tag matching drawings, equipment dimensions, dimensioned locations of field connections, make and model, performance curves including the specified operating points listed, capacity, HP, voltage, all accessories and options being provided, and all other specified parameters (e.g. sound data). Room schedules shall be provided for multiple units.
- .6 All submittals shall be clearly legible. Submittals containing information that is illegible will be returned without review and will be required to be resubmitted.
- .7 Contractor shall carefully review shop drawings for compliance with all specified parameters and shall stamp submitted shop drawings with Contractor's identification review stamp including company name, submittal date, name of individual who completed the review and has certified that the submittal is complete and in compliance with all requirements, and a signature. Contractor's stamp shall also state that the document to which it has been applied is certified to be in accordance with all requirements. Drawings that have not been stamped in this manner will not be reviewed by the Consultant.
- .8 The Contractor shall pay the Consultant on an hourly basis for shop drawing reviews once shop drawing revisions have been submitted to the consultant more than two times due to poor shop drawing preparation and insufficient adherence to contract design requirements.
- .9 For each shop drawing submittal, either original or revision, the Contractor shall allow 15-business days for review by the Consultant.
- .10 Shop drawings will be returned stamped "Reviewed", "Reviewed as Noted", or "Revise and Resubmit".

- .1 Drawings stamped "Reviewed" shall be considered in general conformance with the drawings and specifications. The Contractor must still ensure that the Products supplied meet all requirements of the drawings and specifications.
- .2 Drawings stamped "Reviewed as noted" shall be considered in general conformance with the design concept including corrections or comments as noted on drawings. The Contractor must still ensure that the Products supplied meet all requirements of the drawings and specifications.
- .3 Drawings stamped "Revise & Resubmit" shall be considered as not conforming with the design concept and work shall not proceed on the manufacture or provision of the Products. These drawings shall be corrected and re-submitted for review and shall include all corrections, if any, as noted on drawings.

#### **1.14 Scaffolding, Hoisting, Rigging, and Shoring**

- .1 Provide scaffolding, hoisting, rigging, and shoring necessary to complete the work of this Division. This equipment shall be adequate to protect workers according to all Provincial and Local Regulations.
- .2 Immediately remove from site scaffolding, rigging, hoisting, and shoring equipment when no longer required to complete the work.
- .3 Contractor shall not place scaffolding and/or hoisting equipment loads on the building structure without written approval from the Consultant.

#### **1.15 Changes or Revisions**

- .1 Changes in work required by an Authority Having Jurisdiction shall be carried out without charge.
- .2 When the Consultant proposes in writing a change or revision to the work required by the Contract Documents via a Proposed Change Notice (PCN) or Contemplated Change Notice (CCN), prepare and submit for Consultant review a quotation for the proposed cost of executing the change or revision.
- .3 Quotation shall contain a detailed estimate of the product, labour, and equipment costs associated with the change or revision, for both additions and deletions. List the overhead and profit percentages, applicable taxes and duties, and present a summary of the total charges. State the source of the materials and labour rate estimates.
- .4 Unless otherwise specified in Divisions 00 or 01, the following requirements apply to all quotations submitted:
  - .1 the cost of deleted work (less overhead and profit but including taxes and duties) shall be subtracted from the cost of additional work before overhead and profit are applied to the additional work;
  - .2 material costs shall not exceed those published in regional estimating guides;
  - .3 mechanical material labour unit costs are to be in accordance with Mechanical Contractors Association of America Labor Estimating Manual, less 25%;

- .4 electrical material labour unit costs are to be in accordance with National Electrical Contractors Association Manual of Labor Units at difficult level, less 25%;
  - .5 site superintendent's hours shall not exceed 10% of labour hours estimated for change or revision;
  - .6 the quotation shall not include a line item for estimation time, as this cost shall be considered part of the overhead percentage applied to the quotation;
  - .7 if overhead and profit percentages are allowable under Contract but not specified in Division 00 or 01, then allowable percentages for overhead and profit shall be 7% and 5% respectively;
  - .8 quotations shall include an estimate of any required change to Contract time.
- .5 Submitted quotations not confirming to the requirements specified above will be rejected and returned for re-submittal. Failure to submit a proper quotation shall not be grounds for any additional change to Contract time.
  - .6 Contractor-initiated requests for changes or revisions shall be made to the Consultant in writing. If the Consultant approves, a Change Order will be issued.
  - .7 Do not commence work on any change or revision until written authorization for the change or revision has been issued by the Consultant.

#### **1.16 Excavation, Trenching, and Backfilling**

- .1 Mechanical contractor shall be responsible for excavation, compacting, backfill, removal and disposal of materials necessary to accommodate all buried equipment in the mechanical scope of work including but not limited to sump pits, buried ductwork, cisterns, piping, and ground heat exchangers.
- .2 Before commencing with excavation and trenching, investigate locations of all existing and proposed underground services. Contractor shall retain and pay for the services of a qualified firm to mark the location of all existing underground services prior to commencing excavation and trenching.
- .3 Grade bottom of trenches as required to maintain design slopes on all piping.
- .4 In firm, undisturbed soil, lay pipes directly on the soil and shape soil to fit the lower one-third (1/3) of pipes and pipe bells. Ensure continuous and uniform bearing along the entire pipe barrel.
- .5 Unless otherwise noted, granular material shall be compacted to 98% Standard Proctor Density and all native material shall be compacted to 95% Standard Proctor Density.
- .6 Backfill trenches within the building and under traffic or parking areas or similar with clean sharp sand or Granular 'A' (Type 33 Fill) in individual layers of maximum 150mm (6") thickness, compacted to 100% Standard Proctor Density. Hand compact the first layers up to a compacted level of minimum 500mm (20") above the top of pipe. Machine compact the balance up to grade.
- .7 In all areas not within building and under traffic or parking areas or similar, backfill trenches up to 500mm (20") above the pipes using the method described above. Backfill

- the balance of the trench with approved excavated material replaced in 300mm (12") lifts and compacted to a minimum of 95% Standard Proctor Dry Density.
- .8 In over-excavated areas and similar disturbed soil conditions, restore bedding base with Granular 'A' (Type 33 Fill) material compacted to 98% Standard Proctor Density and follow above requirements for backfilling.
  - .9 Trench walls shall be vertical to a minimum depth of 500mm (20") over pipe. Trench minimum width shall be pipe diameter plus 450mm (18").
  - .10 Support piping passing through building foundation walls or concrete supports and near footings as directed by the Structural Consultant.
  - .11 Provide timber sheeting, bracing, shoring, guard rails, etc. as required to protect all persons having access to the site from excavations. All excavation work shall comply with the latest edition of the Occupational Health and Safety Act. Keep all excavations free of water.
  - .12 Fill all depressions to correct grade level with approved material. After a sufficient period has passed to reveal any settlement, use maximum possible compaction and pay all costs required to make good all damages caused by settlement.
  - .13 Obtain approval before backfill.
  - .14 Remove all excavated materials not used as backfill from site.

#### **1.17 Cutting, Patching, and Coring**

- .1 Layout all cutting, patching, and coring required to accommodate mechanical services. Coordinate work with other Divisions.
- .2 All cutting and patching is the responsibility of the Division requiring the opening and shall be performed by trades specializing in the materials to be cut.
- .3 This Division shall be responsible for installing all required framing and sleeves for mechanical services unless otherwise indicated.
- .4 This Division shall be responsible for any costs incurred from remedial work required by other trades to cut openings and install frames and sleeves as a result of failure to install these measures at the appropriate stage of construction.
- .5 All cutting, coring, grinding, and drilling shall be done in a neat and accurate manner and shall not be done on any portion of the building envelope or structural elements without the written permission of the Consultant.
- .6 Consult with Structural Engineer prior to cutting any existing floors or ceilings. Where X-rays are required by the Structural Engineer, this Division shall be responsible for the cost of the X-rays.

#### **1.18 Sleeves**

- .1 Provide pipe and duct sleeves at points where pipes and ducts pass through concrete or masonry.
- .2 Partition Walls: Sleeves shall be constructed of a minimum of 22-gauge (0.8mm) galvanized sheet steel with lock seam joints.
- .3 Through foundation walls: Sleeves shall be cast iron or steel pipe with annular fin continuously welded at midpoint.
- .4 Through poured concrete slabs: minimum 16 gauge flanged galvanized steel or, where permitted by governing authorities, factory fabricated plastic sleeves.
- .5 Provide 6mm (1/4") clearance all around, between sleeve and pipes or between sleeve and insulation.
- .6 Where piping passes below footings, provide a minimum of 50mm (2") of clearance between sleeve and pipe. Backfill to underside of footing using same concrete strength as footing material.
- .7 Terminate sleeves flush with masonry and concrete walls. Terminate sleeves 50mm (2") above and below floors. Terminate flush with top of concrete floors on grade.
- .8 Cast iron sleeves with caulking recess and flashing clamp shall be used for pipes passing through roofs. Anchor sleeve in place to roof assembly, caulk between the sleeve recess and the pipe, fasten roof flashing to clamp, complete watertight and durable joint.
- .9 Fill voids around pipes using the following methods:
  - .1 Seal between sleeve and pipe in foundation walls, tank walls, and below grade floors with permanent mechanical seal equal to Metraflex Metraseal or GPT Link-Seal.
  - .2 Where sleeves pass through above-grade walls or floors, caulk space between insulation and sleeve or between pipe and sleeve with non-hardening, fire-retardant, waterproof mastic.
  - .3 Take measures to ensure no contact is possible between copper pipe and ferrous sleeves.
  - .4 Any sleeves which have been installed for future use shall be filled with a fire retardant and easily removable filler.
  - .5 Coat exposed surfaces of ferrous sleeves with zinc rich paint.
- .10 Where pipes pass through fire rated floor or walls, use approved firestop methods and devices to maintain the required fire rating of the wall or floor. Leave sufficient space for ducts penetrating fire separations to allow proper installation and maintenance of fire dampers.

#### **1.19 Flashing**

- .1 Provide flashings for the work of this Division. Where flashing details are not specified, provide a description and/or sample for review prior to commencing work.
- .2 Flash pipes and small ducts or stacks passing through the roof with an 18 gauge steel sleeve soldered watertight and fastened to the roof deck before the roofing is applied.

Spun aluminum flashings as supplied by National Roofing Supply or equal are an acceptable alternate to soldered galvanized sheet steel.

- .3 Flashings shall overlap with roof deck for a minimum of 200mm (8"), extend 200mm (8") up the pipe or duct, and shall be sealed with a weather skirt.
- .4 Vent stacks may be flashed with flashing cones.
- .5 Profiled metal roof flashings shall be designed for that application.

#### **1.20 Curbs and Sleepers**

- .1 Prefabricated curbs for mechanical equipment shall be provided by this Division. Built-up curbs and sleepers, where specified, will be fabricated and installed by other divisions, except as specified herein and noted on the drawings.
- .2 This Division shall be responsible for supplying detailed requirements for curbs, including their locations, sizes, required materials, and loads imposed on the curbs.
- .3 Curbs are required for roof mounted equipment, surrounding holes in equipment room floors where groups of pipes and/or ducts pass through, and all other locations indicated on the Drawings.
- .4 Sleepers shall be provided as noted on Drawings for equipment installed outdoor without a roof curb. Sleepers shall be constructed of pressure treated lumber and shall be covered by 18-gauge steel cladding, primed and painted unless otherwise noted on the drawings.
- .5 Roof curbs shall be minimum 12" (300 mm) height above finished roof and higher where noted on drawings or in specifications.
- .6 Curbs around holes in equipment room floors shall be concrete or steel, extending at least 150mm (6") above finished floor. Make watertight connection between curb and floor.
- .7 Spaces between curbs and pipes and ducts shall be packed with glass fibre material. Caulk with fire-resistant waterproof sealant to make watertight connection. Where ducts penetrate equipment room floors, coordinate curb to enable proper installation and maintenance of fire dampers.

#### **1.21 Painting**

- .1 All mechanical equipment, grilles and diffusers shall be shop prime-coated ready for finish painting by Architectural Trades. Where the prime coat has been marred, touch up the surface.
- .2 Exposed ductwork and equipment shall be factory satin finished or degreased and etched on site by Mechanical Contractor and left in paint ready condition to the approval of Architectural Trades.
- .3 Equipment exposed to the exterior shall be finished with factory-applied rust-resistant paint unless otherwise specified or noted.
- .4 Painting for all exposed ductwork, piping and conduits shall be by Architectural Trades.
- .5 Contractor shall leave all work in a clean, paintable condition.



## **1.22 Access Doors**

- .1 Provide access doors for concealed mechanical equipment, fixtures, and fittings requiring access for service and maintenance. Group these items together to share one access door whenever possible. Minimum door size shall be 200mm x 200 mm (8"x8"). Minimum door size shall be 600mm x 450 mm (24"x18") where head-and-shoulders access is required. Manufacturer's recommended service access size shall be used if it exceeds these recommendations.
- .2 Doors shall be manufactured by Acudor Acorn or approved equal and shall be of the following types:
  - .1 Drywall & Block: UF-5000, prime coated steel, flush style door with wall frame and screwdriver operated cam lock.
  - .2 Ceramic Tile Areas: UF-5000-SS, #4 satin polish stainless steel door with wall frame and screwdriver operated cam lock.
  - .3 Acoustical Tile (Non Removable): AT-5020, prime coated steel, recessed style door with wall frame and screwdriver operated camlock.
  - .4 Plaster Finish: PS-5030, prime coated steel, flush style door with wall frame and screwdriver operated cam lock.
  - .5 Fire Rated Partitions: FB-5060, prime coated steel fire rated door, ULC-2.0 hour 'B' label with self-closing key operated locking door.
  - .6 Fire Rated Ceilings: FW-5050, prime coated steel fire rated door, ULC-1.5 hour 'B' label with self-closing key operated locking door.
- .3 Provide ULC listed and labelled doors for all fire rated surfaces. Door rating shall match or exceed rating of surface. Non-rated surfaces do not require ULC listed, fire rated access doors.
- .4 Installation of access doors shall be by this Division unless otherwise indicated within the scope of work of Architectural Trades.

## **1.23 Escutcheons and Plates**

- .1 Provide on pipes passing through finished walls, partitions, floors, and ceilings.
- .2 Plates shall be stamped brass, solid type, chrome-plated or nickel-plated, with set screw for securing.
- .3 Inside diameter shall fit around finished pipe. Outside diameter shall cover sleeve and opening.
- .4 Secure plates to pipes or finished surface. Do not secure plates to pipe insulation.
- .5 Where sleeve extends above finished floor or beyond wall, escutcheons or plates shall clear sleeve extension.

#### **1.24 Firestopping**

- .1 All services penetrating fire rated separations shall be sealed by a fire stop system in compliance with ULC-S115-11. All voids around services penetrating rated or non-rated/0-rated fire separations shall be sealed using a fire-rated caulking compatible with the remaining fire stop systems in the building.
- .2 Firestop materials and systems shall be by the same manufacturer as used by the General Trades. Where not specified, mechanical fire stopping systems shall be based on a single manufacturer: Tremco, 3M, Hilti, or equal.
- .3 Fire stop systems shall meet the Flame (F) and Thermal (T) ratings of the fire separation in which they are installed. Systems shall be identified with appropriate SP numbers and complete with a 0.007psi (50 Pa) pressure differential where required by Code.
- .4 Verify the construction of fire separations on Architectural drawings and provide the type and number of firestop devices required. Systems shall be identified with appropriate SP numbers.
- .5 Where services pass through walls and floors which do not form part of a fire separation, pack mineral wool around duct or pipe to reduce noise transmission.
- .6 Upon project completion, the firestop manufacturer shall provide a letter certifying that all mechanical fire stop systems throughout the project have been installed per their detailed installation instructions and Code requirements.

#### **1.25 Dissimilar Metals**

- .1 Provide dielectric coupling wherever pipes of dissimilar metals are joined.
- .2 For pipes size NPS 2 and smaller, use insulating unions. For pipes larger than size NPS 2, uses dielectric flanges.
- .3 Brass fittings or brass valves are acceptable in making connections between copper and steel piping.
- .4 Use electrolytic action tape or equivalent or use copper / plastic coated supports where supporting copper pipe.
- .5 Direct contact between copper piping and concrete, masonry or precast construction shall be avoided.

#### **1.26 As-Built Drawings**

- .1 Drawings for this project have been prepared in electronic format using AutoCAD software (release version may be confirmed with Consultant). Obtain electronic copies of the project drawings from Consultant for the purpose of producing record "as built" drawings. Obtaining the electronic drawings from the Consultant shall be at the Contractor's expense. Rates shall be set at \$50.00 CAD plus HST for the first drawing and \$25 CAD plus HST per additional drawing. Drawings may also to be used for preparation of layouts and interference drawings.

- .2 Maintain three (3) sets of bound white prints of Contract Drawings on site in Contractor's office. Clearly mark in red ink in a neat and legible manner on these drawings on a daily basis. Mark-ups shall show all changes and deviations from routing of services and locations of equipment from that shown on Contract Drawings. Keep as-built mark-up set up-to-date at all times, and ensure set is always available for periodic review by the Consultant. The purpose of the as-built drawings is to provide the Owner with a record of the exact location of all piping, ductwork and equipment upon completion of the job. As such, the as-built set shall also include the following:
  - .3 dimensioned location of inaccessible concealed work;
  - .4 locations and identification of control devices;
  - .5 location of piping system air vents;
  - .6 for underground piping and ducts, record dimensions, invert elevations, offsets, fittings, and locate dimensions from visible reference points, such as walls or columns;
  - .7 for fire protection systems, record actual locations of equipment, sprinkler heads, and valves, drains, and test locations, and deviations of pipe routing and sizing from that shown on the drawings;
  - .8 location of concealed services terminated for future extension.
- .9 Submit a copy of the marked-up as-built white prints to the Consultant for review prior to applying for a Certificate of Substantial Performance of the Work. Make necessary revisions to drawings as per Consultant's comments, to satisfaction of Consultant.
- .10 Use Consultant-reviewed white prints to generate the CAD files of drawings, thereby creating the as-built set of Contract Drawings, identified as "Project Record Copy". Provide two (2) complete sets of electronic as-built drawings on separate USBs. Submit as-built sets of white prints and USBs to Consultant.
- .11 Submitted drawings shall be of same quality as original Contract Drawings. Layers shall be used to differentiate services. CAD drawing files shall be compatible with AutoCAD software release version confirmed with Consultant.
- .12 Unless otherwise noted, failure to maintain accurate record drawings will incur additional 5% holdback on progress claims until drawings are brought up to date to satisfaction of Consultant.

#### **1.27 Maintaining Equipment Prior to Acceptance**

- .1 Do not operate equipment during construction.
- .2 Keep all opening in equipment sealed with plastic, cardboard, and/or tape, as required, to keep dust and dirt from entering the equipment until all pipe and duct connections are made.
- .3 Maintain equipment per the manufacturer's printed instructions prior to start-up, testing and commissioning.

- .4 Employ qualified tradespeople to check and align shafts, drives, and couplings on all base mounted split coupled motor driven equipment.
- .5 Use copper or aluminum tubing to extend lubrications fittings that are not easily accessible.
- .6 All filters shall be new upon Substantial Performance of the Work. Provide spare filters where specified.

#### **1.28 Use Of Systems during Construction**

- .1 The Construction Manager shall provide all temporary heat/dehumidification for the building during its construction.
- .2 The permanent mechanical system shall not be used during construction. The Owner may accept the use of the permanent mechanical equipment/systems for temporary heating/dehumidification during construction to expedite completion of the building, provided all the following conditions are met:
- .3 The Consultant has provided written permission to use the mechanical systems or a portion thereof for temporary heat/dehumidification.
- .4 The conditions for start-up have been met and the following conditions are complied with:
  - .1 The building is fully enclosed;
  - .2 Major dust generating activities are complete;
  - .3 Freeze protection measures are in place for any systems subject to freezing;
  - .4 All systems are properly maintained, operated, and lubricated by the Contractor;
  - .5 Mechanical rooms are kept broom clean;
  - .6 Air filters operated systems are installed in air handling units, inspected regularly and replaced as necessary by the Contractor;
  - .7 Air filters are installed in all return air openings, inspected regularly and replaced as necessary by the contractor;
  - .8 Guarantees on any equipment or systems are not affected.
- .5 Before turning the systems over to the Owners comply with the following conditions:
  - .1 Bring all mechanical systems to as-new condition in operation and appearance;
  - .2 Replace all filters with new filters;
  - .3 Obtain the services of an independent duct cleaning company to clean all ductwork

#### **1.29 Manufacturer's Certification**

- .1 Arrange and pay for the equipment manufacturer's authorized representative to visit the site to examine the equipment installation. This inspection shall occur when system installation is complete, but prior to start-up procedures. After any required corrective

measures have been made, obtain written confirmation from manufacturer's authorized representative certifying that the equipment installation is complete and in accordance with the manufacturer's instructions.

### **1.30 System Start-Up**

- .2 It is this responsibility of this Division to start-up equipment and operate for a minimum of five (5) days. During this period, Contractor shall make any necessary controls adjustments, clean strainers & fluid filters, replace any used air filters, replace faulty gauges and thermometers, fasten any loose equipment and eliminate any unnecessary noise sources.
- .3 All the following conditions shall be met before starting mechanical systems:
  - .1 Safety controls are installed and fully operational;
  - .2 Qualified personnel employed by this Division will be on site to operate the equipment and systems;
  - .3 Ducts, equipment, and plenums are clean, protective measures have been removed, duct access doors are in place, and new air filters have been installed;
  - .4 Motor starters have been checked for correct size of thermal overload;
  - .5 Control systems sequence of operations have been tested and verified;
  - .6 Fans have been checked rotation direction, proper operation, and have been adjusted, fan drives are properly aligned;
  - .7 Fluid systems have been flushed, cleaned and chemically treated;
  - .8 Fire dampers are in the open position and their operation has been verified;
  - .9 Pipe and duct insulation has been installed and sealed to prevent condensation;
  - .10 Freeze protection measures have been installed for systems subject to freezing;
  - .11 All bearings have been lubricated;
  - .12 Adjust and set all direct drives and 'V' belt drives and drivers for proper alignment and tension;
  - .13 Motors and speed switches have been tested and verified for correct wiring sequences.
- .4 Follow start-up procedures as recommended by the manufacturer unless otherwise specified.
- .5 For major equipment including boilers, energy/heat recovery units, air handling units, etc. this Division shall supply the services of a manufacturer's trained specialist to assist in the equipment start-up and provide thorough instructions on the operation, service and maintenance of the equipment to the full satisfaction of the Consultant and Owner.
- .6 Where requested by the Consultant, provide acceptance tests to demonstrate that the equipment and systems meet the specified requirements. Make all changes, adjustments or replacements indicated in the preliminary tests as being required, prior to final tests

**1.31 System Operation & Maintenance Demonstration and Training**

- .1 Refer to Division 01 equipment and system operational and maintenance training requirements.
- .2 When all systems are complete, this Division shall instruct the Owner's representative in the operation and maintenance of all equipment. Demonstrations and training shall be performed by qualified technicians employed by equipment manufacturer and/or supplier. Supply hard copies of training materials to each attendee. Provide a minimum of 48 hours' notice to Consultant and Owner's representative when scheduling training session(s) and schedule session(s) at Owner convenience.
- .3 Minimum demonstration and training requirements are for the manufacturer and/or supplier of each system and major equipment to provide a minimum of two (2) separate sessions each consisting of minimum four (4) hours of on-site training of up to six (6) of the Owner's designated personnel, on operation and maintenance procedures of system, unless otherwise specified. At Owner's option, training may take place at manufacturer's factory.
- .4 For each item of equipment and for each system for which training is specified, prepare training modules as specified below. Use O&M Manuals during training sessions to familiarize operations staff with this document. Training modules shall include but are not limited to:
  - .5 Operational Requirements and Criteria – equipment function including stopping and starting, safeties, operating characteristics, performance curves, and limitations;
  - .6 Documentation – equipment and system warranties, manufacturer and supplier parts and service contact information;
  - .7 Maintenance – inspection instructions, regular maintenance schedule including but not limited to filter changes, belt changes, cleaning methods and materials, preventive maintenance procedures, and use of any special tools;
  - .8 Troubleshooting and Repairs – diagnostic instructions, test and inspection procedures, disassembly, component removal and repair instructions, instructions for identifying parts and components, and review of any spare parts inventory.
- .9 Submit to Consultant for review a preliminary copy of training manual and a proposed schedule of demonstration and training dates and times prior to commencing training. Incorporate Consultant's comments in final training program.
- .10 Submit training attendance logs to Consultant prior to application for a Certificate of Substantial Performance of the Work. Logs shall contain the following information at a minimum:
  - .11 date instructions were given to Owner's staff;
  - .12 duration of instruction;
  - .13 names of persons instructed and a signature from each attendee;

- .14 other parties present (manufacturer's representative, consultants, etc.).
- .15 Contractor shall be responsible for videotaping all training sessions and making digital files of the training videos available to the owner on USB flash drives or portable hard drives, at Contractor's expense.
- .16 Obtain signatures of Owner's staff to verify they properly understood system installation, operation and maintenance requirements, and have received O&M manuals and as-built record drawings.
- .17 Submit to Consultant, copy of electronic version of training materials used to train Owner's designated personnel as well as digital files of the videotaped training. Include in O&M manuals submission.

### **1.32 Operation & Maintenance Manuals**

- .1 Provide a minimum of three (3) complete sets of operation & maintenance (O&M) manuals in 3-ring binders, tabulated, and two (2) USB keys containing the following:
  - .1 cover info: project name, "Mechanical Systems Operating and Maintenance Manual", date of preparation;
  - .2 contact sheet listing Consultant, Contractor, and Subcontractors, complete with full contact details for each;
  - .3 Table of Contents and corresponding tab sheets in binder;
- .2 Equipment information:
  - .1 description of each system, method of operation for each piece of equipment, and list of equipment with replacement parts, part number, suppliers, addresses etc.;
  - .2 reviewed shop drawing, manufacturer's literature, parts list, recommended maintenance instructions, and name and address of closest service organization and spare parts source, for each equipment item;
  - .3 voltage and amperage rating for each item, complete with manufacture's wiring diagrams and job specific contractor's wiring diagrams as herein specified;
  - .4 schematic drawings for electrical, ventilating, heating and plumbing systems (mount one set of schematic drawings in a glazed frame in the mechanical room).
- .3 Operating data:
  - .1 description of operation of each system at various loads together with reset schedules and seasonal variances;
  - .2 description of actions to be taken in event of emergencies and/or equipment failure;
  - .3 controls complete with diagrams;
  - .4 description of the seasonal operation for each equipment item;
  - .5 valve tag schedule and flow diagrams indicating valve locations.
- .4 Maintenance data:

- .1 maintenance, lubrication and service point schedule;
- .2 type of lubricant and filters to be used on each piece of equipment;
- .3 complete numbered parts list.
- .5 Performance data:
  - .1 TAB Reports.
  - .2 contractor warranty and equipment extended warranties.
- .6 O&M manual shall be submitted and approved before training of the Owner's personnel
- .7 Review O&M manual with Owner's operating personnel to ensure a thorough understanding of each item of equipment and its operation.

### **1.33 Final Inspection and Completion**

- .1 Submit written request for final inspection of systems to Consultant. Written request shall include certification that:
  - .1 deficiencies noted during job inspections have been completed;
  - .2 systems have been tested, adjusted, and balanced and are ready for operation;
  - .3 O&M manuals have been completed, submitted for review, and accepted by Consultant;
  - .4 tags and nameplates are in place and equipment identifications have been completed;
  - .5 final clean is complete;
  - .6 spare parts and replacement parts specified have been provided;
  - .7 as-built and record drawings have been completed, submitted for review, and accepted by Consultant;
  - .8 Owner's staff has been instructed in operation and maintenance of systems;
  - .9 commissioning procedures have been completed.

### **1.34 Warranty**

- .1 All equipment and systems shall be guaranteed against defects in workmanship and materials for a period of one (1) year from date of Substantial Performance, in accordance with the contract. Should the manufacturer's warranty not meet this requirement, provide extended warranties as required to meet this duration.
  - .1 Warranty shall include parts and labour, as well as travel costs and living expenses incurred by manufacturer's authorized technician to provide factory authorized on-site service.
  - .2 Owner deductible amounts shall not be included in warranties.



- .3 Repair and/or replace any defects that appear in Work within warranty period without additional expense to Owner.
- .4 This Division shall be responsible for all costs incurred in repairing defective work, including repairing or replacing building finishes and repairing damage to other equipment.
- .2 Where equipment includes extended warranty period beyond a period of one (1) year, the first year of warranty period shall be governed by terms and conditions of warranty in Contract Documents. The remaining years of extended warranty shall be direct from equipment manufacturer and/or supplier to Owner.
- .3 Warranties shall commence on the date of Substantial Performance of the Work. This Division shall be responsible for providing additional extended warranty as required from date of material purchase until Substantial Performance.
- .4 Submit signed and dated copies of extended warranties to Consultant

#### **1.35 Correction After Completion**

- .1 Contractor shall attend immediately to all defects occurring during a period of one (1) year from the date of Substantial Performance of the completed work, or as further defined in Division 01. This shall be done at no cost to the Owner.
- .2 Repair all defects in a manner that will prevent recurrence of the problem.
- .3 Contractor shall instruct all manufacturers and suppliers that guarantee on products shall commence at the date for Substantial Performance and not from the date the products were put into operation.

### **PART 2 - PRODUCTS**

Not applicable.

### **PART 3 - EXECUTION**

Not applicable.

**END OF SECTION**

## **PART 1 – GENERAL**

### **1.1 GENERAL REQUIREMENTS**

- .1 Read and be governed by conditions of the *Contract Documents*, including sections of Division 01.

### **1.2 SUMMARY**

- .1 Section Includes
  - .1 Pipe, fittings, valves, and connections for sprinkler systems.
- .2 Related Sections
  - .1 Section 20 05 00 – Mechanical General Provisions.
  - .2 Section 21 13 00 – Fire Protection Sprinkler Systems.
  - .3 Section 23 05 53 - Mechanical Identification.
  - .4 Section 26 05 80 - Equipment Wiring: Electrical characteristics and wiring connections.

### **1.3 SUBMITTALS**

- .1 Submittals for Review:
- .2 Section 01 33 00: Submission procedures.
- .3 Shop Drawings/Product Data: Submit shop drawings/product data sheets to the regulatory authority for review and approval prior to submitting to the Consultant. Conform to the following requirements.
  - 1. Indicate pipe materials used, jointing methods, supports, floor and wall penetration seals. Indicate installation, layout, weights, mounting and support details, and piping connections.
  - 2. Provide manufacturers catalogue information. Indicate valve data and ratings.
- .4 Closeout Submittals
  - 1. Project Record Documents: Record actual locations of components and tag numbering.
  - 2. Operation and Maintenance Data: Include installation instructions and spare parts lists.

### **1.4 REGULATORY REQUIREMENTS**

- .1 Codes and Standards
  - .1 Conform to OBC and OFC.
  - .2 Sprinkler Systems: Conform work to NFPA 13.
  - .3 Welding Materials and Procedures: Conform to ASME Code.
  - .4 Valves: Bear FM label or marking. Provide manufacturer's name and pressure rating marked on valve body.

- .5 Products Requiring Electrical Connection: Listed and classified as suitable for the purpose specified and indicated.

## **1.5 REFERENCE STANDARDS**

- .1 ASME Boiler and Pressure Vessel Code Section IX - Welding and Brazing Qualifications.
- .2 ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings.
- .3 ASME B16.3 - Malleable Iron Threaded Fittings.
- .4 ASME B16.4 - Cast Iron Threaded Fittings.
- .5 ASME B16.5 - Pipe Flanges and Flanged Fittings.
- .6 ASME B16.9 - Factory-made Wrought Steel Buttwelding Fittings.
- .7 ASME B16.11 - Forged Fittings Socket Welding and Threaded.
- .8 ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
- .9 ASME B16.25 - Buttwelding Ends.
- .10 ASME B36.10 - Welded and Seamless Wrought Steel Pipe.
- .11 ASTM A135 - Electric-Resistance-Welded Steel Pipe.
- .12 ASTM A47/A47M - Ferritic Malleable Iron Castings.
- .13 ASTM A53/A53M - Pipe, Steel, Black and Hot-Dipped, Zinc-coated Welded and Seamless.
- .14 ASTM A234/A234M - Piping Fittings of Wrought-Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
- .15 ASTM A795 - Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use.
- .16 AWS A5.8 - Filler Metal for Brazing and Braze Welding.
- .17 AWS D10.10 - Recommended Practices for Local Heating of Welds in Piping and Tubing.
- .18 AWWA C110 - Ductile-Iron and Gray-Iron Fittings 3" (76 mm) through 48" (1219 mm) for Welder.
- .19 AWWA C151 - Ductile Iron Pipe, Centrifugally Cast, for Water.
- .20 NFPA 13 - Installation of Sprinkler Systems.
- .21 NFPA 14 - Installation of Standpipe, Private Hydrants, and Hose Systems.
- .22 NFPA 24 - Installation of Private Fire Service Mains and Their Appurtenances
- .23 ULC - Fire Resistance Directory.
- .24 UL 262 - Gate Valves for Fire-Protection Service.
- .25 UL 312 - Check Valves for Fire-Protection Service.
- .26 UL 405 - Fire Department Connections.

## **1.6 DELIVERY, STORAGE, AND HANDLING**

- .1 Section 01 61 00: Transport, handle, store, and protect products.
- .2 Deliver and store valves in shipping containers, with labelling in place.
- .3 Provide temporary protective coating on cast iron and steel valves.

- .4 Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

## **PART 2 – PRODUCTS**

### **2.1 ABOVE GROUND PIPING**

- .1 Steel Pipe: ASTM A53; Schedule 10.
  - .1 Joined by welding or by roll grooved pipe and fittings:
    - .1 Schedule 10 for sizes 5" (125mm) and smaller,
    - .2 0.134" (3.40mm) for 6" (150mm) diameter,
    - .3 0.188" (4.78mm) for 8" and 10" (200mm and 250mm) diameter.
  - .2 Joined with threaded fittings or cut groove pipe and fittings:
    - .1 Schedule 40 for sizes 6" (150mm) diameter and smaller,
    - .2 Schedule 30 for sizes 8" (200mm) diameter and larger.
- .2 Pipe Hangers and Supports
  - .1 Conform to NFPA 13 and NFPA 14.
  - .2 Hangers for Pipe Sizes 1/2" to 1-1/2" (15 to 40 mm): Carbon steel, adjustable swivel, split ring.
  - .3 Hangers for Pipe Sizes 2" (50 mm) and Over: Carbon steel, adjustable, clevis.
  - .4 Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
  - .5 Wall Support for Pipe Sizes to 3-1/4" (80 mm): Cast iron hook.
  - .6 Wall Support for Pipe Sizes 4" (100 mm) and Over: Welded steel bracket and wrought steel clamp.
  - .7 Vertical Support: Steel riser clamp.
  - .8 Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
- .3 Valves – General
  - .1 cUL or ULC and FM approved, listed and labelled.
  - .2 All valves controlling connections to water supplies shall be listed indicating valves.
  - .3 Conform to requirements of ANSI, ASTM, ASME, and applicable MSS standards.
  - .4 Provide valves of the same manufacturer where possible.
  - .5 Manufacturer's name and pressure rating clearly marked on body to MSS-SP-25.
  - .6 All valves supplied for this project shall have a current and valid Canadian Registration Number for the Province of Ontario with TSSA. Suppliers shall provide a copy of the Statutory Declaration for valves, stamped, signed and dated by TSSA as validation of the CRN registration. This shall be included with the shop drawing submittal package.
  - .7 Materials:
    - .1 Bronze: ASTM B62 or B61 as applicable

- .2 Brass: ASTM B283 C3770
    - .3 Cast Iron: ASTM A126 Class B
  - .8 End Connections:
    - .1 Threaded ends: ANSI B1.20.1
    - .2 Flanged ends: ANSI B16.1 (Class 125), ANSI B16.5
    - .3 Face-to-face dimensions: ANSI B16.10
  - .9 Design and Testing:
    - .1 Bronze Gate & Check valves: MSS-SP-80
    - .2 Cast Iron Gate Valves: MSS-SP-70
    - .3 Cast Iron Globe Valves: MSS-SP-85
    - .4 Cast Iron Check: MSS-SP-71
    - .5 Butterfly Valves: MSS-SP-67
  - .10 Acceptable manufacturers:
    - .1 Kitz Corporation
    - .2 Crane & Jenkins Valve Group Incorporated
    - .3 Conbraco Industries Canada
    - .4 Nibco Incorporated.
- .4 Isolation Valves
- .1 Electrically Supervised: ULC listed, FM approved, NO/NC SPDT dry contact switch suitable for electrical supervision on trouble circuit of facility fire alarm system. Valve monitoring switches shall be Potter Electric Signal and Manufacturing Limited or equivalent.
  - .2 Up to 2" (50 mm):
    - .1 Construction: ULC listed, FM approved, 300 psig non-shock WOG, ASTM B62 bronze body, solid wedge disc, rising stem, bronze trim, threaded ends, Kitz #25
  - .3 2-1/2" (65 mm) and Larger:
    - .1 Construction: ULC listed, FM approved, 175 psi 1210 kPa CWP, outside screw and yoke, cast iron body, stem with ACME double threads, tapered solid wedge disc, flanged ends, renewable bronze seat rings.
- .5 Check Valves
- .1 2-1/2 " (65 mm) and Larger:
  - .2 Construction: ULC listed, FM approved, 175psi (1210 kPa)CWP, iron body and bolted cap, bronze trim, bronze swing disc with replaceable bronze seat rings, flanged ends OR
  - .3 Construction: ULC listed, FM approved, 175 psi (1210 kPa), Cast Iron body, 316 stainless steel shaft, Double Door Bronze Disc to B-62, Buna seat, 316 stainless steel spring, wafer style.
- .6 Drain Valves

- .1 Construction: ULC listed and FM approved, brass ball valve with cap and chain, 3/4" (20 mm) hose thread.

## **PART 3 – EXECUTION**

### **3.1 PREPARATION**

- .1 Ream pipe and tube ends. Remove burrs.
- .2 Remove scale and foreign material, from inside and outside, before assembly.
- .3 Prepare piping connections to equipment with flanges or unions.

### **3.2 INSTALLATION**

- .1 Install piping to NFPA 13 for sprinkler systems.
- .2 Route piping in orderly manner, plumb and parallel to building structure. Maintain gradient.
- .3 Install piping to conserve building space, to not interfere with use of space and other work.
- .4 Group piping whenever practical at common elevations.
- .5 Sleeve pipes passing through partitions, walls, and floors.
- .6 Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- .7 Inserts:
  - .1 Provide inserts for placement in concrete formwork.
  - .2 Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
  - .3 Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 100 mm.
  - .4 Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
  - .5 Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.
- .8 Pipe Hangers and Supports:
  - .1 Install to NFPA 13.
  - .2 Install hangers to provide minimum 13 mm space between finished covering and adjacent work.
  - .3 Place hangers within 300 mm of each horizontal elbow.
  - .4 Use hangers with 38 mm minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
  - .5 Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.
  - .6 Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
  - .7 Provide copper plated hangers and supports for copper piping.

- .9 Slope piping and arrange systems to drain at low points. Use eccentric reducers to maintain top of pipe level.
- .10 Prepare pipe, fittings, supports, and accessories for finish painting. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.
- .11 Do not penetrate building structural members unless indicated.
- .12 Provide sleeves when penetrating floors, walls and footings. Seal pipe and sleeve penetrations to achieve fire resistance equivalent to fire separation required.
- .13 When installing more than one piping system material, ensure system components are compatible and joined to ensure the integrity of the system. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.
- .14 Die cut threaded joints with full cut standard taper pipe threads with red lead and linseed oil or other non-toxic joint compound applied to male threads only.
- .15 Install valves with stems upright or horizontal, not inverted. Remove protective coatings prior to installation.
- .16 Provide ball valves for shut-off or isolating service.
- .17 Provide drain valves at main shut-off valves, low points of piping and apparatus.
- .18 All control, drain and test connection valves shall be provided with permanently engraved and marked weatherproof metal or rigid plastic identification signs, secured with weather resistant chain or other approved method.

**END OF SECTION**

## **PART 1 – GENERAL**

### **1.1 GENERAL REQUIREMENTS**

- .1 Read and be governed by conditions of the Contract Documents, including sections of Division 01.

### **1.2 Summary**

- .1 Section Includes
  - .1 Dry-pipe sprinkler assembly.
  - .2 System design, installation, and certification.
  - .3 Fire department connections.
- .2 Related Sections
  - .1 Section 31 23 18 - Trenching.
  - .2 Section 20 05 00 – Mechanical General Provisions.
  - .3 Section 23 05 53 - Mechanical Identification.
  - .4 Section 23 05 48 - Vibration Isolation.
  - .5 Section 26 05 80 - Equipment Wiring: Electrical characteristics and wiring connections.

### **1.3 SUBMITTALS**

- .1 Submittals for Review
  - .1 Section 01 33 00: Submission procedures.
  - .2 Shop Drawings/Product Data: Submit shop drawings/product data sheets to the regulatory authority for review and approval prior to submitting to the Consultant. Conform to the following requirements.
    - .1 Submit shop drawings/product data sheets for all products specified in this Section except pipe and fittings;
    - .2 Submit complete white print CAD layout drawings indicating the source of water supply with test flow and pressure, “head-end” equipment piping schematic, pipe routing and sizing, and zones, all signed and sealed by a qualified professional mechanical engineer as specified below;
    - .3 Submit copies of all calculations, including hydraulic calculations, stamped and signed by the same engineer who signs the layout drawings, and a listing of all design data used in preparing the calculations, system layout and sizing, including occupancy-hazard design requirements.
  - .3 Test Certificate: Certify that system has been tested and meets or exceeds code requirements as specified in Part 3 of this Section.

### **1.4 REGULATORY REQUIREMENTS**

- .1 Codes and Standards
  - .1 All system components must be UL and/or ULC listed and labelled.
  - .2 Sprinkler Systems: Conform to NFPA 13, Standard for the Installation of Sprinkler Systems.



- .3 Products Requiring Electrical Connection: Listed and classified by CSA testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.
- .2 Subcontractor and Site Personnel
  - .1 Fire protection sprinkler work is to be performed by a sprinkler company who is a member in good standing of the Canadian Automatic Sprinkler Association. All site personnel are to be sprinkler fitters licensed in the jurisdiction of the work and under the continuous supervision of a foreman who is an experienced fire protection system installer and a journeyman pipe fitter.
- .3 Dimensions and Coordination: Check and verify all dimensions and conditions at the site and ensure that the work can be performed as indicated. Co-ordinate fire protection sprinkler work with all trades at the site and accept responsibility for and the cost of adjusting piping and/or spacing to avoid interference with other building components.

## **1.5 Design Requirements**

- .1 Design Criteria: Fire protection sprinkler work is to be designed in accordance with NFPA 13 and Provincial Standards and, where required, local building and fire department requirements and the standards of the Owner's Insurer. If water supply flow and pressure test data is not available, conduct Municipal main water flow and pressure tests at the nearest fire hydrant to obtain criteria to be used in sprinkler system design. Include hydrant location and flow and pressure test data with system design calculations.
- .2 System Designer: Fire protection sprinkler work is to be designed by a fully qualified mechanical professional engineer registered and licensed in the jurisdiction of the work. Refer to Section 20 05 00 – Mechanical General Provisions for requirements governing employment of the engineer.
- .3 Consultant Approval: The fire protection sprinkler system design, including all piping runs and sprinkler locations, are to be approved by the Consultant prior to the commencement of work on-site.
- .4 Sprinkler / System Occupancy – Hazard Design Requirements: As per NFPA 13 occupancy-hazard density requirements, unless otherwise specified.

## **PART 2– PRODUCTS**

### **2.1 Pipe, Fittings and Joints**

- .1 Pipe, fittings and joints are to be as follows, with exceptions as specified in Part 3 of this Section:
  - .1 PVC – underground service pipe inside or outside building: Class 200, DR14, rigid, hub and spigot pattern PVC pipe and CSA certified fittings to CAN/CSA B137.2 and B137.3 and complete with gasketed joints.
  - .2 Schedule 40 Steel – Grooved Coupling Joints: Schedule 40 mild black carbon steel, ASTM A53, Grade B, complete with grooved ends and mechanical fittings and couplings equal to Victaulic "FireLock" fittings and Victaulic Style 005 rigid coupling joints. Strap type outlet fittings such as Victaulic "Snap-Let" are not acceptable. Use for pipe inside building and above ground from the service connection to the discharge side of "head end" equipment such as alarm valve, etc., and for all piping to the siamese connection
  - .3 Schedule 40 Steel – Screwed and Welded Joints: Schedule 40 mild black carbon steel, ASTM A53, Grade B. Screwed piping is to be complete with Class 125 cast iron screwed fittings to ANSI/ASME B16.4. Welded piping is to be complete with factory made seamless carbon steel butt welding fittings to ASTM A234, Grade WPB, long sweep

pattern wherever possible. Use for pipe similar to .2 above.

- .4 Schedule 10 Steel – Grooved Coupling Joints: Schedule 10 mild black carbon steel, ASTM A53, Grade B, complete with grooved ends and fittings and couplings equal to Victaulic "FireLock" fittings and Victaulic Style 005 rigid coupling joints.
- .5 "Lightwall" Steel – Grooved Coupling Joints: Commercial quality. "Lightwall" rolled mild carbon steel pipe to ASTM A135, Grade A, complete with a galvanized exterior, grooved ends, and fittings and couplings equal to Victaulic "Fire Lock" grooved fittings and Victaulic Style 005 rigid coupling joints.
- .6 Flexible Pipe: FlexHead Industries flexible stainless steel metallic hose sprinkler head connections or Victaulic "VicFlex" flexible stainless steel metallic hose sprinkler head connections, each complete with attachment bracket. For short sprinkler piping connections off a main to heads in exhaust ducts, in suspended ceilings, etc.

## **2.2 SERVICE MAIN DOUBLE CHECK VALVE ASSEMBLY**

- .1 Minimum 1205 kPa (175 psi) rated dual check valve backflow preventer assembly (less shut-off valves) to CAN/CSA B64, complete with test cocks. For service mains extended from domestic water main and where Municipality requires a double check valve assembly in lieu of a single check valve as required by Code.

## **2.3 SHUT-OFF VALVES**

- .1 Minimum 1205 kPa (175 psi) rated full port bronze body screwed ball valves and lug body or grooved end type butterfly valves.

## **2.4 CHECK VALVES**

- .1 Minimum 1205 kPa (175 psi) resilient seat check valves.
- .2 Check valves associated with Fire Department connections and fire pump test connection are to be tapped for site installation of a 20 mm ( $\frac{3}{4}$ ") diameter ball drip.

## **2.5 BALL DRIPS**

- .1 Equal to National Fire Equipment Ltd. Model #A58, 20 mm ( $\frac{3}{4}$ ") diameter automatic ball drip.

## **2.6 SHUT-OFF VALVE SUPERVISORY SWITCHES**

- .1 Tamper-proof supervisory switches, each arranged to activate a fire alarm system trouble alarm condition if the valve is closed or tampered with, each suitable in all respects for the application, and with each complete with all required mounting and connection hardware.

## **2.7 FIRE DEPARTMENT CONNECTION**

- .1 Wall mounting polished brass clapper type dual inlet Fire Department connection with two 65 mm ( $2\frac{1}{2}$ ") diameter inlets threaded to Fire Department hose requirements and equipped with caps and chains, an outlet sized as shown, and a faceplate.
- .2 The faceplate is to be complete with "AUTO SPKR STANDPIPE" cast-in raised lettering.

## **2.8 SPRINKLER MAIN "LOSS OF PRESSURE" ALARM SENSOR**

- .1 Piping mounted adjustable pressure sensor designed to actuate an alarm upon sensing a loss of pressure in the fire protection main. The switch is to be low voltage or line voltage as required.

## **2.9 WATER FLOW ALARM SWITCH**

- .1 Pipe mounting water flow alarm switch, minimum 1725 kPa (250 psi) rated, designed to actuate two 7 ampere rated (at 125/250 VAC) SPDT snap action switches when water flow exceeds 0.758 L/sec. (10 gpm), complete with a tamper-proof cover with conduit connection opening, a piping saddle and U-bolt, and an automatic reset pneumatic retard device with field adjustable (0 to 70 second) switch actuation delay to reduce false alarms caused by a single or series of transient water flow surges.

## **2.10 ALARM CHECK VALVE**

- .1 Enameled cast iron check type valve designed for either vertical or horizontal mounting with divided seat ring, rubber faced clapper to automatically actuate water motor alarm. The assembly is to be minimum 1205 kPa (175 psi) cold water rated with all moving parts constructed of brass, bronze, stainless steel or EPDM, and is to be complete with:
  - .1 basic trim including piping materials and check valve for an external by-pass, potable water supply and system water supply pressure gauges with gauge test ports and shut-off valves, an angle type main drain valve, and fittings for mounting an alarm test by-pass;
  - .2 alarm test by-pass piping with ball valve to permit alarm testing without operation of the alarm valve;
  - .3 alarm trim with pipe and fittings for connection to a water motor alarm, and an adjustable pressure switch for electrical connection to an alarm system upon flow through the valve.

## **2.11 AIR COMPRESSOR**

- .1 Single unit, electric motor driven, motor, motor starter, safety valves, check valves, air maintenance device incorporating electric pressure switch and unloader valve.
  - .1 0.25 kW – 0.38 kW
  - .2 125 volts, single phase, 60 Hz

## **2.12 ZONE CONTROL RISER MODULES**

- .1 Equal to Victaulic Co. "FireLock" Series 747M factory assembled zone control riser modules, each complete with a painted cast ductile iron grooved end body, a ball type shut-off valve, a test and drain combination with properly sized orifice, a flow alarm switch, a pressure gauge with cock, and a pressure relief valve kit.

## **2.13 SPRINKLER HEADS**

- .1 Sprinkler heads, unless otherwise specified, are to be as scheduled in Part 3 of this Section.
- .2 Recessed sprinkler heads in finished areas are to be chrome plated unless otherwise specified. Concealed sprinkler head ceiling plates are to match the ceiling colour.
- .3 Where exposed pendent heads occurs in areas with suspended ceilings, they are to be complete with chrome plated escutcheon plates. Similarly, sidewall heads with concealed piping are to be complete with chrome plated escutcheon plates.

- .4 Sprinkler heads which are exposed in areas where they may be subject to damage are to be complete with wire guards, chrome plated where in finished areas.
- .5 Sprinkler heads located in areas or over equipment where high ambient temperature is present are to be, unless otherwise specified, 74°C (165°F) heads. All other heads, unless otherwise specified or required, are to be 57°C (135°F) rated.
- .6 Acceptable sprinkler head manufactures are:
  - .1 Tyco Fire Suppression & Building Products;
  - .2 Victaulic Corporation.;
  - .3 The Viking Corporation;
  - .4 The Reliable Automatic Sprinkler Corporation.

#### **2.14 SPARE SPRINKLER HEAD CABINET**

- .1 Surface wall mounting, red enameled steel, identified cabinet with hinged door, shelves with holes for mounting sprinkler heads, a wrench or wrenches suitable for each type of sprinkler head, and a full complement of spare sprinkler heads.
- .2 The cabinet is to be sized to accommodate a minimum of four spare heads for each type of head used on the project, however, each cabinet is to be full of spare heads.

### **PART 3 – EXECUTION**

#### **3.1 PIPING INSTALLATION REQUIREMENTS**

- .1 Provide all required sprinkler system piping.
- .2 Do all piping work in accordance with requirements of NFPA 13, governing regulations, and "reviewed" shop drawings.
- .3 Piping, unless otherwise specified, is to be as follows:
  - .1 for underground pipe inside or outside the building – Class 200, DR14 rigid PVC, braced and secured at bends and tees with concrete blocks in accordance with Municipal standards and details;
  - .2 for piping inside the building and above ground except as noted below – Schedule 40 grooved end black steel with Victaulic or equal fittings and coupling joints, or, for piping to and including 50 mm (2") diameter, screwed fittings and joints, or, for piping 65 mm (2½") diameter and larger, welding fittings and welded joints;
  - .3 for piping downstream of "head end" alarm valve(s) and equipment – Schedule 10 or "Lightwall" black steel pipe with Victaulic or equal fittings and coupling joints or screwed fittings and joints;
  - .4 for branch piping to heads in suspended ceilings, etc.: At your option, flexible piping installed in accordance with the manufacturer's instructions;
- .4 Exceptions to above piping requirements are as follows:
  - .1 all ferrous pipe hangers, supports, and similar hardware used for galvanized steel piping are to be electro-galvanized.

- .5 All pipe sizes, pipe routing, sprinkler head quantities and locations, and layout of work shown on the drawings are to assist you during the tendering period. Ensure adequate head coverage, head quantities and pipe sizing as specified in Part 1 of this Section. Do not reduce the size of the sprinkler main or re-route the main unless approved.
- .6 All pipe, fittings, couplings, flanges and similar components are to be clean after erection is complete. Any ferrous pipe, fitting, coupling, flange, hanger, support and similar component which exhibits rust is to be wire brush cleaned and carefully coated with suitably coloured primer.
- .7 When sprinkler work is complete, test system components and the overall system(s) and submit completed test certificate and other documentation in accordance with Chapter 8 of NFPA 13.

### **3.2 INSTALLATION OF DOUBLE CHECK VALVE ASSEMBLY**

- .1 Provide a double check valve assembly in the sprinkler main inside the building where shown.
- .2 Support each end of the assembly from the floor by means of flanged pipe supports with saddles.

### **3.3 INSTALLATION OF SHUT-OFF VALVES AND CHECK VALVES**

- .1 Provide shut-off valves and check valves in piping where shown, and wherever else required.
- .2 Locate all valves for easy operation and maintenance.
- .3 Confirm exact locations prior to roughing-in.

### **3.4 INSTALLATION OF SHUT-OFF VALVE SUPERVISORY SWITCHES**

- .1 Unless otherwise specified, equip each shut-off valve with a supervisory switch.
- .2 Identify each supervised valve with a 150 mm (6") square, engraved, laminated red-white plastic tag to correspond with supervised valve numbering specified and/or shown as part of the electrical work fire alarm system.

### **3.5 INSTALLATION OF FIRE DEPARTMENT CONNECTION**

- .1 Provide an exterior Fire Department connection where shown. Confirm exact location prior to roughing-in. Confirm finish prior to ordering.
- .2 Equip the connection with a check valve. Equip the check valve with a ball drip to drain the piping between the Fire Department connection and the check valve, and extend drainage piping from the outlet of the ball drip to the nearest suitable floor drain.

### **3.6 INSTALLATION OF LOSS OF PRESSURE SENSOR**

- .1 Supply and mount a pressure sensor in the fire protection piping main to activate a "LOSS OF PRESSURE" trouble alarm should Municipal water service pressure fall below the acceptable level.
- .2 Locate the sensor for easy access and maintenance, and set the alarm pressure to suit site conditions. Confirm setting on site.
- .3 Identify the pressure sensor and its normal setting with a 150 mm (6") square red-white laminated plastic tag engraved to read "LOSS OF WATER PRESSURE SENSOR - NORMAL SETTING 210 kPa". Confirm wording prior to engraving.

### **3.7 INSTALLATION OF FLOW ALARM SWITCHES**

- .1 Provide water flow alarm switches in accessible locations in zone piping where shown.
- .2 Adjust to suit site water pressure conditions. Check and test operation.
- .3 Identify each switch with a 150 mm (6") square red-white laminated engraved plastic tag. Confirm wording prior to engraving.

### **3.8 INSTALLATION OF ALARM CHECK VALVES**

- .1 Provide alarm check valves, complete with trim, for dry pipe fire protection sprinkler piping where shown.
- .2 Check and test operation of each valve and adjust as required to suit site water pressure conditions.
- .3 Identify each valve with a 150 mm (6") square red-white laminated engraved plastic tag. Confirm wording prior to engraving.

### **3.9 INSTALLATION OF AIR COMPRESSOR**

- .1 Install air compressor on vibration isolators.

### **3.10 INSTALLATION OF ZONE CONTROL RISER MODULES**

- .1 Provide zone control riser modules with drain piping where required. Terminate drainage piping over a funnel floor drain unless otherwise shown or specified. Identify each assembly.

### **3.11 INSTALLATION OF SPRINKLER HEADS**

- .1 Provide all required sprinkler heads. Sprinkler head types are to be in accordance with the following schedule, unless otherwise specified. Sprinkler head manufacturers indicated on the schedule are for type indication purposes. Acceptable manufacturers are listed in Part 2 of this Section.
- .2 Unless otherwise specified, sprinkler heads are to be in accordance with the following schedule:

APPLICATION	SPRINKLER HEAD TYPE
Rooms/areas with a suspended ceiling	Tyco Series RFII "Royal Flush II" concealed pendent  Tyco Series TY-FRB recessed pendent  Tyco Series TY-FRB pendent with escutcheon plates
Rooms/areas without a suspended ceiling	Tyco Series TY-RFB pendent
Elevator shafts	Tyco Series TY-FRB horizontal sidewall
Heated areas with overhead doors	Tyco Series TY-FRB horizontal sidewall
At non-rated windows in rated walls	Tyco Model WS horizontal and pendent vertical sidewall

- .3 Sprinkler head locations must be carefully coordinated with all drawings, including architectural reflected ceiling plan drawings, and, where applicable, electrical drawings. Coordinate sprinkler head locations in areas with suspended ceilings with the location of lighting, grilles, diffusers, and similar items recessed in or surface mounted on the ceiling as per the reflected ceiling plans. In areas with lay-in tile, centre the sprinkler head both ways in the lay-in tile wherever possible. Confirm locations prior to roughing-in.
- .4 Maintain maximum headroom in areas with no ceilings.
- .5 Provide guards for heads where they are subject to damage.
- .6 Provide high temperature heads in equipment rooms and similar areas over heat producing or generating equipment.

### **3.12 INSTALLATION OF SPARE SPRINKLER HEAD CABINET**

- .1 Supply a full complement (to fill cabinet) of spare sprinkler heads of the types used (minimum four of each type) and place in a wall mounting storage cabinet located adjacent to the sprinkler system "head end" equipment where later directed.

**END OF SECTION**

## **2.1 GENERAL**

### **3.1. APPLICABLE STANDARDS**

- .1 Applicable Standards are listed below:
  - .1 2015 ASHRAE Handbook – HVAC Applications Chapter 43 HVAC Commissioning
  - .2 ASHRAE Guideline 1.1 – 2007 – The HVAC&R Technical Requirements for the Commissioning Process
  - .3 ASHRAE Guideline 0 – 2013 – The Commissioning Process
  - .4 ASHRAE 202 – 2013 – Commissioning Process for Buildings and Systems
  - .5 ASHRAE Guideline 4-2008 – Preparation of O&M Documentation
  - .6 ATSM E2813 – Standard Practice for Building Enclosure Commissioning
  - .7 ATSM E2947 – Standard Guide for Building Enclosure Commissioning
  - .8 CSA Z320-11 Building Commissioning Standard & Check Sheets
  - .9 CSA C282-15 – Emergency Power Supply for Buildings
  - .10 NIBS Guideline 3-2012 – Building Enclosure Commissioning Process

### **3.2. GENERAL**

- .2 The purpose of this section is to specify Division 22 responsibilities in the commissioning process.
- .3 Commissioning requires the participation of Division 22 to ensure that all systems are operating in a manner consistent with the Contract Documents. The general commissioning requirements and coordination are detailed in Section 01 91 00. Division 22 shall be familiar with all parts of Section 01 91 00 and the commissioning plan issued by the CxA and shall execute all commissioning responsibilities assigned to them in the Contract Documents.

### **3.3. SYSTEMS TO BE COMMISSIONED**

- .4 Systems to be commissioned as part of this contract include, but may not be limited to the following:
  - .1 Plumbing, including domestic hot water systems, pumps and controls

### **3.4. COMMISSIONING TEAM**

- .5 The Commissioning Team shall consist of representatives of the following as appropriate:
  - .1 Owner and the Owner's FM Staff
  - .2 Consultant
  - .3 Commissioning Authority (CxA)
  - .4 General Contractor (GC)
  - .5 Subcontractors (Mechanical, Electrical, Controls, TAB)
  - .6 Specialized third-party for verification

## **2.2 PRODUCTS**

Not Used.



## **2.3 EXECUTION**

### **3.5. COMMISSIONING AUTHORITY RESPONSIBILITIES**

- .6 The Commissioning Authority shall:
  - .1 Plan, organize and implement the commissioning process as specified herein;
  - .2 Prepare the commissioning plan, ensure its distribution for review and comment;
  - .3 Revise the commissioning plan as required during construction;
  - .4 Chair commissioning meetings, and prepare and distribute minutes to all commissioning team members, whether or not they attended the meeting;
  - .5 In conjunction with the GC, coordinate commissioning activities;
  - .6 Monitor system verification checks, and ensure the results are documented as the checks are done;
  - .7 Observe select start-ups and initial system operations tests and checks;
  - .8 Direct the GC to operate equipment and systems as required to ensure that all required functional performance tests are carried out for verification purposes;
  - .9 Witness functional performance tests and document the results;
  - .10 Prepare and submit a commissioning report which documents all checks and tests done throughout the commissioning process, and the results obtained from each;
  - .11 Ensure all required O&M manuals, instructions and demonstrations are provided to the Owner's designated facility operating staff.

### **3.6. CONSULTANT RESPONSIBILITIES**

- .7 The Consultant commissioning responsibilities are outlined below:
  - .1 Review the commissioning plan, proposed test procedures, and participate (as appropriate) in on-site commissioning meetings.
  - .2 At their discretion during the acceptance phase of the commissioning process, be on site to review commissioning documentation, to witness functional performance tests, and to analyze the installation and its performance

### **3.7. OWNER RESPONSIBILITIES**

- .8 The Owner shall have the following commissioning responsibilities
  - .1 Ensure the availability of facility operations staff for all scheduled instructions and demonstration sessions (training).
  - .2 At their discretion, witness commissioning performance tests.

### **3.8. SUBCONTRACTOR RESPONSIBILITIES**

- .9 The responsibilities of the Subcontractor, during construction and acceptance phases in addition to those listed above are (all references apply to commissioned equipment only)
  - .1 Documentation of all procedures performed shall be provided and forwarded to the engineer/ consultant. Written documentation must contain recorded test values of all tests performed per the individual product specification.
  - .2 The start-up service company shall be present during energization of the plumbing equipment. Jobsite and equipment access must be provided by the Subcontractor.

- .3 The subcontractor shall supply a power source, specified by the start-up service company, for on-site test equipment.
- .4 The subcontractor is to attend all factory witness testing required within the respective specification sections. The contractor is responsible to cover all their costs and include them in their bid.
- .5 Perform tests using qualified personnel. Provide necessary instruments and equipment.
- .6 Include the cost of commissioning in the contract price, if not yet included.
- .7 In each purchase order or subcontract written, include requirements for submittal data, O&M data and training.
- .8 Attend a commissioning scoping meeting and other necessary meetings scheduled by the CxA to facilitate the Cx process.
- .9 Contractors shall provide normal cut sheets and shop drawing submittals to the CxA of commissioned equipment. Provide additional requested documentation, prior to normal O&M manual submittals, to the CxA for development of pre-functional and functional testing procedures.
  - .1 Typically this will include detailed manufacturer installation and start-up, operating, troubleshooting and maintenance procedures, full details of any owner-contracted tests, fan and pump curves, full factory testing reports, if any, and full warranty information, including all responsibilities of the Owner to keep the warranty in force clearly identified. In addition, the installation and checkout materials that are actually shipped inside the equipment and the actual field checkout sheet forms to be used by the factory or field technicians shall be submitted to the Commissioning Authority.
  - .2 The Commissioning Authority may request further documentation necessary for the commissioning process. This data request may be made prior to normal submittals.
- .10 Provide a copy of the O&M manuals submittals of commissioned equipment, through normal channels, to the CxA for review.
- .11 Contractors shall assist (along with the Consultant) in clarifying the operation and control of commissioned equipment in areas where the specifications, control drawings or equipment documentation is not sufficient for writing detailed testing procedures.
- .12 Provide assistance to the CxA in preparation of the specific functional performance test procedures specified in Section 22. Subs shall review test procedures to ensure feasibility, safety and equipment protection and provide necessary written alarm limits to be used during the tests.
- .13 Develop a full start-up and checkout plan using manufacturer's start-up procedures and the pre-functional test sheets from the CxA. Submit manufacturer's detailed start-up procedures and the full start-up plan and procedures and other requested equipment documentation to CxA for review.
- .14 During the startup and checkout process, execute and document the mechanical-related portions of the pre-functional test sheets provided by the CxA for all commissioned equipment.
- .15 Perform and clearly document all completed startup and system operational checkout procedures, providing a copy to the CxA.
- .16 Provide skilled technicians to execute starting of equipment and to execute the functional performance tests. Ensure that they are available and present during the agreed upon schedules and for sufficient duration to complete the necessary tests, adjustments and problem-solving.

- .17 Perform functional performance testing under the direction of the CxA for specified equipment to be commissioned. Assist the CxA in interpreting the monitoring data, as necessary.
- .18 Correct deficiencies (differences between specified and observed performance) as interpreted by the CxA, GC and Consultant and retest the equipment.
- .19 Prepare O&M manuals according to the Contract Documents, including clarifying and updating the original sequences of operation to as-built conditions.
- .20 During construction, maintain as-built red-line drawings for all drawings and final CAD as-builts for subcontractor-generated coordination drawings. Update after completion of commissioning (excluding deferred testing). Prepare red-line as-built drawings for all drawings and final as-builts for subcontractor-generated coordination drawings
- .21 Provide training of the Owner's operating personnel as specified.
- .22 Coordinate with equipment manufacturers to determine specific requirements to maintain the validity of the warranty.
- .23 Execute seasonal or deferred functional performance testing, witnessed by the CxA, according to the specifications.
- .24 Correct deficiencies and make necessary adjustments to O&M manuals and as-built drawings for applicable issues identified in any seasonal testing.
- .10 Assist and cooperate with the Mechanical and TAB contractor and CxA by:
  - .1 Putting all equipment and systems into operation and continuing the operation during each working day of TAB and commissioning, as required.
  - .2 Providing temperature and pressure taps according to the Construction Documents for TAB and commissioning testing.
- .11 Install a P/T plug at each water sensor which is an input point to the control system.
- .12 List and clearly identify on the as-built drawings the locations of applicable sensors and meters
- .13 Prepare a preliminary schedule, in conjunction with Division 25 Contractors for Division 22 pipe system testing, flushing and cleaning, equipment start-up and TAB start and completion for use by the CxA. Update the schedule as appropriate.
- .14 Notify the GC or CxA depending on protocol, when pipe system testing, flushing, cleaning, startup of each piece of equipment and TAB will occur. Be responsible to notify the GC or CxA, ahead of time, when commissioning activities not yet performed or not yet scheduled will delay construction. Be proactive in seeing that commissioning processes are executed and that the CxA has the scheduling information needed to efficiently execute the commissioning process.

### **3.9. SUBMITTALS**

- .15 Section 22 Contractors shall provide submittal documentation relative to commissioning to the CxA as requested by the CxA. Refer to Section 01 91 00 for additional Division 22 requirements.

### **3.10. START-UP OF EQUIPMENT**

- .16 The Subcontractor shall follow the start-up and initial checkout procedures listed in the Responsibilities list in this section and in 01 91 00, Part 3.10. Division 22 has start-up responsibility and is required to complete systems and sub-systems so they are fully functional, meeting the design objectives of the Contract Documents. The commissioning procedures and functional testing do not relieve or lessen this responsibility or shift that responsibility partially to the CxA or Owner.

- .17 Functional testing is intended to begin upon completion of a system. Functional testing may proceed prior to the completion of systems or sub-systems at the discretion of the CxA and GC. Beginning system testing before full completion does not relieve the Contractor from fully completing the system, including all pre functional checklists as soon as possible.
- .18 Prior to the start-up of equipment, the Division 22 Subcontractor shall arrange to have the Manufacturer of all major equipment inspect the installation to ensure their equipment has been installed in accordance with their recommendations. Document the results of all inspections and checks on the checklists and sign them. If deficient or incomplete work is discovered, ensure corrective action is taken and re-check until the results are satisfactory, and the system is ready for safe start-up.
- .19 The Supplier shall submit a written report of their findings.
- .20 Upon confirmation that the equipment has been installed in accordance with the Manufacturers Recommendations the equipment may be started.
- .21 All equipment shall be started by the Manufacturer's representative.

### **3.11. PRE-FUNCTIONAL TEST SHEETS**

- .22 Pre-functional test sheets contain items for Section 22 Contractors to perform. On each checklist, a column is provided that is to be completed by the contractor assigning responsibility for that line item to a trade. Those executing the test sheets are only responsible to perform items that apply to the specific application at hand. These test sheets do not take the place of the manufacturer's recommended checkout and start-up procedures or report. Some checklist procedures may be redundant in relation to checkout procedures that will be documented on typical factory field checkout sheets. Double documenting may be required in those cases.
- .23 Refer to Section 01 91 00 for additional requirements regarding pre-functional test sheets, startup and initial checkout.

### **3.12. FUNCTIONAL TESTING, DOCUMENTATION, NON-CONFORMANCE AND ACCEPTANCE**

- .24 Refer to Specification 01 91 00 for more information in addition to this 22 08 00.

### **3.13. OPERATION AND MAINTENANCE MANUALS**

- .25 Section 22 Contractors shall compile and prepare documentation for all equipment and systems covered in Section 22 and deliver to the GC for inclusion in the O&M manuals.
- .26 ASHRAE Guideline 4-2008 is the recommended format.
- .27 The CxA shall receive a copy of the O&M manuals for review.

### **3.14. TRAINING OF OWNER PERSONNEL**

- .28 The GC shall be responsible for training coordination and scheduling and ultimately to ensure that training is completed. Refer to Section 01 91 00 for additional details.
- .29 The CxA shall be responsible for overseeing and approving the content and adequacy of the training of Owner personnel for commissioned equipment. Refer to Section 01 91 00 for additional details.
- .30 The Subcontractor shall have the following training responsibilities:
  - .1 Provide the CxA with a training plan two weeks before the planned training according to the outline described in Section 01 91 00, Part 3.14.
  - .2 Provide designated Owner personnel with comprehensive orientation and training in the understanding of the systems and the operation and maintenance of each piece of commissioned plumbing equipment

- .3 Training shall normally start with classroom sessions followed by hands-on training on each piece of equipment, which shall illustrate the various modes of operation, including startup, shutdown, fire/smoke alarm, power failure, etc.
- .4 During any demonstration, should the system fail to perform in accordance with the requirements of the O&M manual or sequence of operations, the system will be repaired or adjusted as necessary and the demonstration repeated.
- .5 The appropriate trade or manufacturer's representative shall provide the instructions on each major piece of equipment. This person may be the start-up technician for the piece of equipment, the installing contractor or manufacturer's representative. Practical building operating expertise as well as in-depth knowledge of all modes of operation of the specific piece of equipment is required. More than one party may be required to execute the training.
- .6 The training sessions shall follow the outline in the Table of Contents of the operation and maintenance manual and illustrate whenever possible the use of the O&M manuals for reference.
- .7 Training shall include:
  - .1 Use of the printed installation, operation and maintenance instruction material included in the O&M manuals.
  - .2 A review of the written O&M instructions emphasizing safe and proper operating requirements, preventative maintenance, special tools needed and spare parts inventory suggestions. The training shall include start-up, operation in all modes possible, shut-down, seasonal changeover and any emergency procedures.
  - .3 Discussion of relevant health and safety issues and concerns.
  - .4 Discussion of warranties and guarantees.
  - .5 Common troubleshooting problems and solutions.
  - .6 Explanatory information included in the O&M manuals and the location of all plans and manuals in the facility.
  - .7 Discussion of any peculiarities of equipment installation or operation.
- .31 The format and training agenda in The HVAC Commissioning Process, ASHRAE Guideline 1, latest edition
- .32 Classroom sessions shall include the use of overhead projections, slides, video/audio-taped material as might be appropriate.
- .33 Hands-on training shall include start-up, operation in all modes possible, including manual, shut-down and any emergency procedures and preventative maintenance for all pieces of equipment.
- .34 The mechanical subcontractor shall fully explain and demonstrate the operation, function and overrides of any local packaged controls, not controlled by the central control system.
- .35 Training shall occur after functional testing is complete, unless approved otherwise by the Project Manager.

### **3.15. DEFERRED TESTING**

- .36 Refer to Section 01 91 00, Part 3.15 for requirements of deferred testing.

### **3.16. WRITTEN WORK PRODUCTS**

- .37 Written work products of Section 22 Contractors will consist of the startup and initial checkout plan as described in Section 01 91 00, as well as completed startup, initial checkout and pre-functional test sheets. Refer to Section 01 91 00 Part 3.16.

**END OF SECTION**

## **PART 1 – GENERAL**

### **1.1 General requirements**

- .1 Read and be governed by conditions of the *Contract Documents*, including sections of Division 01.

### **1.2 Summary**

- .1 Provide all metering equipment required to monitor consumption by end use type.

### **1.3 Related Section**

- .1 Division 23 09 00 Instrumentation and Control Devices for HVAC
- .2 Division 26 09 23 Metering and Switchboard Instruments
- .3 Division 01 91 00 Commissioning

### **1.4 Submittals**

- .1 Submittals for review
  - .1 Submit shop drawings in accordance with Section 20 05 00 – Mechanical General Provisions.

## **PART 2– PRODUCTS**

### **2.1 End Uses to be Monitored**

- .1 Provide meters for all end uses, including but not limited to:
  - .1 Facility incoming domestic cold water;

### **2.2 Metering Equipment**

- .1 Water Meters
  - .1 Use of utility's meter is acceptable, and preferable, if allowable by utility, and meter meets requirements below.
  - .2 Coordinate with local Water Utility for water meter installation. Water meter provided by Utility shall be capable of providing multiple tap points, with pulse outputs suitable for use with specified data logger, rather than providing separate water sub-meter for data logging purposes.
  - .3 Provide water meters complete with bypass piping arrangement or other means to remove or isolate for service without interruption to water flow.
  - .4 Materials shall be compatible with the systems in which they are installed at all potential operating temperatures and pressures.
  - .5 Meters shall provide a pulse output scaled to an appropriate volume. In general, provide a scaled pulse output of 1 litre per pulse unless high consumption would result in pulses too frequent to be reliably captured by the pulse counting equipment.
  - .6 Meters requiring power shall be hard-wired. Battery powered units are not acceptable.
  - .7 Provide meters with readout of totalized volume.

- .8 Accuracy +/- 1.5% in expected operating flow range
  - .1 Acceptable Products
    - .1 Equal to Neptune Technology Group (Canada) Ltd. with Tricon hardware, or approved equal.

**END OF SECTION**



## **PART 1- GENERAL**

### **1.1 GENERAL REQUIREMENTS**

- .1 Read and be governed by conditions of the *Contract Documents*, including sections of Division 01.

### **1.2 SUMMARY**

- .1 Section Includes
  - .1 Pipe, pipe fittings, valves, and connections for piping systems.

### **1.3 SUBMITTALS**

- .1 Shop Drawings / Product Data
  - .1 Submit shop drawings / product data for all products specified in Part 2 of this Section except for pipe and fittings.
- .2 Water Purity Data
  - .1 Submit laboratory water purity test results indicating chlorine residual as required by local authority prior to applying for Substantial Performance.
- .3 Plumbing Inspection Certificate
  - .1 Submit a copy of the final plumbing inspection certificate prior to applying for Substantial Performance.
- .4 Maintenance Material Submittals
  - .1 Spare Parts: Provide two (2) repacking kits for each size valve.

### **1.4 ENVIRONMENTAL REQUIREMENTS**

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

## **PART 2- PRODUCTS**

### **2.1 SANITARY SEWER PIPING, BURIED, INSIDE BUILDING**

- .1 PVC Pipe: CAN/CSA-B1800, SDR 35 sewer pipe.
  - .1 Application: Sanitary sewer piping buried inside building and to points 1.5m (5') outside building lines, sizes 100mm (4") and larger.
  - .2 Fittings: Spigot and hub type with gasket joints assembled with pipe lubricant.
  - .3 Joints: Spigot and hub type with gasket joints assembled with pipe lubricant.
- .2 Copper Tube: Type 'L' hard copper tubing.
  - .1 Application: Sanitary sewer piping buried inside building, sizes up to and including 40mm (1½").
  - .2 Fittings: ASME B16.23 cast bronze or ASME B16.29 wrought copper.
  - .3 Joints: ASTM B32, silver solder.

- .3 ABS Pipe: CAN/CSA-B1800, Type DWV.
  - .1 Application: Sanitary sewer piping buried inside building, sizes up to and including 150mm (6").
  - .2 Fittings: ASTM D2468, ABS socket type.
  - .3 Joints: ASTM D2235, solvent cement and primer for fittings; ASTM D3138, solvent cement and primer for transition joints.

## **2.2 SANITARY SEWER PIPING, ABOVE GROUND**

- .1 Cast Iron Pipe: CAN/CSA-B70, Class 4000.
  - .1 Application: Above ground in sizes 80mm (3") diameter and larger.
  - .2 Fittings: Hubless Cast Iron Pipe Fittings: FSWW-P-401.
  - .3 Joints: ASTM C564, rubber or compression gaskets.
- .2 Copper Tube: ASTM B306, DWV.
  - .1 Application: Above ground in sizes to and including 65mm (2½") diameter.
  - .2 Fittings: ASME B16.29 wrought copper.
  - .3 Joints: ASTM B32, 50% tin – 50% lead solder joints.
- .3 PVC DWV Pipe flame spread/smoke rated for plenums: CSA B181.2.
  - .1 Application: Above ground, tested in accordance with CAN/ULC S102.2 clearly marked with certification logo indicating flame spread rating of 25, smoke developed classification of 50, permissible to be installed in air return plenums in accordance with local codes.
  - .2 Fittings: CSA B181.2.
  - .3 Joints: ASTM D2564 solvent cement and primer.

## **2.3 AIR-CONDITIONING CONDENSATE PIPING, CEILING PLENUM**

- .1 Copper Tube: ASTM B306, DWV.
  - .1 Application: Above ground, in ceiling plenum, in sizes to and including 65mm (2½") diameter.
  - .2 Fittings: ASME B16.29 wrought copper.
  - .3 Joints: ASTM B32, 50% tin – 50% lead solder joints.
- .2 PVC DWV Pipe flame spread/smoke rated for plenums: CSA B181.2.
  - .1 Application: Above ground, tested in accordance with CAN/ULC S102.2 clearly marked with certification logo indicating flame spread rating of 25, smoke developed classification of 50, permissible to be installed in air return plenums in accordance with local codes.
  - .2 Fittings: CSA B181.2.
  - .3 Joints: ASTM D2564 solvent cement and primer.

## **2.4 AIR-CONDITIONING CONDENSATE PIPING, ABOVE GROUND, NOT IN CEILING PLENUM**

- .1 PVC Pipe: CAN/CSA-B1800.
  - .1 Application: Above ground in lieu of type DWV copper and cast iron, at contractor's option and where permitted by governing Codes and Regulations, including smoke and flame spread requirements for use in plenums.
  - .2 Fittings: CAN/CSA-B1800, socket type.
  - .3 Joints: ASTM D2564 solvent cement and primer.

## **2.5 DOMESTIC WATER PIPING, BELOW GROUND**

- .1 PVC Pipe: CAN/CSA B-137.3.
  - .1 Application: For underground water mains 100mm (4") and larger.
  - .2 Fittings: CAN/CSA B137.2, AWWA C900.
  - .3 Joints: Gasket joints, Ford "Uni-Flange" restraint collars, or equal.
- .2 Semi-Rigid Polyethylene Tubing: 13mm (1/2") diameter, high density semi-rigid polyethylene tubing, 1380 kPa (200 psi) rated.
  - .1 Application: Floor drain trap seal primer piping underground or in concrete slab.

## **2.6 DOMESTIC WATER PIPING, ABOVE GROUND**

- .1 Copper Tubing: ASTM B88, Type L, hard drawn.
  - .1 Application: Domestic water piping above ground.
  - .2 Fittings: ASME B16.18 cast copper alloy, ASME B16.22 wrought copper and bronze, ASME B16.26 cast copper alloy, ASME B16.50 wrought copper.
  - .3 Joints: ASTM B32, soldered joints using The Canada Metal Co. Ltd. "SILVABRITE 100" or equivalent lead-free solder for cold water pipe, AWS A5.8 brazed.
- .2 Stainless Steel Pipe: Type "L" ASTM A312, Schedule 10, 304L stainless steel.
  - .1 Application: Domestic water piping above ground, size 50mm and larger, at Contractor's option.
  - .2 Fittings: ASTM A774, 304L stainless steel.
  - .3 Joints: ASTM B75, grooved end fittings, Victaulic or equal stainless steel roll grooved end fittings and, mechanical couplings with EPDM Grade E gasket, suitable for operating temperatures up to 110 degrees C (230 degrees F).

## **2.7 STORM WATER PIPING, BELOW GROUND**

- .1 PVC Pipe: CAN/CSA-B1800, SDR 35 pipe.
  - .1 Fittings: CAN/CSA-B1800.
  - .2 Joints: ASTM D2564 solvent cement.

## **2.8 STORM WATER PIPING, ABOVE GROUND**

- .1 Cast Iron Pipe: CAN/CSA-B70, Class 4000.

- .1 Application: Above ground in sizes 80mm (3") diameter and larger.
- .2 Fittings: Hubless Cast Iron Pipe Fittings: FSWW-P-401.
- .3 Joints: ASTM C564, rubber or compression gaskets.
- .2 Copper Tube: ASTM B306, DWV.
  - .1 Application: Above ground in sizes to and including 65mm (2½") diameter.
  - .2 Fittings: ASME B16.29 wrought copper.
  - .3 Joints: ASTM B32, 50% tin – 50% lead solder joints.
- .3 PVC DWV Pipe flame spread/smoke rated for plenums: CSA B181.2.
  - .1 Application: Above ground, tested in accordance with CAN/ULC S102.2 clearly marked with certification logo indicating flame spread rating of 25, smoke developed classification of 50, permissible to be installed in air return plenums in accordance with local codes.
  - .2 Fittings: CSA B181.2.
  - .3 Joints: ASTM D2564 solvent cement and primer.

## **2.9 HUMIDIFIER STEAM LINES AND CONDENSATE**

- .1 Copper Tube, Type L
- .2 Stainless Steel (min. DIN 1.4301)

## **2.10 FLANGES, UNIONS, AND COUPLINGS**

- .1 Ferrous Pipe Size 80mm (3") and Under: Class 150 malleable iron threaded unions.
- .2 Copper Tube and Pipe Size 80mm (3") and Under: Class 150 bronze unions with soldered joints.
- .3 Ferrous Pipe Size Over 25mm (1"): Class 150 malleable iron threaded or forged steel slip-on flanges; preformed neoprene gaskets.
- .4 Copper Tube and Pipe Size Over 25mm (1"): Class 150 slip-on bronze flanges; preformed neoprene gaskets.
- .5 Grooved and Shouldered Pipe End Couplings:
  - .1 Housing: Malleable iron clamps to engage and lock, designed to permit some angular deflection, contraction, and expansion; steel bolts, nuts, and washers; galvanized for galvanized pipe.
  - .2 Sealing gasket: C-shape composition sealing gasket.
- .6 Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.

## **2.11 PIPE HANGERS AND SUPPORTS**

- .1 Plumbing Piping - Drain, Waste, and Vent:
  - .1 Conform to MSS SP-58.
  - .2 Hangers for Pipe Sizes 13mm to 40mm (½" to 1-½"): Carbon steel, adjustable swivel, split ring.

- .3 Hangers for Pipe Sizes 50mm (2") and Over: Carbon steel, adjustable, clevis.
  - .4 Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
  - .5 Wall Support for Pipe Sizes to 80mm (3"): Cast iron hook.
  - .6 Wall Support for Pipe Sizes 100mm (4") and Over: Welded steel bracket and wrought steel clamp.
  - .7 Vertical Support: Steel riser clamp.
  - .8 Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
  - .9 Copper Pipe Support: Carbon steel ring, adjustable, copper plated.
- .2 Plumbing Piping - Water:
- .1 Conform to MSS SP-58.
  - .2 Hangers for Pipe Sizes 13mm to 40mm (1/2" to 1-1/2"): Carbon steel, adjustable swivel, split ring.
  - .3 Hangers for Cold Pipe Sizes 50mm (2") and Over: Carbon steel, adjustable, clevis.
  - .4 Hangers for Hot Pipe Sizes 50mm to 100mm (2" to 4"): Carbon steel, adjustable, clevis.
  - .5 Hangers for Hot Pipe Sizes 150mm (6") and Over: Adjustable steel yoke, cast iron pipe roll, double hanger.
  - .6 Multiple or Trapeze Hangers: Steel channels with welded supports or spacers and hanger rods.
  - .7 Multiple or Trapeze Hangers for Hot Pipe Sizes 150mm (6") and Over: Steel channels with welded supports or spacers and hanger rods, cast iron roll.
  - .8 Wall Support for Pipe Sizes to 80mm (3"): Cast iron hook.
  - .9 Wall Support for Pipe Sizes 100mm (4") and Over: Welded steel bracket and wrought steel clamp.
  - .10 Wall Support for Hot Pipe Sizes 150mm (6") and Over: Welded steel bracket and wrought steel clamp with adjustable steel yoke and cast iron pipe roll.
  - .11 Vertical Support: Steel riser clamp.
  - .12 Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
  - .13 Floor Support for Hot Pipe Sizes to 100mm (4"): Cast iron adjustable pipe saddle, locknut, nipple, floor flange, and concrete pier or steel support.
  - .14 Floor Support for Hot Pipe Sizes 150mm (6") and Over: Adjustable cast iron pipe roll and stand, steel screws, and concrete pier or steel support.
  - .15 Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

## 2.12 BALL VALVES

- .1 Ball Valves 80 mm (3") and Smaller in copper pipe, solder joints: Class 600, 4140 kPa (600 psi), WOG rated full port, forged brass body, forged brass cap, sold forged brass

chrome plated ball, Teflon or PTFE seats, blow-out proof stem, removable lever handle, solder ends. Provide stem extensions for valves installed in insulated piping.

- .1 Toyo Valve Co. Fig. 5049A
- .2 Milwaukee Valve Co.
- .3 Kitz Corporation Code 59
- .4 Apollo Valves
- .5 Watts Industries (Canada) Inc.

## **2.13 BUTTERFLY VALVES**

- .1 Butterfly Valves 100mm (4") and Larger: Non-corrosive, 1200 kPa (175 psi) CWP, cast or ductile iron body, stainless steel shaft, bronze disc, EPDM seat, worm gear operators, and chain-wheel operators for valves mounted over 2.4m (8') above floor.
  - .1 DeZurik APCO Hilton
  - .2 Kitz Corporation Code
  - .3 Toyo Valve Corporation.
  - .4 Bray Valve and Controls Canada Series 34
  - .5 Apollo Valves
  - .6 Watts Industries (Canada) Inc.

## **2.14 SWING CHECK VALVES**

- .1 Horizontal Swing Check Valves: Class 125, 1380 kPa (200 psi) WOG rated horizontal swing type check valve with soldered ends, bronze body and cap, bronze swing disc with rubber seat.
  - .1 Toyo Valve Co. Fig 237
  - .2 Milwaukee Valve Co.
  - .3 Kitz Corporation Code 23
  - .4 Apollo Valves #61-600
- .2 Vertical Lift Check Valves: 1725 kPa (250 psi) WOG rated vertical lift bronze check valve with soldered ends.
  - .1 Kitz Corporation Code 26

## **2.15 DRAIN VALVES**

- .1 Drain Valves: 2070 kPa (300 psi) water rated, 20mm (3/4") diameter, full port bronze ball valves, complete with threaded male outlet suitable for connecting a 20mm (3/4") diameter garden hose, cap and chain.
  - .1 Toyo Valve Co. Fig 5046
  - .2 Dahl Brothers Canada Ltd. 50430
  - .3 Kitz Corporation Code 58CC
  - .4 Apollo Valves # 78-104-01

.5 Watts Industries (Canada) Inc. #B6000-CC

## **2.16 WATER PRESSURE REDUCING VALVES**

- .1 Water Pressure Reducing Valves: CSA 356, bronze body, stainless steel and thermoplastic internal parts, fabric reinforced diaphragm, strainer.

## **PART 3- EXECUTION**

### **3.1 EXAMINATION**

- .1 Verify existing conditions before starting work.
- .2 Verify that excavations are to required grade, dry, and not over-excavated.

### **3.2 PREPARATION**

- .1 Ream pipe and tube ends. Remove burrs.
- .2 Remove scale and dirt, on inside and outside, before assembly.
- .3 Prepare piping connections to equipment with flanges or unions.

### **3.3 INSTALLATION**

- .1 Install to manufacturer's written instructions.
- .2 Provide non-conducting dielectric connections wherever jointing dissimilar metals.
- .3 Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.
- .4 Install piping to maintain headroom, conserve space, and not interfere with use of space.
- .5 Group piping whenever practical at common elevations.
- .6 Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. Refer to Section 23 05 16.
- .7 Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings. Refer to Section 23 07 19.
- .8 Provide access where valves and fittings are not exposed.
- .9 Establish elevations of buried piping outside the building to ensure not less than 1.5m (4') of cover. Install frost protection measures where ground cover is inadequate.
- .10 Install vent piping penetrating roofed areas to maintain integrity of roof assembly.
- .11 Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.
- .12 Provide support for utility meters to requirements of utility companies.
- .13 Prepare exposed, unfinished pipe, fittings, supports, and accessories ready for finish painting. Refer to Section 09 91 10.
- .14 Excavate to Sections in Division 31 for work of this Section.
- .15 Backfill to Sections in Division 31 for work of this Section.
- .16 Install bell and spigot pipe with bell end upstream.
- .17 Install valves with stems upright or horizontal, not inverted.

- .18 Pipe vents from gas pressure reducing valves to outdoors and terminate in weather proof hood.
- .19 Install water piping to ASME B31.9.
- .20 Sleeve pipes passing through partitions, walls and floors.
- .21 Inserts:
  - .1 Provide inserts for placement in concrete formwork.
  - .2 Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
  - .3 Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 100mm (4").
  - .4 Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
  - .5 Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut flush with top of slab.
- .22 Pipe Hangers and Supports:
  - .1 Install to OBC, ASME B31.9.
  - .2 Support horizontal piping as scheduled.
  - .3 Install hangers to provide minimum 13mm (1/2") space between finished covering and adjacent work.
  - .4 Place hangers within 300mm (12") of each horizontal elbow.
  - .5 Use hangers with 40mm (1-1/2") minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
  - .6 Support vertical piping at every floor. Support riser piping independently of connected horizontal piping.
  - .7 Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
  - .8 Provide copper plated hangers and supports for copper piping, or provide electrolytic action tape or equivalent if copper pipe attachment is not provided.
  - .9 Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
  - .10 Provide hangers adjacent to motor driven equipment with vibration isolation; refer to Section 23 05 29.
  - .11 Support cast iron drainage piping at every joint.

### **3.4 APPLICATION**

- .1 Use grooved mechanical couplings and fasteners only in accessible locations.
- .2 Install unions downstream of valves and at equipment or apparatus connections.
- .3 Install brass male adapters each side of valves in copper piped system. Solder adapters to pipe.
- .4 Install ball valves for shut-off and to isolate equipment, part of systems, or vertical risers.
- .5 Provide lug end butterfly valves adjacent to equipment when provided to isolate equipment.
- .6 Provide spring loaded check valves on discharge of water pumps.



- .7 Provide plug valves in natural gas systems for shut-off service.
- .8 Provide flow controls in water recirculating systems where indicated.

### **3.5 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM**

- .1 Prior to starting work, verify the system is complete and clean.
- .2 Flush and disinfect all new and/or reworked domestic water piping after leakage is complete.
- .3 Provide connections and pumps as required. Flush piping until all foreign materials have been removed and the flushed water is clear. Open and close valves, faucets, hose outlets, and service connections to ensure thorough flushing.
- .4 Ensure Ph of water to be treated is between 7.4 and 7.6 by adding alkali (caustic soda or soda ash) or acid (hydrochloric).
- .5 When flushing is complete, disinfect the piping with a solution of chlorine in accordance with AWWA C601. Inject disinfectant, free chlorine in liquid, powder, tablet or gas form, throughout system to obtain 50 to 80 mg/L residual.
- .6 Bleed water from outlets to ensure distribution and test for disinfectant residual at minimum 15% of outlets.
- .7 Maintain disinfectant in system for twenty-four (24) hours.
- .8 If final disinfectant residual tests less than 25 mg/L, repeat treatment.
- .9 Flush disinfectant from system until residual equal to that of incoming water or 1.0 mg/L.
- .10 When disinfecting is complete, submit water samples to a certified laboratory for purity testing. Take samples no sooner than twenty-four (24) hours after flushing, from 5% of outlets and from water entry, and analyze to AWWA C651.
- .11 When testing indicates pure water in accordance with governing standards, submit a copy of the test results and fill the system.

### **3.6 SCHEDULES**

- .1 Pipe Hanger Schedule:
  - .1 Metal Piping:
    - .1 Pipe size: 13mm to 32mm (1/2" to 1-1/4"):
      - .1 Maximum hanger spacing: 2m (6.5').
      - .2 Hanger rod diameter: 9mm (3/8").
    - .2 Pipe size: 40mm to 50mm (1-1/2" to 2"):
      - .1 Maximum hanger spacing: 3m (10').
      - .2 Hanger rod diameter: 10mm (3/8").
    - .3 Pipe size: 65mm to 75mm (2-1/2" to 3"):
      - .1 Maximum hanger spacing: 3m (10').
      - .2 Hanger rod diameter: 13mm (1/2").
    - .4 Pipe size: 100mm to 150mm (4" to 6"):
      - .1 Maximum hanger spacing: 3m (10').

- .2 Hanger rod diameter: 15mm (5/8").
- .5 Pipe size: 200mm to 300 mm (8" to 12"):
  - .1 Maximum hanger spacing: 4.25m (14').
  - .2 Hanger rod diameter: 22mm (7/8").
- .6 Pipe size: 350mm and Over (14" and Over):
  - .1 Maximum hanger spacing: 6m (20').
  - .2 Hanger rod diameter: 25mm (1").
- .2 Plastic Piping:
  - .1 All Sizes:
    - .1 Conform to pipe manufacturer's recommended support spacing.
    - .2 Hanger rod diameter: 9mm (3/8").

### **3.7 SERVICE CONNECTIONS**

- .1 Provide new sanitary sewer services. Before commencing work check invert elevations required for sewer connections, confirm inverts and ensure that these can be properly connected with slope for drainage and cover to avoid freezing.
- .2 Provide new water service complete with approved reduced pressure backflow preventer and water meter with by-pass valves pressure reducing valve.
- .3 Provide new gas service complete with gas meter and regulators. Gas service distribution piping to have initial minimum pressure of 1.75 kPa. Provide regulators on each line serving gravity type appliances, sized to equipment

**END OF SECTION**

## **PART 1- GENERAL**

### **1.1 GENERAL REQUIREMENTS**

- .1 Read and be governed by conditions of the *Contract Documents*, including sections of Division 01.

### **1.2 SUMMARY**

- .1 Section Includes
  - .1 Roof and floor drains.
  - .2 Floor drain trap seal primers.
  - .3 Cleanouts.
  - .4 Hose bibs.
  - .5 Hydrants.
  - .6 Backwater valves.
  - .7 Water hammer arrestors.
  - .8 Oil Interceptor.
  - .9 Thermostatic mixing valves.
  - .10 Backflow preventers.
- .2 Related Sections
  - .1 Section 20 05 00 – Mechanical General Provisions.
  - .2 Section 22 10 00 - Plumbing Piping.
  - .3 Section 22 42 02 - Plumbing Fixtures.
  - .4 Section 22 47 00 - Plumbing Equipment.

## **PART 2– PRODUCTS**

### **2.1 ROOF DRAINS**

- .1 Aluminum or galvanized cast iron drain with sump, removable cast aluminum, coated cast iron or cast bronze domed strainer with vandal proof screws and including the following accessories.
  - .1 Membrane flange and membrane clamp with integral gravel stop.
  - .2 Adjustable under deck clamp.
  - .3 Roof sump receiver.
  - .4 Waterproofing flange.
  - .5 Levelling frame.
  - .6 Adjustable extension sleeve for roof insulation.
  - .7 Perforated or slotted ballast guard extension for inverted roof.
  - .8 Perforated stainless steel ballast guard extension.

- .9 Control flow weir, only for locations shown on drawings denoted as 'CFRD', for number of weirs shown on drawing.
- .10 Plastic components are not acceptable.
- .11 Provide drains by single manufacturer throughout.
- .12 Acceptable Manufacturers:
  - .1 Zurn.
  - .2 Lexcor.
  - .3 Jay R. Smith.
  - .4 Mifab.
  - .5 Watts.

## **2.2 FLOOR DRAINS**

- .1 Unless otherwise specified or scheduled, floor drains are to be vandal-proof drains, each complete with a cast iron body and a trap seal primer connection. All cast iron components are to be factory finished with latex based paint coating.
- .2 MIFAB or equal J.R. Smith, Watts or Zurn, of the following types (Contractor to choose applicable type. Refer also to drawings.) Selection of bronze or stainless finishes by Architect. (Refer also to drawings.)
  - .1 Provide on floor areas except as noted below, MIFAB F1100-1-5-7, 125mm dia. round nickel bronze, or F1100-3-5-7, 125mm dia. round stainless steel strainer.
  - .2 Provide on ceramic tile, quarry tile or terrazzo floor areas, MIFAB F1100-S-1-5-7, 150 x 150 mm square nickel bronze, or F1100-S-3-5-7, 150 x 150 mm square stainless-steel strainer.
  - .3 Hub drains shall be provided where indicated on the drawing(s), MIFAB F1100-DD-1-5-7, 125mm dia. round nickel bronze, or F1100-DD-3-5-7, 125mm dia. round stainless steel hub.
  - .4 Funnel floor drains shall be provided where indicated on the drawing(s). Provide next to equipment where only one (1) pipe has to relieve to drain, MIFAB F1100-EF-1-5-7, 125mm dia. round nickel bronze, or F1100-EF-3-5-7, 125mm dia. round stainless steel strainer and 100mm funnel.
  - .5 Funnel floor drains receiving more than one (1) pipe relief to drain, shall be revised to MIFAB F-1100-EG type, supplied with a 4" x 9" (100 x 230mm) funnel in lieu of the 100mm funnel above.
  - .6 All floor and funnel drains shall be complete with adjustable top assemblies, cast iron frames, sediment buckets and trap seal primer tapings.
  - .7 Floor and funnel drains installed in water-proofed areas shall be revised to MIFAB F1100C type supplied with clamp collar and weep holes.
- .3 Lacquered finish is standard. Use clamping collar on floors above grade. The following is a standard floor drain.

## **2.3 FLOOR DRAIN TRAP SEAL PRIMERS**

- .1 Electronic type

- .1 CSA certified electronic automatic trap priming manifold, sized and located to suit the quantity of traps, complete with:
  - .1 16 ga. galvanized steel cabinet with door, flush recessed mounting for exposed areas and surface mounted in services areas (e.g. mechanical rooms, custodial rooms);
  - .2 20 mm (3/4") dia. NPT copper pipe inlet with shut-off valve, solenoid valve, atmospheric vacuum breaker, calibrated discharge manifold for equal water distribution, compression fitting connections to suit quantity of traps to be primed;
  - .3 UL certified electronic assembly including manual override / test switch, 24-hour adjustable timer, circuit breaker.
- .2 Acceptable manufacturers:
  - .1 Precision Plumbing Products PT series;
  - .2 Mifab, Inc.;
  - .3 or approved equal.

## 2.4 CLEANOUTS

- .1 Horizontal Piping: TY pipe fitting with an extra heavy brass plug screwed into the fitting.
- .2 Vertical Piping: Bronze or copper cleanout tees in copper piping, each complete with a bronze ferrule, and, for cast iron piping, "BARRETT" type cast iron cleanout tees, each gas and water-tight and complete with a bolted cover.
- .3 Urinal(s): Wall access cleanout assemblies, each complete with a tapered plug, threaded brass insert, urethane rubber seal, and polished stainless-steel access cover with vandal-proof stainless-steel securing screw. Acceptable products are:
  - .1 Zurn #ZSS-1666-1;
  - .2 Jay R. Smith #SQ4-1819;
  - .3 Mifab #C1440-RD;
  - .4 Watts Industries (Canada) Ltd. #CO-440.

## 2.5 CLEANOUTS – VEHICLE BAY

- .1 Epoxy-coated cast iron floor cleanout with adjustable gasketed extra heavy duty stainless steep top, and removable gas tight gasketed brass cleanout plug. Suitable for live loads up to 10,000 pounds.
  - .1 Acceptable products:
    - .1 Watts CO-1200-RX;
    - .2 Or approved equal.

## 2.6 FLOOR CLEANOUT TERMINATIONS

- .1 Factory finished cast iron terminations, each adjustable and complete with a cast iron body with neoprene sleeve, solid, gasketed, polished nickel-bronze scoriated top access cover to suit the floor finish, a seal plug, and captive, vandal-proof, stainless steel securing hardware.
- .2 MIFAB or equal J.R. Smith, Watts or Zurn, of the following types (Contractor to choose applicable type. Selection of bronze or stainless finishes by Architect. Refer also to drawings.)

- .1 Provide on floor areas except as noted below, MIFAB C1100-R-1-34, round nickel bronze, or C1100-R-3-34, round stainless steel access cover.
- .2 Provide on vinyl tile floor areas, MIFAB C1100-TS-1-34, square nickel bronze, or C1100-TS-3-34, square stainless steel access cover.
- .3 Provide on ceramic tile, quarry tile or terrazzo floor areas, MIFAB C1100-US-1-34, square nickel bronze, or C1100-US-3-34, square stainless steel recessed access cover.
- .4 All floor cleanouts shall be complete with adjustable top assemblies, cast iron frames, primary gasket seals and secondary plugs.
- .5 Floor cleanouts installed in water-proofed areas shall be revised to MIFAB C1100C type supplied with clamp collar and weep holes.
- .6 Provide at the base of each vertical stacks MIFAB C1450 or C1460.
- .7 Provide on exposed walls, accessible pipe chases and outside grade, MIFAB C1450.
- .8 Provide on plaster walls, MIFAB C1450-RD-6.
- .9 Provide at urinals, MIFAB C1440-RD-6 with round stainless steel access cover and neoprene plug.
- .10 In plastic piping (where not terminating through building finishes), provide plastic cleanouts.
- .11 Access doors shall be provided as specified elsewhere in the specification.
- .3 Acceptable products are:
  - .1 Zurn # ZN-1602-SP Series;
  - .2 Jay R. Smith #4020-F-C Series;
  - .3 Mifab # as noted above
  - .4 Watts Industries (Canada) Ltd. # CO-200-R-1.

## **2.7 INTERIOR HOSE BIBBS**

- .1 Flush-Concealed: Recessed, 92 mm (3 5/8") deep, recessed, encased wall hydrant with lockable bronze or stainless-steel box with hinged cover identified "WATER", bronze interior parts, a screwdriver operated stop in the supply, key operated control valve, 20 mm (3/4") dia. hose connection, and a vacuum breaker. Acceptable products are:
  - .1 Jay R. Smith #5509QT-CL-SAP;
  - .2 Zurn #Z1350;
  - .3 Mifab #MHY-55.
- .2 Semi-Recessed - Finished Areas: Anti-siphon type, 100 mm (4") deep hose bib with stainless steel face with operating key, bronze interior parts, 20 mm (3/4") dia. solder inlet, 20 mm (3/4") dia. hose connection, and integral vacuum breaker. Acceptable products are:
  - .1 Jay R. Smith #5619-SAP-98;
  - .2 Zurn #Z1333 "ECOLOTROL";
  - .3 Mifab #MHY-30. HOSE BIBS
- .3 Surface - Exposed – Cold Water -Unfinished Areas: Brass or bronze hose bibb with hose end vacuum breaker. Acceptable products are:
  - .1 Watts Industries (Canada) Inc. #SC8-1;

- .2 Zurn/Wilkins # Z1341 with hose end vacuum breaker;
- .3 Chicago Faucets #293-E27CP;
- .4 Jay R. Smith #5609QT-SAP.
- .4 Exposed – Unfinished Areas – Hot and Cold Water: Mixing faucet for surface mounting. Acceptable products are:
  - .1 Delta Commercial #28T8083;
  - .2 Zurn #Z841L1-RC;
  - .3 Jay R. Smith #5560QT-LB-SAP.

## **2.8 EXTERIOR NON-FREEZE WALL HYDRANTS**

- .1 Flush-Concealed: Recessed, encased, self-draining hydrants, each complete with a copper casing, operating rod assembly to suit the wall thickness, polished nickel bronze box with hinged locking cover, 20 mm (¾") dia. threaded hose connection outlet, vacuum breaker, and a loose tee handle operating key. Acceptable products are:
  - .1 Jay R. Smith #5519-98;
  - .2 Zurn #Z1320;
  - .3 Mifab #MHY-26.

## **2.9 BACKWATER VALVES**

- .1 Heat bonded powder epoxy coated cast iron in-line type, each complete with a bolted and gasketed cover, bronze flapper, stainless steel extension, and stainless-steel hardware. Acceptable products are:
  - .1 Zurn #Z-1095-15-MJ;
  - .2 Jay R. Smith #7022.

## **2.10 WATER HAMMER ARRESTORS**

- .1 Piston type, sealed, pressurized water hammer arrestors suitable for either horizontal or vertical installation, each complete with a hard-drawn copper body, "O"-ring piston seals, an air charge, and an inlet opening equal to the diameter of the pipe in which the arrestor is required. Acceptable products are:
  - .1 Zurn #Z1705;
  - .2 Precision Plumbing Products Inc. #SC;
  - .3 Watts Industries (Canada) Inc.;
  - .4 Mifab MWH Series.

## **2.11 OIL INTERCEPTOR**

- .1 Oil interceptor with extra heavy duty cover and extension as required. Acceptable products are:
  - .1 Watts Drainage OI-525-X

## **2.12 THERMOSTATIC MIXING VALVES**

- .1 Chrome plated cast brass body, stainless steel or copper alloy bellows, integral temperature adjustment, check valve on inlets, volume control shut-off valve on outlet, stem thermometer on outlet and strainer stop checks on inlets.
- .1 Watts or equal manufacturer.

## **2.13 BACKFLOW PREVENTER**

- .1 Reduced pressure zone dual check valve design backflow preventers in accordance with CAN/CSA B64 (including supplements), each of bronze or epoxy coated cast iron bronze fitted construction depending on size, and complete with inlet strainer, inlet and outlet shut-off valves, an intermediate relief valve, ball valve type test cocks, and a proper air gap fitting. Acceptable products are:
  - .1 Watts Industries #009QT-S for 12 mm (½") size, #909QT-S for 20 mm to 50 mm (¾" to 2") size, and #909-NRS-S for 65 mm (2½") and larger size;
  - .2 Zurn/Wilkins 975XL and 375 Series;
  - .3 Conbraco Industries Inc. Series 40-200;
  - .4 Danfoss Flomatic Corp. Series RPZ. SUMPS

## **PART 3- EXECUTION**

### **3.1 INSTALLATION**

- .1 Roof Drains
  - .1 Supply roof drains and place roof drain bodies in position for flashing into roof construction as part of the roofing work. Connect with piping and provide accessories.
  - .2 Protect roof drains from damage and entrance of debris until roofing work is complete and refinish any areas where the cast iron factory finish has been damaged or removed, including rusted areas.
- .2 Floor Drains
  - .1 Provide floor drains where shown on the drawings. Confirm the exact location of drains prior to roughing in.
  - .2 Equip each drain with a trap.
  - .3 In equipment rooms and similar areas, exactly locate floor drains to suit the location of mechanical equipment and equipment indirect drainage piping. In washrooms, exactly locate floor drains to avoid interference with toilet partitions.
  - .4 Temporarily plug and cover floor drains during construction procedures. Remove plugs and covers during final cleanup work and when requested, demonstrate free and clear operation of each drain. Replace any damaged grates and refinish any areas of the drain where the cast iron finish has been damaged or removed, including rusted areas.
- .3 Cleanouts
  - .1 Provide cleanouts in drainage piping in locations as follows:



- .1 in the building drain or drains as close as possible to the inner face of the outside wall, and, if a building trap is installed, locate the cleanout on the downstream side of the building trap;
  - .2 at or as close as practicable to the foot of each drainage stack;
  - .3 at maximum 15 m (50') intervals in horizontal pipe 100 mm (4") dia. and smaller;
  - .4 at maximum 30 m (100') intervals in horizontal pipe larger than 100 mm (4") dia.;
  - .5 in the wall at each new urinal or bank of urinals in a washroom;
  - .6 wherever else shown on the drawings.
- .2 Cleanouts are to be the same diameter as the pipe in piping to 100 mm (4") dia., and not less than 100 mm (4") dia. in piping larger than 100 mm (4") dia.
- .3 Where cleanouts in vertical piping are concealed behind walls or partitions, install the cleanouts near the floor and so that the cover is within 25 mm (1") of the finished face of the wall or partition.
- .4 Floor Cleanout Terminations
  - .1 Where cleanouts occur in horizontal inaccessible underground piping, extend the cleanout TY fitting up to the floor, and provide a cleanout termination set flush with the finished floor.
  - .2 In waterproof floors, ensure that each cleanout termination is equipped with a flashing clamp device. Cleanout terminations are to suit the floor finish.
  - .3 Where cleanout terminations occur in finished areas, confirm locations prior to rough-in and arrange piping to suit.
  - .4 Ensure that cleanout termination covers in tiled floor are square in lieu of round.
- .5 Hose Bibbs
  - .1 Provide hose bibbs where shown and/or specified on the drawings.
  - .2 Unless otherwise shown, specified, or required, mount hose bibbs approximately 1 m (3') above the floor. Confirm exact locations prior to roughing-in.
- .6 Exterior Non-Freeze Wall Hydrants
  - .1 Provide non-freeze wall hydrants where shown.
  - .2 Install hydrants level and plumb such that hose outlets are approximately 600 mm (2') above grade level. Confirm exact locations prior to roughing-in.
  - .3 Provide a shut-off valve inside the building to each exterior non-freeze wall hydrant.
  - .4 Provide sign "Non potable water – do not drink"
- .7 Backwater Valves
  - .1 Provide backwater valves in drainage piping where shown on the drawings and connect with piping as indicated.
- .8 Water Hammer Arrestors
  - .1 Provide accessible water hammer arrestors in domestic water piping in locations as follows:
    - .1 in headers at groups of plumbing fixtures;
    - .2 at the top of risers;
    - .3 at ends of long horizontal runs of piping;

- .4 in piping connecting solenoid valves or equipment with integral solenoid valves;
- .5 wherever else shown or required by Code.
- .2 Install each unit in a piping tee either horizontally or vertically in the path of potential water shock in accordance with the manufacturer's published instructions and details.
- .9 Thermostatic Mixing Valves
  - .1 Provide a domestic hot water thermostatic mixing valves at DHW tanks and as required by local code.
  - .2 Adjust each valve to design requirements and check and test operation. Set maximum temperature limit stops.
- .10 Backflow Preventers
  - .1 Provide a backflow preventer on incoming DCW incoming service and in each direct domestic cold water connection to equipment other than plumbing fixtures and fittings. Backflow preventers are not required at fixtures connected to non-potable water.
  - .2 Locate each backflow preventer on floor or wall between 765 mm and maximum 1.5 m (30" and 60") above the floor such that it is easily accessible for maintenance and testing. Equip each backflow preventer with an air gap fitting and pipe the reduced pressure zone water outlet to drain.
  - .3 Test operation of each backflow preventer in accordance with requirements of CAN/CSA B64 by personnel certified for such testing by governing authorities, and submit signed test results and a properly and clearly identified and marked inspection and test record card for each backflow preventer.

**END OF SECTION**

## **PART 1- GENERAL**

### **1.1 GENERAL REQUIREMENTS**

- .1 Read and be governed by conditions of the *Contract Documents*, including sections of Division 01.

### **1.2 SUMMARY**

- .1 Section Includes
  - .1 Water closets.
  - .2 Urinals.
  - .3 Lavatories.
  - .4 Sinks.
  - .5 Service sinks.
  - .6 Showers.
  - .7 Eye wash fountains.
  - .8 Emergency showers.

### **1.3 SUBMITTALS**

- .1 Shop Drawings / Product Data
  - .1 Submit shop drawings / product data for all plumbing fixtures and fittings that confirm the proposed products meet all requirements of this Section. Provide catalogue illustrations of fixtures, sizes, rough-in dimensions.
- .2 Maintenance Material Submittals
  - .1 Section 01 78 40: Maintenance and extra material requirements.
  - .2 Spare Parts: Supply two (2) sets of faucet washers, flush valve service kits.

## **PART 2- PRODUCTS**

### **2.1 GENERAL: PLUMBING FIXTURES AND FITTINGS**

- .1 Plumbing fixtures and fittings shall be in accordance with the requirements of CAN/CSA B45 Series, General Requirements for Plumbing Fixtures, including all supplements.
- .2 Supply and install all barrier-free fixtures and fittings in accordance with governing code requirements.
- .3 All vitreous china, porcelain enameled, and acrylic fixtures shall be white unless otherwise specified.
- .4 All fittings and exposed piping shall be chrome plated and polished unless otherwise specified.
- .5 All fitting shall be vandal-proof unless located in a private washroom.
- .6 Fixture carriers shall be suitable for the fixture they support and the wall construction in which they are installed.

- .7 Floor flanges for floor mounted water closets shall be cast iron or brass construction and shall be secured to the floor to prevent movement. Furnish with wax seal and brass or stainless steel nuts, bolts, and washers. Plastic floor flanges are not acceptable.
- .8 Exposed traps for fixtures not equipped with integral traps shall be fitted with adjustable chrome plated cast brass 'P' traps complete with cleanouts. Provide minimum 17 gauge, chrome plated tubular extension complete with chrome escutcheon.
- .9 Concealed traps for fixtures not equipped with traps shall be cast brass complete with cleanout plugs.
- .10 Exposed fixture supplies for fixtures not equipped with integral stops shall be solid chrome plated brass angle valves with loose key stops for public areas and wheel stops for private areas, flexible stainless steel risers and stainless steel or chrome plated steel escutcheons.
- .11 Concealed fixture supplies for fixtures not equipped with integral stops shall be as specified with the water piping.

## **2.2 PLUMBING FIXTURES AND FITTINGS**

- .1 Provide plumbing fixtures and fittings as listed on Drawings.

## **PART 3- EXECUTION**

### **3.1 EXAMINATION**

- .1 Verify existing conditions before starting work.
- .2 Verify that walls and floor finishes are prepared and ready for installation of fixtures.
- .3 Verify that electric power is available and of the correct characteristics.
- .4 Confirm that millwork is constructed with adequate provision for the installation of counter top lavatories and sinks.

### **3.2 PREPARATION**

- .1 Rough-in fixture piping connections to minimum sizes indicated Drawings for the respective fixture. Confirm exact location of all plumbing fixtures and trim prior to roughing in. Refer to architectural plans and elevations for mounting heights.

### **3.3 INSTALLATION**

- .1 Install to manufacturer's written instructions.
- .2 Install each fixture with trap, easily removable for servicing and cleaning.
- .3 Install components level and plumb.
- .4 Install and secure fixtures in place with wall carriers and bolt, washer, nut fasteners.
- .5 Install barrier free fixtures in compliance with governing codes.
- .6 Supply templates for all counter-mounted fixtures and trim to the trades responsible for cutting the counters. Verify openings are properly located.
- .7 Seal fixtures to wall and floor surfaces with sealant as specified in Section 07 92 00, colour to match fixture.

- .8 Solidly attach water closets to floor with lag screws. Lead flashing is not intended hold fixture in place.
- .9 Located control panels for electronic faucets under lavatories and recessed into the wall. Coordinate location and installation with electrical trades who will provide power to the panels. Install cord from faucet in flexible conduit from the faucet to the control box. Make complete hot, cold, and tempered water connections and set mixing valve temperature limit stops to 43°C (110°F). Verify each controller is functioning properly and water shuts off after 3 seconds from deactivation.
- .10 Locate electronic flush valve transformers in the ceiling space above the flush valves being served. Coordinate location and installation with electrical trades who will provide power to the panels. Provide low voltage wiring from the controller to each electronic flush valve. All line and low voltage wiring shall be concealed. Maintain access to transformer for servicing.
- .11 Protect bathtubs and shower bases from damage during construction until final clean. Pack concealed voids under bathtubs with mineral wool insulation.
- .12 Confirm exact showerhead and mixing valve locations with architect prior to roughing in.
- .13 Provide roughed-in water and drain connections for Owner-supplied dishwasher consisting of a 13mm (1/2") domestic hot water connections with valve as specified with the water piping, complete with a water hammer arrestor, a 40mm (1-1/2") diameter DWV copper drain connection with 'P' trap and cleanout plug.
- .14 Provide roughed-in water and drain connections for Owner-supplied clothes washer consisting of a recessed supply box with supply valves and waste drain equal to Oatey Metal 20 gauge steel laundry box complete with 13mm (1/2") piping connections for both hot and cold water terminated at a 1/4 turn brass hammer ball valve, a 50mm (2") drain opening to receive clothes washer discharge pipe.

### **3.4 INTERFACE WITH OTHER PRODUCTS**

- .1 Review millwork shop drawings. Confirm location and size of fixtures and openings before rough-in and installation.

### **3.5 ADJUSTING**

- .1 Adjust stops or valves for intended water flow rate to fixtures without splashing, noise, or overflow.

### **3.6 CLEANING**

- .1 Clean installed work.
- .2 Clean plumbing fixtures and equipment.

### **3.7 PROTECTION OF FINISHED WORK**

- .1 Protect installed work.
- .2 Do not permit use of fixtures.

**END OF SECTION**

## **PART 1- GENERAL**

### **1.1 GENERAL REQUIREMENTS**

- .1 Read and be governed by conditions of the *Contract Documents*, including sections of Division 01.

### **1.2 SUMMARY**

- .1 Section Includes
  - .1 Water heaters.
  - .2 Anti-scale system.
  - .3 Expansion tanks.
  - .4 Pumps.
- .2 Related Sections
  - .1 Section 20 05 00 – Mechanical General Provisions.
  - .2 Section 22 10 00 – Plumbing Piping.
  - .3 Section 22 41 01 – Plumbing Specialties.
  - .4 Section 22 42 02 – Plumbing Fixtures.

### **1.3 SUBMITTALS**

- .1 Shop Drawings / Product Data
  - .1 Submit shop drawings/product data sheets for all products specified in this Section.

## **PART 2– PRODUCTS**

### **2.1 FUEL FIRED DOMESTIC WATER HEATER**

- .1 Acceptable Manufacturers:
  - .1 A.O.Smith – Model No. BTH 120 (A) (Natural Gas) – Cyclone MXi, 95% thermal efficiency
  - .2 Lochinvar
  - .3 Rheem
- .2 Minimum 95% efficiency.
- .3 Direct-vented.
- .4 Maximum hydrostatic working pressure of 160 psi.
- .5 Modulating gas burner that automatically adjusts the input based on demand.
- .6 Powered anodes that are non sacrificial and maintenance free.
- .7 Seamless glass-lined steel tank construction with glass lining applied to all water-side surfaces after the tank has been assembled and welded.
- .8 Meets thermal efficiency and/or standby loss requirements of NRCan and ASHRAE 90.1.
- .9 Have foam insulation and CSA certified and ASME rated T&P relief valve.

- .10 Be approved for 0" clearance to combustibles.
- .11 The control shall be an integrated solid-state temperature and ignition control device with integral diagnostics, graphic user interface, fault history display, and shall have digital temperature readout.

## **2.2 ANTI-SCALE SYSTEM**

- .1 Manufacturer: Watts Model OF1665-75 (75 GPM).
- .2 Equivalent products by other manufacturers.

## **2.3 DIAPHRAGM TYPE EXPANSION TANKS**

- .1 Construction: Fixed diaphragm construction expansion tank, designed, stamped and constructed to ASME BPVC-Section VIII Division 1, complete with:
  - .1 system connection, air charging valve, and an oxide primer finish;
  - .2 heavy-duty butyl NSF/ANSI 61 diaphragm;
  - .3 for use in closed, potable water systems;
  - .4 pressure rating: 1034 kPa (150 psi) at 93°C (200°F);
  - .5 sizes as per the drawing schedule.
- .2 Manufacturers:
  - .1 Amtrol "Therm-X-Trol";
  - .2 ITT Bell & Gossett;
  - .3 S.A Armstrong Ltd.

## **2.4 HOT WATER RECIRCULATING PUMPS**

- .1 EC motor, variable-speed, wet-rotor circulator, corrosion resistant casing with materials suitable for potable water.
- .2 Acceptable Manufacturers:
  - .1 Taco
  - .2 Wilo
  - .3 Or approved equal

# **PART 3- EXECUTION**

## **3.1 INSTALLATION**

- .1 Gas fired Domestic Water Heaters
  - .1 Provide electric domestic water heaters where shown.
  - .2 Secure the heater in place, level and plumb, on a concrete housekeeping pad, and:
    - .1 pipe the temperature/pressure relief valve outlet to drain;
    - .2 pipe the drain valve outlet to drain;

- .3 coordinate installation with the electrical trade who will connect the heater with power wiring.
  - .3 Provide and set a thermostatic mixing valve to produce 48.8°C (120°F) hot water.
  - .4 Provide heat traps in the water piping feed to the domestic hot water system. The trap shall consist of an arrangement of pipe fittings, such as elbows, connected so that the piping makes vertically upward runs just before turning downward to connect to the domestic hot water system.
- .2 Expansion tanks
  - .1 Charge the tank to the required pressure for proper system operation.
  - .2 Secure the tank in place, level and plumb.
  - .3 Provide isolation and drain valves and pressure gauge on connection piping.
- .3 Hot Water Recirculating Pumps
  - .1 Provide electric hot water recirculating pumps where shown.
  - .2 Secure the pump in place horizontally inside the finish millwork and below the height of the fixture served by the pump.
  - .3 Connect the shut-off flanges to the recirculating pump and the supply tees to the shut-off flanges with flexible supply lines.
  - .4 Provide vibration isolation pads or spring hangers for pump.
  - .5 Coordinate installation with the electrical trade who will connect the heater with power wiring.
  - .6 Install the manual start button in a location approved by the Consultant.
- .4 Equipment and System Manufacturer's Certification:
  - .1 Refer to the article entitled Equipment and System Manufacturer's Certification in the mechanical work Section entitled Mechanical Work General Instructions.
- .5 Start-Up:
  - .1 Refer to the article entitled Equipment and System Start-up in the mechanical work Section entitled Mechanical Work General Instructions.
- .6 Demonstration and Training:
  - .1 Refer to the article entitled Equipment and System O&M Demonstration & Training in the mechanical work Section entitled Mechanical Work General Instructions. Include for a one-half day on-site operation demonstration and training session. The training is to be a full review of all components including but not limited to a full operation and maintenance demonstration, with abnormal events.

**END OF SECTION**



## **PART 1 GENERAL**

### **1.1 GENERAL REQUIREMENTS**

- .1 Read and be governed by conditions of the Contract Documents, including sections of Division 01.

### **1.2 SUMMARY**

- .1 Section Includes
  - .1 Flexible pipe connectors.
  - .2 Expansion joints and compensators.
  - .3 Pipe loops, offsets, and swing joints.
- .2 Related Sections
  - .1 Section 21 11 00 - Fire Protection Piping.
  - .2 Section 22 10 00 - Plumbing Piping.
  - .3 Section 23 23 00 - Refrigerant Piping And Specialties.

### **1.3 PERFORMANCE REQUIREMENTS**

- .1 Provide structural work and equipment required to control expansion and contraction of piping. Verify that anchors, guides, and expansion joints provided, adequately protect system.
  - .1 Expansion Calculations:
    - .1 Installation Temperature: <10 degrees C (50 degrees F).
    - .2 Hot Water Heating: 99 degrees C (210 degrees F).
    - .3 Domestic Hot Water: 60 degrees C (140 degrees F).
    - .4 Safety Factory: 30%.

### **1.4 SUBMITTALS FOR REVIEW**

- .1 Flexible Pipe Connectors: Indicate maximum temperature and pressure rating, face-to-face length, live length, hose wall thickness.
- .2 Expansion Joints: Indicate maximum temperature and pressure rating, and maximum expansion compensation.

### **1.5 SUBMITTALS FOR INFORMATION**

- .1 Design Data: Indicate selection calculations.
- .2 Installation Data: Indicate special procedures, and external controls.

### **1.6 CLOSEOUT SUBMITTALS**

- .1 Record Documentation: Record actual locations of flexible pipe connectors, expansion joints, anchors, and guides Installation Data: Indicate special procedures, and external controls.
- .2 Maintenance Data: Include adjustment instructions.

## **1.7 QUALITY ASSURANCE**

- .1 Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum [three (3)] years [documented] experience.
- .2 Design expansion compensating system under direct supervision of a Professional Structural Engineer experienced in design of this Work and licensed at the place where the Project is located.

## **PART 2 PRODUCTS**

### **2.1 FLEXIBLE PIPE CONNECTORS**

- .1 High Temperature:
  - .1 Double braided, heat resistant, up to 200°C bronze braid, up to 230°C stainless steel braid.
  - .2 Chemically inert and resistant to steam and moisture.
  - .3 Capacity to absorb 150 mm with length across flexible portion not less than six diameters.
  - .4 Manufacturers:
    - .1 Anaconda, Flexonics

### **2.2 EXPANSION JOINTS**

- .1 Stainless Steel Bellows Type:
  - .1 For axial, lateral or angular movements. Bellows type, corrugated, packless.
  - .2 Designed for maximum operating pressure and temperature of 2068 kPa and 200°C.
  - .3 Internal stainless steel guide sleeves. External machined cast-iron control rings, full circumference. With external guide rods and flanged ends.
  - .4 Manufacturers
    - .1 Adsko, Anaconda, Flexonics, Hydro-Flex, Tube Turns, United Flexible, Vibra-Flo.

### **2.3 EXPANSION COMPENSATORS**

- .1 Copper Pipe Expansion Compensator - Low Pressure
  - .1 Bronze or stainless-steel convoluted bellows.
    - .1 suitable for 415 kPa working pressures.
    - .2 19 mm to 32 mm diameter, suitable for 12 mm compression and 6.0 mm extension.
  - .2 Steel Pipe Expansion Compensator.
    - .1 Factory assembled unit, with stainless steel or phosphor bronze in carbon steel casing. Antitorque groove in casing, internal pipe guide at both ends, full length internal liner. Suitable for 1,034 kPa operating pressure. Suitable for 38 mm compression and 6.0 mm extension.
    - .2 Acceptable Products:
      - .1 Adsko Manufacturing Corporation
      - .2 Senior Flexonics Canada
      - .3 Flextech Industries Incorporated
      - .4 Hydroflex Hose Limited

.5 Metraflex Piping System Solutions

**2.4 ACCESSORIES**

- .1 Anchors:
  - .1 Anchors shall be fabricated from mild steel plate and structural steel angle and channel
  - .2 sections, in accordance with ANSI B.31
  - .3 Anchors shall securely attach piping to structural members. Size anchors to accommodate forces due to pipe expansion and weight.
  - .4 Where bolts secure anchor to structure, weld bolts to plate. Arrange anchors so that bolts are in shear not in tension.
  - .5 Provide anchors on both sides of expansion devices, as indicated on drawings, and as required to control flexing of the piping system

**PART 3 EXECUTION**

**3.1 INSTALLATION**

- .1 Install to manufacturer's written instructions.
- .2 Ensure that piping is properly aligned through expansion joint, over full travel.
- .3 Be aware of temperature when expansion compensator is installed to properly establish the length
- .4 Locate expansion joint centrally between anchors and position guides to Manufacturer's specific
- .5 requirement. Provide structure as required to properly mount guides
- .6 Construct spool pieces to exact size of flexible connection for future insertion.
- .7 Install flexible pipe connectors on pipes connected to equipment supported by vibration isolation. Provide line size flexible connectors.
- .8 Install flexible connectors at right angles to displacement. Install one end immediately adjacent to isolated equipment and anchor other end. Install in horizontal plane unless indicated otherwise.
- .9 Rigidly anchor pipe to building structure where necessary. Provide pipe guides so movement is directed along axis of pipe only. Erect piping such that strain and weight is not on cast connections or apparatus.
- .10 Provide support and equipment required to control expansion and contraction of piping. Provide loops, pipe offsets, and swing joints, or expansion joints where [required] [indicated].
- .11 Provide victaulic piping with minimum one joint per 25 mm (1 inch) pipe diameter instead of flexible connector supported by vibration isolation. Victaulic piping need not be anchored.
- .12 Provide expansion loops as indicated on drawings.

**3.2 MANUFACTURER'S FIELD SERVICES**

- .1 Provide inspection services by flexible pipe manufacturer's representative for final installing and certify installation is to manufacturer's recommendations and connectors are performing satisfactorily.

**END OF SECTION**

## **PART 1- GENERAL**

### **1.1 GENERAL REQUIREMENTS**

- .1 Read and be governed by conditions of the *Contract Documents*, including sections of Division 01.

### **1.2 SUMMARY**

- .1 Section Includes
  - .1 Pressure gauges and Pressure gauge taps.
  - .2 Thermometers and thermometer wells.
  - .3 Test plugs and kits.
  - .4 Static pressure gauges.

### **1.3 REFERENCES**

- .1 Reference Standards
  - .1 ASME B40.100-2013 - Pressure Gauges and Gauge Attachments.
  - .2 ASTM E1-13 - Standard Specification for ASTM Liquid-in-Glass Thermometers.
  - .3 ASTM E77-07 - Standard Test Method for Inspection and Verification of Thermometers.

### **1.4 SUBMITTALS**

- .1 Submittals for review
  - .1 Submit shop drawings in accordance with Section 20 05 00 – Mechanical General Provisions.
  - .2 Product Data: Submit manufacturer's instructions, printed product literature and data sheets for thermometers and pressure gauges and include product characteristics, performance criteria, physical size, finish and limitations.
- .2 Close-Out Submittals
  - .1 Operation and Maintenance Data: Submit maintenance data including monitoring requirements for incorporation into manuals

### **1.5 ENVIRONMENTAL REQUIREMENTS**

- .1 Do not install instrumentation when areas are under construction, except for required rough-in, taps, supports and test plugs.

### **1.6 DELIVERY, STORAGE, AND HANDLING**

- .1 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .2 Storage and Handling Requirements:
  - .1 Store thermometers and pressure gauges off ground indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

- .2 Store and protect thermometers and pressure gauges from nicks, scratches, and blemishes.
- .3 Replace defective or damaged materials with new.

## **PART 2– PRODUCTS**

### **2.1 PRESSURE GAUGES**

- .1 Manufacturers:
  - .1 H. O. Trerice Co.
  - .2 Weiss Instruments
  - .3 Ashcroft
- .2 Gauges:
  - .1 Adjustable, glycerine filled, 100 mm or 115 mm (4" or 4½") diameter, complete with a type 304 stainless steel case with relief valve and polished stainless steel bayonet, stainless steel rotary movement with stainless steel bushings and socket, a clear acrylic window, a dual scale white dial with a scale range such that the working pressure of the system is at the approximate mid-point of the scale, and black pointer.
  - .2 Accuracy to be +/- 1% of full scale.
  - .3 On all pumps liquid filled gauges shall be utilized.
  - .4 A bronze ball type shut-off valve is to be provided in the piping to each pressure gauge.
  - .5 Each pressure gauge for piping and equipment with normal everyday flow is to be equipped with a brass pressure snubber.
  - .6 Materials regardless of specification shall be compatible with system requirements and media.
  - .7 Gauges shall have combined kPa and psi scales.
  - .8 All pressure gauges shall comply with the requirements outlined in ASME B40.1. Manufacturers shall provide valid CRN registration numbers for the appropriate governing province.
  - .9 Pressure gauges in fire protection piping must be ULC listed and labelled.

### **2.2 THERMOMETERS**

- .1 Manufacturers:
  - .1 H. O. Trerice Co.
  - .2 Weiss Instruments
  - .3 Ashcroft
- .2 Direct Reading Thermometers

- .1 Round, 125 mm (5") diameter, adjustable (90°) angle bimetal dial type thermometers, complete with a hermetically sealed stainless steel case with stainless steel ring, dampened bimetal coil, calibration adjustment screw, white aluminum dual scale dial with black and blue markings and a range such that the working temperature of the system is the approximate mid-point of the scale, black aluminum pointer, double strength glass window, 12 mm (½") NPT connection with 6.4 mm (¼") diameter stainless steel stem, and a suitable thermowell.
  - .2 Accuracy to be +/- 1% of full scale.
  - .3 Scale shall be suitable for 2 times the temperature range of service. Scale shall be combined Celsius and Fahrenheit.
  - .4 Thermometer shall be fully adjustable to provide full 360 degree positioning on the vertical axis and 180 degree rotation on the horizontal axis. The thermometer shall be able to be locked into any position along this arc.
  - .5 All thermometers and thermowells shall comply with all aspects of ASME B40.8 including internal thermowell dimensions.
- .3 Remote Reading Thermometers
- .1 Dial size shall be 4 ½" (112mm) with black and red markings.
  - .2 Casing shall be aluminum with polycarbonate lens.
  - .3 Pointer to be anodized black pointer.
  - .4 Internals shall be phosphor bronze tube, brass movement.
  - .5 Connection shall be brass 7/16" OD x 2" insertion depth brass bulb. Operating range shall be 75% of full scale range.
  - .6 Capillary length will be a minimum of 5 feet in length, with brass braiding to provide mechanical protection of the capillary.
  - .7 Provide with 5 feet of double braided bronze armor over copper capillary. Care shall be taken to ensure that the capillary tube is not located in areas of extreme temperatures.
  - .8 Provide with ½" NPT removable brass union connection. Thermometer shall be designed as a sealed system for easy replacement of the thermometer without the need for shut down or drain the system. A proper brass thermowell is required.
  - .9 Thermometer shall be gas filled accuracy to be 0.5% of full scale.
  - .10 All thermometers and thermowells shall comply with the requirements outlined in ASME B40.4.

## **2.3 THERMOWELLS**

- .1 Copper pipe: copper or bronze.
- .2 Steel pipe: brass.

## **2.4 THERMOMETER TEST WELLS**

- .1 ¾" NPT female connection brass test well.
- .2 Test well to be provided with cap and chain.
- .3 Test well to be provided for future installation of thermometer specified above.

## **PART 3- EXECUTION**

### **3.1 INSTALLATION**

#### **.1 Pressure Gauges:**

- .1 Provide in the following locations:
  - .1 In valved tubing across the suction, suction strainer (if applicable), and discharge piping of each circulating pump;
  - .2 In the supply and return piping connections to main mechanical plant equipment such as boilers, chillers, heat exchangers, main coils, etc.;
  - .3 In separate domestic hot water storage tank(s);
  - .4 In piping at each side of a pressure reducing valve;
  - .5 In potable water service piping downstream of the meter;
  - .6 Wherever else shown and/or specified on the drawings or in the Specification.
- .2 Install to manufacturer's written instructions.
- .3 For pressure gauges in piping at equipment locations, install the pressure gauge between the equipment and the first pipe fitting.
- .4 Locate, mount and adjust all instruments so they are easily readable from floor or platform.
- .5 Where gauges are located at high level or in an area where they cannot be easily seen, provide remote reading instruments.
- .6 Install gauge cocks for balancing purposes, elsewhere as indicated.
- .7 Use extensions where pressure gauges are installed through insulation.

#### **.2 Thermometers:**

- .1 Provide in the following locations:
  - .1 In supply and return piping connections to main mechanical plant equipment such as boilers, chillers, cooling towers, heat exchangers, main coils, etc., unless temperature indication is supplied with the equipment;
  - .2 Wherever else shown and/or specified on the drawings or in the Specification.
- .2 Install to manufacturer's written instructions.
- .3 Locate, mount and adjust all instruments so they are easily readable from floor or platform.
- .4 Where gauges are located at high level or in an area where they cannot be easily seen, provide remote reading instruments.
- .5 Install in wells on piping.
- .6 Thermometer shall be designed as a sealed system to allow for easy replacement of the thermometer without the need to shut down or drain the system.
- .7 Provide thermal grease in the well to ensure good heat transfer between the
- .8 thermometer probe and the well. Include heat conductive material inside well.
- .9 Install wells as indicated only for balancing purposes.
- .10 Use extensions where thermometers are installed through insulation.

#### **.3 Protection:**

- .1 Protect installed products and components from damage during construction.
- .2 Repair damage to adjacent materials caused by thermometer and gauge installation.

### **3.2 IDENTIFICATION**

- .1 Locate engraved lamaroid nameplate as specified in Section Identification, identifying medium adjacent to thermometers and gauges.

**END OF SECTION**



## **PART 1- GENERAL**

### **1.1 GENERAL REQUIREMENTS**

- .1 Read and be governed by conditions of the *Contract Documents*, including sections of Division 01.
- .2 Where requirements of this section contradict requirements of section 23 05 48 Sound and Vibration Controls for HVAC Piping and Equipment, section 23 05 48 shall govern.

### **1.2 SUMMARY**

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

### **1.3 SUBMITTALS**

- .1 Submittals for Review
  - .1 Product Data: Provide manufacturers catalogue data including load capacity.
  - .2 Shop Drawings: Indicate system layout with location and detail of trapeze hangers.

### **1.4 REGULATORY REQUIREMENTS**

- .1 Conform to applicable code for support of plumbing and hydronic piping.
- .2 Supports for Sprinkler Piping: To NFPA 13.
- .3 Supports for Standpipes: To NFPA 14.

## **PART 2- PRODUCTS**

### **2.1 PIPE HANGERS AND SUPPORTS**

- .1 Acceptable Manufacturers:
  - .1 E. Myatt & Co. Inc.;
  - .2 Anvil International Inc.;
  - .3 Empire Tool & Mfg. Co. Inc.;
  - .4 Hunt Manufacturing Ltd. ;
  - .5 Unistrut Canada Ltd.
  - .6 Nibco Inc. "Tolco";
  - .7 Taylor Pipe Supports.
- .2 Fire Protection Piping:
  - .1 Conform to NFPA 13 and NFPA 14.

- .2 Hangers for Pipe Sizes 13 to 38 mm: carbon steel, adjustable swivel, split ring.
- .3 Hangers for Pipe Sizes 50 mm and Over: Carbon steel, adjustable, clevis.
- .4 Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
- .5 Wall Support for Pipe Sizes to 80 mm: Cast iron hook.
- .3 Wall Support for Pipe Sizes 100 mm and Over: Welded steel bracket and wrought steel clamp.
  - .1 Vertical Support: Steel riser clamp.
  - .2 Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
  - .3 Copper Pipe Support: Carbon steel ring, adjustable, copper plated.
- .4 Plumbing Piping - DWV:
  - .1 Conform to ASME B31.9.
  - .2 Hangers for Pipe Sizes 13 to 38 mm: Carbon steel, adjustable swivel, split ring.
  - .3 Hangers for Pipe Sizes 50 mm and Over: Carbon steel, adjustable, clevis.
  - .4 Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
  - .5 Wall Support for Pipe Sizes to 80 mm: Cast iron hook.
  - .6 Wall Support for Pipe Sizes 100 mm and Over: Welded steel bracket and wrought steel clamp.
  - .7 Vertical Support: Steel riser clamp.
  - .8 Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
  - .9 Copper Pipe Support: Carbon steel ring, adjustable, copper plated.
- .5 Plumbing Piping - Water:
  - .1 Conform to ASME B31.9.
  - .2 Hangers for Pipe Sizes 13 to 38 mm: Carbon steel, adjustable swivel, split ring.
  - .3 Hangers for Cold Pipe Sizes 50 mm and Over: Carbon steel, adjustable, clevis.
  - .4 Hangers for Hot Pipe Sizes 50 to 100 mm: Carbon steel, adjustable, clevis.
  - .5 Hangers for Hot Pipe Sizes 150 mm and Over: Adjustable steel yoke, cast iron roll, double hanger.
  - .6 Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
  - .7 Multiple or Trapeze Hangers for Hot Pipe Sizes 150 mm and Over: Steel channels with welded spacers and hanger rods, cast iron roll.
  - .8 Wall Support for Pipe Sizes to 80 mm: Cast iron hook.
  - .9 Wall Support for Pipe Sizes 100 mm and Over: Welded steel bracket and wrought steel clamp.
  - .10 Wall Support for Hot Pipe Sizes 150 mm and Over: Welded steel bracket and wrought steel clamp with adjustable steel yoke and cast iron roll.
  - .11 Vertical Support: Steel riser clamp.
  - .12 Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

- .13 Floor Support for Hot Pipe Sizes to 100 mm: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
- .14 Floor Support for Hot Pipe Sizes 150 mm and Over: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.
- .15 Copper Pipe Support: Carbon steel ring, adjustable, copper plated.
- .6 Hydronic Piping:
  - .1 Conform to ASME B31.9.
  - .2 Hangers for Pipe Sizes 13 to 38 mm: Carbon steel, adjustable swivel, split ring.
  - .3 Hangers for Cold Pipe Sizes 50 mm and Over: Carbon steel, adjustable, clevis.
  - .4 Hangers for Hot Pipe Sizes 50 to 100 mm: Carbon steel, adjustable, clevis.
  - .5 Hangers for Hot Pipe Sizes 150 mm and Over: Adjustable steel yoke, cast iron roll, double hanger.
  - .6 Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
  - .7 Multiple or Trapeze Hangers for Hot Pipe Sizes 150 mm and Over: Steel channels with welded spacers and hanger rods, cast iron roll.
  - .8 Wall Support for Pipe Sizes to 80 mm: Cast iron hook.
  - .9 Wall Support for Pipe Sizes 100 mm and Over: Welded steel bracket and wrought steel clamp.
  - .10 Wall Support for Hot Pipe Sizes 150 mm and Over: Welded steel bracket and wrought steel clamp with adjustable steel yoke and cast iron roll.
  - .11 Vertical Support: Steel riser clamp.
  - .12 Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
  - .13 Floor Support for Hot Pipe Sizes to 100 mm: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
  - .14 Floor Support for Hot Pipe Sizes 150 mm and Over: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.
  - .15 Copper Pipe Support: Carbon steel ring, adjustable, copper plated.
- .7 Refrigerant Piping:
  - .1 Conform to ASME B31.5.
  - .2 Hangers for Pipe Sizes 13 to 38 mm: Carbon steel adjustable swivel, split ring.
  - .3 Hangers for Pipe Sizes 50 mm and Over: Carbon steel, adjustable, clevis.
  - .4 Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
  - .5 Wall Support for Pipe Sizes to 80 mm: Cast iron hook.
  - .6 Wall Support for Pipe Sizes 100 mm and Over: Welded steel bracket and wrought steel clamp.
  - .7 Vertical Support: Steel riser clamp.
  - .8 Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
  - .9 Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

## **2.2 ACCESSORIES**

- .1 Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.

## **2.3 INSERTS**

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

## **2.4 FLASHING**

- .1 Metal Flashing: 0.50 mm (26 ga) galvanized steel.
- .2 Metal Counterflashing: 0.80 mm (22 ga) galvanized steel.
- .3 Lead Flashing:
  - .1 Waterproofing: 24.5 kg/sq m (5 lb/sq ft) sheet lead.
  - .2 Soundproofing: 5 kg/sq (1 lb/sq ft) sheet lead.
- .4 Flexible Flashing: 1.2 mm (47 mil) thick sheet compatible with roofing.
- .5 Caps: Steel, 0.8 mm (22 ga) minimum; 1.5 mm (16 ga) at fire resistant elements.

## **2.5 EQUIPMENT CURBS**

- .1 Fabrication: Welded 1.2 mm (18 gauge) galvanized steel shell and base, mitred 80 mm (3 inch) cant, variable step to match root insulation 38 mm thick insulation, factory installed wood nailer.

## **2.6 SLEEVES**

- .1 Sleeves for Pipes Through Non-fire Rated Floors: 1.2 mm thick (18 gauge) galvanized steel.
- .2 Sleeves for Pipes Through Non-fire Rated Beams, Walls, Footings, and Potentially Wet Floors: Steel pipe or 1.2 mm thick (18 gauge) galvanized steel.
- .3 Sleeves for Pipes Through Fire Rated and Fire Resistive Floors and Walls, and Fire Proofing: Prefabricated fire rated sleeves including seals.
- .4 Sleeves for Round Ductwork: Galvanized steel.
- .5 Sleeves for Rectangular Ductwork: Galvanized steel or wood.
- .6 Firestopping Insulation: Glass fibre type, non-combustible.

# **PART 3- EXECUTION**

## **3.1 INSTALLATION**

- .1 Install components to manufacturer's written instructions.

## **3.2 INSERTS**

- .1 Provide inserts for placement in concrete formwork.
- .2 Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.

- .3 Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 100 mm.
- .4 Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
- .5 Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate recessed into slab.

### **3.3 PIPE HANGERS AND SUPPORTS**

- .1 Support horizontal piping as scheduled.
- .2 Install hangers to provide minimum 13 mm space between finished covering and adjacent work.
- .3 Place hangers within 300 mm of each horizontal elbow.
- .4 Use hangers with 38 mm minimum vertical adjustment.
- .5 Support horizontal cast iron pipe adjacent to each hub, with 1.5 m maximum spacing between hangers.
- .6 Support vertical piping at every floor. Support vertical cast iron pipe at each floor at hub.
- .7 Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
- .8 Support riser piping independently of connected horizontal piping.
- .9 Provide copper plated hangers and supports for copper piping.
- .10 Design hangers for pipe movement without disengagement of supported pipe.
- .11 Prime coat exposed steel hangers and supports [as specified in Section 09 91 10]. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

### **3.4 EQUIPMENT BASES AND SUPPORTS**

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

### **3.5 FLASHING**

- .1 Provide flexible flashing and metal counterflashing where piping and ductwork penetrate weather or waterproofed walls, floors, and roofs.
- .2 Flash vent and soil pipes projecting 80 mm minimum above finished roof surface with lead worked 25 mm minimum into hub, 200 mm minimum clear on sides with 600 x 600 mm sheet size. For pipes through outside walls, turn flanges back into wall and caulk, metal counterflash, and seal.
- .3 Flash floor drains in floors with topping over finished areas with lead, 250 mm clear on sides with minimum 910 x 910 mm sheet size. Fasten flashing to drain clamp device.
- .4 Seal floor drains and mop sink drains watertight to adjacent materials.

- .5 Provide acoustical lead flashing around ducts and pipes penetrating equipment rooms, installed to manufacturer's written instructions for sound control.
- .6 Provide curbs for mechanical roof installations 350 mm minimum high above roofing surface. Flash and counterflash with sheet metal; seal watertight. Attach counterflashing mechanical equipment and lap base flashing on roof curbs. Flatten and solder joints.
- .7 Adjust storm collars tight to pipe with bolts; caulk around top edge. Use storm collars above roof jacks. Screw vertical flange section to face of curb.

### 3.6 SLEEVES

- .1 Set sleeves in position in formwork. Provide reinforcing around sleeves.
- .2 Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.
- .3 Extend sleeves through floors 25 mm above finished floor level. Caulk sleeves.
- .4 Where piping or ductwork penetrates floor, ceiling, or wall, close off space between pipe or duct and adjacent work with fire stopping insulation and caulk air tight. Provide close fitting metal collar or escutcheon covers at both sides of penetration.
- .5 Install chrome plated steel escutcheons at finished surfaces.

### 3.7 SCHEDULES

PIPE SIZE	MAX. HANGER SPACING	DIAMETER
12 - 32 mm	2 m	9 mm
38 - 50 mm	3 m	9 mm
62 - 75 mm	3 m	13 mm
100 - 150 mm	3 m	15 mm
200 - 300 mm	4.25 m	22 mm
350 and over mm	6 m	25 mm
PVC (All Sizes)	1.8 m	9 mm
C.I. Bell and Spigot (or No-Hub) and at Joints	1.5 m	

**END OF SECTION**

## **PART 1 GENERAL**

### **1.1 GENERAL REQUIREMENTS**

- .1 Read and be governed by conditions of the *Contract Documents*, including sections of Division 01.

### **1.2 GENERAL INSTRUCTIONS**

- .1 OBC. This section covers design, supply, installation and inspection of complete SFRS (Seismic Force Resisting System) for all mechanical systems.
- .2 SFRS to be fully integrated into, compatible with noise and vibration controls in accordance with Section 23 05 48 – Sound and Vibration Control.
- .3 Provide restraint devices as required for isolated and non-isolated systems and equipment. Provide calculations to determine restraint loadings for all restrained systems and equipment resulting from seismic forces. Certification documents shall be signed and sealed by a Professional Engineer with at least 5 years experience in the design of seismic restraints.
- .4 The contractor shall utilize a supplier familiar/experienced with the design of seismic systems to provide a comprehensive package of isolation and seismic restraint for the project. Provide detailed shop drawings showing the proposed restraint system for all required equipment, piping and ductwork on the project. The shop drawings shall include calculations certified by a Professional Engineer with at least 5 years experience in the design of seismic restraints.
- .5 Seismic restraints are to be provided for all mechanical & non-structural components of building services in accordance with the current OBC and best practice guidelines:
  - .1 CSA Group (Canadian Standard Association) S832-14, Seismic risk reduction of operation and functional components (OFCs) of building
  - .2 SMACNA (Sheet Metal and Air-conditioning Contractors' National Association's) Seismic Restraint Manual Guidelines for Mechanical Systems (3rd ed.).
  - .3 ASHRAE (American Society for Heating, Refrigerating and Air-conditioning Engineers) A Practical Guide to Seismic Restraint; ASHRAE Applications Handbook, Seismic and Wind Restraint Design Chapter; ASHRAE Standard 171-2008: Methods of Test for Seismic restraints.
  - .4 VISCMA (The Vibration Isolation and Seismic Control Manufacturers Association) has developed Testing and Rating Standards for Seismic Restraint Components that comply with Code and ASHRAE based requirements.
- .6 Contractors on a project shall use a single manufacturer/ designer to provide and certify seismically rated isolators and restraints.
- .7 At the completion of the project, there shall be a review of the installations on site and a sealed written report, certifying that the installations have been completed in accordance with the specified design(s).

### **1.3 ENGINEERING PERFORMANCE REQUIREMENTS**

- .1 Specified design criteria for seismic and vibration for elements and components are to be designed to accommodate these specific calculation components factors:
  - .1 Design (Site Class) Soil Type: D
  - .2 **Importance Category: Post-disaster; Importance Factor, IE = 1.5**

- .2 Wind loads shall be based on the requirements of OBC.
- .3 All mechanical piping systems and equipment of the building is designated as essential and shall structurally resist the design forces of a seismic event. Mechanical systems are required to be operational after the seismic event.
- .4 It shall be understood that the requirements of this seismic restraint section are in addition to other requirements as specified elsewhere for the support and attachment of equipment and mechanical services, and for the vibration isolation of same equipment. Nothing on the project drawings or specifications shall be interpreted as justification to waive the requirements of this seismic restraint section or the other requirements.
  - .1 Seismic restraint systems shall be designed to offer seismic restraint in all directions, unless otherwise noted.
  - .2 Anchor types and sizes are to be per the design data as provided by the seismic restraint designer.
  - .3 Seismic restraint capacities, seismic cable restraint system, rod stiffener clamps to be verified by an independent test laboratory or certified by a registered design professional to ensure that the design intent of this specification is realized. Verification shall be by one of the following methods:
    - .1 a. An NRTL (National Recognized Testing Laboratory), or laboratory recommended by VISCMA.
    - .2 b. By a nationally recognized agency, such as VISCMA, that has reviewed and approved the restraint.
  - .4 It's the contractor's responsibility to ensure the seismic engineers' requirements have been met.

#### **1.4 SEISMIC SYSTEM DESIGN**

- .1 The seismic restraint designer shall be responsible for the selection of the attachment hardware as required to attach snubbers/restraints to both the equipment and supporting structure on vibration isolated equipment, or to directly attach equipment to the building structure for non-isolated equipment.
- .2 The contractor shall provide to the seismic restraint designer, a complete set of approved shop drawings of all equipment that is to be restrained, from which the selection and design of seismic restraint devices and/or attachment hardware will be completed. The shop drawings shall include, at a minimum, basic equipment layout, length and width dimensions, and installed operating weights of the equipment to be restrained.
- .3 All piping and ductwork is to be restrained to meet code requirements. At a minimum, the seismic restraint designer shall provide documentation on maximum restraint spacing for various restraint sizes and anchors, as well as "worst case" reaction loads for each restraint and/or anchor size.
- .4 The contractor shall ensure that all housekeeping pads used are adequately reinforced and are properly dowelled to the building structure, so as to withstand calculated seismic forces. In addition, the size & thickness of the housekeeping pad is to be coordinated with the seismic restraint designer to ensure that adequate edge distances & embedment depths exist in order to obtain the desired equipment anchor capacities.

#### **1.5 COORDINATION**



- .1 Coordinate size, shape, reinforcement and attachment of all housekeeping pads supporting vibration/seismically rated equipment. Concrete shall have a minimum compressive strength of 20 MPa minimum unless it is noted otherwise as requiring more.
- .2 Coordinate with vibration control and the structural engineer of record to locate and size structural supports underneath vibration/seismically restrained equipment (e.g. roof curbs, cooling towers and other similar equipment).
- .3 Coordinate with other trades for locations and compatibility.

## **1.6 SUBMITTALS**

- .1 All seismic / wind / vibration restraint systems shall be by a single Designer.
- .2 Product Data: Include Seismic Rating Data for each seismically rated isolator or restraint component.
- .3 Submit shop drawings for all devices specified herein. Submittals shall include device dimensions, placement, attachment(s) and anchorage requirements. Shop Drawings shall include the following:
  - .1 Design Calculations: Calculate the load requirements for all seismically rated vibration isolators and seismic restraints. Certification documents to be signed and sealed by a registered Professional Engineer with at least 5 years experience in the design of seismic restraint systems.
  - .2 Vibration Isolation Bases: Dimensional drawings including anchorage and attachment to structure and to supported equipment. Include auxiliary motor slides and rails, base weights, equipment static loads.
  - .3 Seismic-Restraint Details: Provide detailed submittal drawings of seismic restraints and snubbers. Show anchorage details and indicate quantity, diameter, and depth of penetration of anchors. Include load rating where appropriate.
  - .4 Equipment Manufacturer Seismic Qualification Certification: The Equipment Manufacturer must submit certification that each piece of provided equipment will withstand seismic forces identified in "Engineering Performance Requirements"; Include the following:
    - .1 Basis for Certification: Indicate whether the "withstand" certification is based on actual test of assembled components or on calculations.
    - .2 Indicate the equipment is certified to be durable enough to:
      - .1 structurally resist the design forces (non-essential equipment) and/or
      - .2 will remain functional after the seismic event (essential equipment).
- .4 Working drawings, schedules, materials lists, schematics and full specifications for all components of each SFRS to be provided. Design calculations are to include restraint loads resulting from seismic forces in accordance with OBC, detailed work sheets and tables as appropriate. Separate shop drawings for each SFRS and devices for each system or equipment are to be provided. Coordinate with building architect and structural engineer to provide project-specific fastening details. These drawings shall be designed and bear the signed stamp of a Professional Engineer.
- .5 Materials and systems specified herein and detailed or scheduled on the drawings are based upon materials manufactured by Kinetics Noise Control, Inc. Materials and systems provided by other manufacturers are acceptable, provided that they meet the requirements as listed in this specification.
- .6 Closeout submittals:

- .1 Maintenance data including monitoring requirements for incorporation into O&M manuals.

## **PART 2 PRODUCTS**

### **2.1 GENERAL**

- .1 Seismic Restraint System or Seismic Force Resisting System (SRS or SFRS) to provide gentle and steady cushioning action and avoid high impact loads.
- .2 SRS to restrain seismic forces in every direction.
- .3 Fasteners and attachment points to resist same load as seismic restraints.
- .4 SRS of Piping systems compatible with:
  - .1 Expansion, anchoring and guiding requirements.
  - .2 Equipment vibration isolation and equipment SRS.
- .5 SRS utilizing cast iron, threaded pipe, other brittle materials not permitted.
- .6 Attachments to reinforced concrete structure:
  - .1 Use high strength mechanical expansion anchors. Coordinate with structural engineer prior to work.
  - .2 Drilled or power driven anchors not permitted.
- .7 Wet pipe sprinkler systems
- .8 Dry pipe sprinkler systems
- .9 Seismic control measures not to interfere with integrity of fire stopping.

### **2.2 SRS FOR STATIC EQUIPMENT, SYSTEMS**

- .1 Floor-mounted equipment, systems:
  - .1 Anchor equipment to equipment supports.
  - .2 Anchor equipment supports to structure.
  - .3 Use size of bolts scheduled in approved shop drawings.
- .2 Suspended equipment, systems:
  - .1 Use one or combination of following methods:
    - .1 Install tight to structure.
    - .2 Cross-brace in every direction.
    - .3 Brace back to structure.
    - .4 Slack cable restraint system.
  - .2 SCS to prevent sway in horizontal plane, "rocking" in vertical plane, sliding and buckling in axial direction.
  - .3 Hanger rods to withstand compressive loading and buckling.

### **2.3 SRS FOR VIBRATION ISOLATED EQUIPMENT**

- .1 Floor mounted equipment, systems:
  - .1 Use one or combination of following methods:

- .1 Vibration/seismic spring floor mounts
- .2 Vibration/seismic Restrained Spring Isolators
- .3 Vibration/seismic modular restrained spring isolators
- .4 All direction neoprene isolator
- .5 Vibration isolators with built-in snubbers.
- .6 Vibration isolators and separate snubbers.
- .7 Other devices as required, reviewed and approved by Seismic Control Engineer
- .2 SRS to resist complete isolator unloading.
- .3 SRS not to jeopardize noise and vibration isolation systems. Provide 4-8 mm clearance between seismic restraint snubbers and equipment during normal operation of equipment and systems.
- .4 Cushioning action: gentle and steady by utilizing elastomeric material or other means in order to avoid high impact loads.
- .2 Suspended equipment, systems:
  - .1 Use one or combination of following methods:
    - .1 Slack cable restraint system.
    - .2 Brace back to structure via vibration isolators and snubbers.

## **2.4 SEISMIC RESTRAINTS**

- .1 Use one or combination of following methods as required:
  - .1 Seismic cable restraints
  - .2 Hanger rod stiffeners
  - .3 Seismic beam clamps
  - .4 Seismic restraint brackets
  - .5 Seismic snubbers
  - .6 Concrete anchor bolts

## **2.5 MANUFACTURERS**

- .1 Acceptable Manufacturers:
  - .1 Kinetics Noise Control, Inc.
  - .2 Vibro-Acoustics
  - .3 Mason Industries.

## **PART 3 EXECUTION**

### **3.1 GENERAL**

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

- .2 Coordinate size, shape, reinforcement and attachment of all housekeeping pads supporting vibration/seismically rated equipment. Concrete shall have a minimum compressive strength of 20 MPa (3,000 psi) or as specified by the project engineer. Coordinate size, thickness, doweling, and reinforcing of concrete equipment housekeeping pads and piers with vibration isolation and seismic restraint device manufacturer to ensure adequate space, embedment and prevent edge breakout failures. Pads and piers must be adequately doweled into structural slab. Housekeeping Pads must be adequately reinforced and adequately sized for proper installation of equipment anchors. Refer to seismic restraint manufacturer's written instructions.
- .3 Coordinate with vibration/seismic restraint manufacturer and the structural engineer of record to locate and size structural supports underneath vibration/seismically restrained equipment (e.g. roof curbs, cooling towers and other similar equipment). Installation of all seismic restraint materials specified in this section shall be accomplished as per the manufacturer's written instructions. Adjust isolators and restraints after piping systems have been filled and equipment is at its operating weight, following the manufacturer's written instructions.
- .4 Isolated and restrained equipment, duct and piping located on roofs must be attached to the structure. Supports (e.g., sleepers) that are not attached to the structure will not be acceptable.
- .5 Attach piping to the trapeze per seismic restraint manufacturer's design. Install cables so they do not bend across sharp edges of adjacent equipment or building structures.
- .6 Do not brace or support equipment to separate portions of the structure that may act differently in response to an earthquake. For example, do not connect a Transverse restraint to a wall and then a Longitudinal restraint to either a floor/ceiling/roof at the same braced location.
- .7 Install vertical braces to stiffen hanger rods and prevent buckling per seismic restraint manufacturer's design. Clamp vertical brace to hanger rods. Requirements apply equally to hanging equipment. Do not weld vertical braces to hanger rods.

### **3.2 SEISMIC RESTRAINTS APPLICATION**

- .1 All equipment, piping and ductwork shall be restrained to resist seismic forces per the applicable building code(s) as a minimum.
- .2 Install seismic restraint devices per the designer's submittals. Any deviation from the manufacturer's instructions shall be reviewed and approved by the manufacturer.
- .3 Attachment to structure for suspended equipment, pipe and duct: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members with a seismic wedge anchor rated for the concrete tension zone.
- .4 Provide hanger rod stiffeners where indicated or as required to prevent buckling of rods due to seismic forces.
- .5 Ensure housekeeping pads have adequate space to mount equipment and seismic restraint devices and shall also be large enough and thick enough to ensure adequate edge distance and embedment depth for restraint anchor bolts to avoid housekeeping pad breakout failure.

### **3.3 CONCRETE ANCHOR BOLTS**

- .1 Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid pre-or post-tensioned tendons, electrical and telecommunications conduit, and gas lines.
- .2 Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.

- .3 Mechanical Anchors: Protect threads from damage during anchor installation.
- .4 Adhesive Anchors: Clean holes to remove loose material and drilling dust per manufactures instructions prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
- .5 Set anchors to manufacturer's recommended torque, using a torque wrench.

### **3.4 EQUIPMENT RESTRAINTS:**

- .1 Seismically restrain equipment as indicated on the schedule by the Seismic Control Engineer. Install fasteners, straps and brackets as required to secure the equipment.
- .2 As indicated on the schedule, install seismic snubbers on HVAC equipment supported by floor-mounted, non-seismic vibration isolators. Position snubbers as necessary and attach to equipment base and supporting structure as required.
- .3 Install neoprene grommet washers or fill the gap with epoxy on equipment anchor bolts where clearance between anchor and equipment support hole exceeds 3.2 mm (0.125 inch).
- .4 Suspended Equipment: All suspended equipment that meets any of the following conditions requires seismic restraints as specified by the supplier:
  - .1 Rigidly attached to pipe or duct that is 75 lbs. and greater,
  - .2 Items hung independently or with flexible connections greater than 20 lbs.
  - .3 Wall mounted equipment weighing more than 20 lbs.
  - .4 The 12" rule does not apply to suspended equipment.
- .5 Base Mounted Equipment: All base mounted equipment that meets any of the following conditions requires attachments and seismic restraints as specified the supplier:
  - .1 Connections to or containing hazardous material,
  - .2 With an overturning moment,
  - .3 Weight greater than 400 lbs.,
  - .4 Mounted on a stand 4 ft. or more from the floor.
- .6 Rigid Mounted Equipment:
  - .1 Anchor floor and wall mounted equipment to the structure as per the stamped seismic certifications / drawings.
  - .2 Suspended equipment shall be restrained using seismic cable restraints, or struts, and hanger rods as per the stamped seismic certifications / drawings.
- .7 Vibration Isolated Equipment:
  - .1 Seismic control shall not compromise the performance of noise control, vibration isolation or fire stopping systems.
  - .2 Equipment supported by vibration-isolation hangers shall be detailed and installed with approximately a 1/8" gap between the isolation hangers and the structure. Isolators at restraint locations must be fitted with uplift limit stops.

### **3.5 PIPING; DUCT; ELECTRICAL SYSTEMS:**

- .1 All piping, duct electrical systems are to be restrained to meet code requirements.

- .1 Seismically restrain / brace all pipes 76 mm (3") in nominal diameter and larger.
- .2 Seismically restrain / brace all exposed piping (not hidden behind suspended ceilings) 32 mm (1 1/4") in nominal diameter and larger.
- .3 Seismically restrain / brace all Gas (ie: natural gas, medical gas, vacuum, petroleum based liquid, compressed air, etc.) piping 25 mm (1") in nominal diameter and larger.
- .4 Branch lines may not be used to brace main lines.
- .2 Restraint Spacing For Piping:
  - .1 For ductile piping: Transverse supports a maximum of 12 m (40') o.c.
  - .2 For ductile piping: Longitudinal supports a maximum of 24 m (80') o.c.
  - .3 For non-ductile piping (e.g., cast iron, PVC) space Transverse supports a maximum of 6 m (20') o.c., and Longitudinal supports a maximum of 12 m (40') o.c. Differential spacing can be designed depending upon pipe size and length(s) of run (design will be indicated on drawings of approved method).
  - .4 For piping with hazardous material inside (e.g., natural gas, medical gas) space Transverse supports a maximum of 6 m (20') o.c., and Longitudinal supports a maximum of 12 m (40') o.c.
  - .5 For pipe risers, restrain the piping at floor penetrations using the same spacing requirements as above.
- .3 Seismically restrain per specific code requirements, all ductwork listed below (unless otherwise indicated on the drawings), using seismic cable restraints (Ductwork not meeting listed below criteria is to be "Exempt"):
  - .1 All ducts with cross sectional area equal to or greater than 0.55 m<sup>2</sup> (6 ft<sup>2</sup>).
  - .2 All round ducts with diameters equal to or greater than 710 mm (28").
  - .3 All ductwork weighing more than 25 kg/m (17 lb/ft).
- .4 Restraint Spacing For Ductwork:
  - .1 Transverse supports a maximum of 9 m (30') o.c.
  - .2 Longitudinal supports a maximum of 18 m (60') o.c.
- .5 Seismically restrain per specific code requirements all Electrical (including controls and data) components listed below (unless otherwise indicated on the drawings), using seismic cable restraints:
  - .1 Seismically restrain all conduit 76 mm (3") in nominal diameter and larger. Single supported conduit is restrained in the same fashion as single clevis supported pipe.
  - .2 Seismically restrain all conduit, bus ducts, or cable trays that are supported on trapeze bars, that have been assigned a Component Importance Factor equal to {1.5}, and that have a total weight greater than 10 lb/ft (146 N/m). This total weight includes not only the conduit, bus duct, or cable trays, but also includes the trapeze bars as well.
- .6 The electrical contractor / engineer are to provide the weight per unit length for cable trays and bus duct.
- .7 Single supported conduit and trapeze supported conduit, bus duct, and cable trays to be seismically restrained in a manner similar to pipe and duct.
  - .1 Conduit: Follow piping spacing requirements and required criteria as listed in Section 3.3.5..2

- .2 Bus Ducts and Cable Trays: Follow duct spacing requirements and required criteria as listed

in section 3.3.5..4

- .8 The seismic restraint components may be intended to be used with suspended single supported conduit and trapeze supported conduit, cable trays, and bus ducts depending on the manufacturer. Components intended to both support and restrain distribution systems such as wall mounted conduit, cable trays, and bus ducts will need to be designed and evaluated for both the dead weight load and the design horizontal seismic load.
- .9 To ensure that the seismic forces are transferred properly to the restraint points, the cables should be strapped either individually or in bundles to the cable tray at regular intervals. It is necessary for the conduit, bus ducts, and cable trays to be attached to the trapeze bars sufficiently to resist the design horizontal seismic forces, both transverse (T) and longitudinal (L).
- .10 Brace a change of direction longer than 3.7 m (12').
- .11 This specification does not allow the use of the "12-inch rule" where the piping, duct and electrical may be exempted from seismic restraint based on the length of the support rods provided that the rods are not subjected to bending moments.
- .12 Install restraint cables so they do not bend across edges of adjacent equipment or building structure. Tie back to structure at 45 degrees to the structure.
- .13 Longitudinal restraints for single pipe supports shall be attached rigidly to the pipe, not to the pipe hanger.
- .14 For supports with multiple pipes (trapezes), secure pipes to trapeze member with clamps approved for application.
- .15 Install flexible metal hose loops in piping which crosses building seismic joints, sized for the anticipated amount of movement. Coordinate any new wetted component of the piping system with Mechanical Engineer prior to order with a clear shop drawing submittal indicating it is for seismic restraint purposes.
- .16 Install flexible piping connectors where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment. Coordinate any new wetted component of the piping system with Mechanical Engineer prior to order with a clear shop drawing submittal indicating it is for seismic restraint purposes.
- .17 Where pipe sizes reduce below required dimensions noted above in Sentence .3.E.1, the final restraint shall be installed at the transition location.
- .18 Where duct sizes reduce below required dimensions noted above in Section 3.E.3, the final restraint shall be installed at the transition location.
- .19 Longitudinal restraints for single conduit supports shall be attached rigidly to the pipe, not to the pipe/conduit hanger.
- .20 For supports with multiple conduits (trapezes), secure conduit to trapeze member with clamps approved for application.
- .21 Where conduit, bus ducts, cable trays sizes reduce below required dimensions noted above in Section 3.E.5, the final restraint shall be installed at the transition location.
- .22 Rod Stiffener Clamps are required where the hanger rod exceeds the maximum length shown in the seismic calculation sheets. They are only required at restraint locations.
- .23 Seismically Rated Beam Clamps are required where welding to or penetrations to steel beams are not approved.



- .24 Adjust restraint cables so that they are not visibly slack. Cable not to support weight during normal operation.
- .25 Seismic systems are to be compatible with requirements for anchoring and guiding of systems.
- .26 Drilled or power driven anchors or fasteners shall not be permitted for use with seismic control measures.
- .27 Friction due to gravity does not constitute a seismic attachment.
- .28 Seismic restraint connections are not to be connected to the bottom chord of steel joists or the bottom flange of steel beams.
- .29 Standard beam clamps can be used to support restrained components; they cannot be used to connect the seismic restraint to the structure – only for the hanger rods.
- .30 Brace remaining piping, ductwork, electrical components to code requirements OBC and in conformance with SMACNA (Sheet Metal and Air Conditioning Contractors National Association, Inc.) “Seismic Restraint Manual Guidelines for Mechanical Systems”, 3rd ed.

### **3.6 INSPECTION AND CERTIFICATION**

- .1 The contractor shall notify the local representative of the seismic restraint materials manufacturer prior to installing any seismic restraint devices. The contractor shall seek the representative's guidance in any installation procedures with which he/she is unfamiliar.
- .2 The contractor shall notify the local representative of the seismic restraint materials manufacturer 30% through the listed project for inspection of any vibration and seismic restraint devices already installed. A typed written report of any installation errors, improperly selected devices, or other fault in the system which could affect the performance of the system shall be documented by the representative and distributed to General contractor and Consultant team. The report shall include clear sketches as required. The contractor shall perform all steps that are required from this written report to properly complete the vibration and seismic restraint work as per the specifications. The contractor shall provide written response to each issue/item identified in the report, noting how the corrections have been made, and distribute the response.
- .3 The contractor shall notify the local representative of the seismic restraint materials manufacturer after completing installation of all vibration and seismic restraint devices already installed. The manufacturer representative shall provide an inspection report certifying compliance with Seismic Control Engineer's design and manufacturer installation requirements.
- .4 The installing contractor shall submit a report to the building architect and/or engineer, including the manufacturer's representative's final report, indicating that all seismic restraint material has been properly installed, or steps that are to be taken by the contractor to properly complete the seismic restraint work as per the specifications. Only include the following paragraph if a manufacturer actually publishes installation instructions - many do not. If the manufacturer does NOT publish such a document, ensure all install criteria that is important to the project, is specified below.

**END OF SECTION**

## **PART 1 GENERAL**

### **1.1 GENERAL REQUIREMENTS**

- .1 Read and be governed by conditions of the *Contract Documents*, including sections of Division 01.

### **1.2 SUMMARY**

- .1 Section Includes
  - .1 Materials and requirements for the identification of piping systems, duct work, valves and controllers, including the installation and location of identification systems.

### **1.3 REFERENCES**

- .1 Reference Standards
  - .1 Canadian Gas Association (CGA)
  - .2 CSA/CGA B149.1-10, Natural Gas and Propane Installation Code.
  - .3 Canadian General Standards Board (CGSB)
  - .4 CAN/CGSB-24.3-[92], Identification of Piping Systems.
  - .5 National Fire Protection Association (NFPA)
  - .6 NFPA 13-2010, Standard for the Installation of Sprinkler Systems.
  - .7 NFPA 14-2010, Standard for the Installation of Standpipe and Hose Systems
  - .8 ASME A13.1-2007 - Scheme for the Identification of Piping Systems.

### **1.4 SUBMITTALS**

- .1 Submittals for review
  - .1 Submit shop drawings in accordance with Section 20 05 00 – Mechanical General Provisions.
  - .2 Product Data: Provide paint colour chips and manufacturers catalogue literature for each product required.
  - .3 Identification Information:
    - .1 Submit list of wording, symbols, letter size, and colour coding for mechanical identification.
    - .2 Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.

## **PART 2 PRODUCTS**

### **2.1 EQUIPMENT IDENTIFICATION**

- .1 Manufacturer's Nameplates
  - .1 Provide metal nameplate on each piece of equipment, mechanically fastened with raised or recessed letters.
  - .2 Include Underwriters' Laboratories Canada (ULC) or Canadian Standards Association (CSA) registration logos and those of other agencies, as required by respective agencies.

- .3 Manufacturer's nameplates shall indicate Manufacturer's name, equipment model, size, serial number and electrical characteristics and pertinent information for any other service connections.
- .4 Locate nameplates so that they are easily read. Do not insulate or paint over plates.
- .2 System Nameplates:
  - .1 Each piece of equipment shall be identified with its equipment schedule identification, e.g. supply fan SF-1, cooling coil CC-1, pump P-1.
  - .2 Wording is generally to be as per the drawings, i.e. Fan EF-1, and is to include equipment service and building area/zone served.
  - .3 Submit list of nameplates for review prior to engraving.
  - .4 Minimum 1.6 mm (1/16") thick 2-ply laminated coloured plastic plates, minimum 12 mm x 50 mm (½" x 2") for smaller items such as damper motors and control valves, minimum 25 mm x 65 mm (1" x 2½") for equipment, and minimum 50 mm x 100 mm (2" x 4") for control panels and similar items.
  - .5 Unless otherwise specified or required, each nameplate is to be white, complete with bevelled edges and black engraved wording to completely identify the equipment and its use with no abbreviations.
  - .6 All plates shall be secured using stainless steel screws or pop rivets.
  - .7 As an alternate, it is acceptable to tag smaller equipment with machine-printed self-adhesive labels.

## 2.2 PIPING IDENTIFICATION

- .1 Each piping system shall be colour coded for identification and labelled with system identification code letters, including temperature and pressure, if applicable, and directional flow arrow in accordance with Pipe Identification Colour Schedule and with CGSB 24-GP-3a.
- .2 Standard pipe identification is to be equal to Smillie McAdams Summerlin Ltd. or Brady vinyl plastic with indoor/outdoor type vinyl ink lettering and directional arrows with a UV vinyl inhibitor, as follows:
  - .1 For pipe to and including 150 mm (6") diameter, coiled type snap-on markers of a length to wrap completely around the pipe or pipe insulation;
  - .2 For pipe larger than 150 mm (6") diameter, saddle type strap-on markers with 2 opposite identification locations and complete with nylon cable ties.
  - .3 Identification labels must use an adhesive that is compatible with surface temperature.
- .3 Identification wording and colours for pipe identification materials are to be as follows:

Pipe Service	Identification Colour	Legend
Domestic cold water	Green	DOM. COLD WTR
Domestic hot water supply	Green	DOM. HW SUPPLY
Domestic hot water recirculation	Green	DOM. HW RECIRC.
Tempered domestic water	Green	TEMP. DOM. WTR
Non-potable water	Purple	NON POT. WTR.

Storm drainage	Green	STORM
Pipe Service	Identification Colour	Legend
Sanitary drainage	Green	SAN
Plumbing vent	Green	SAN. VENT
Natural Gas, High Pressure	Yellow	NAT. GAS – 2 PSIG
Natural Gas	Yellow	NAT. GAS – 9-14 INWC.
Fire protection sprinklers	Red	F.P. SPRINKLER
Condensate	Yellow	COND
Refrigerant suction	Yellow	REFRIG. SUCTION
Refrigerant liquid	Yellow	REFRIG. LIQUID

- .4 Colours for pipe identification legends and directional arrows are to be as follows:

Identification Colour	Legend & Arrow Colour
Yellow	Black
Green	White
Red	White
Purple	White

- .5 Letter heights shall be as follows:

O.D. Range	Letter Height
3/8" to 5/8"	1/4"
3/4" to 1 1/4"	1/2"
1 1/8" to 2 3/8"	3/4"
2 1/2" to 6"	1 1/4"
6" to 10"	1 3/4"
10" to 18"	2 1/2"
Over 18"	3 1/2"

## 2.3 BURIED PIPING IDENTIFICATION/MARKERS

- .1 Metallic Pipe: Provide continuously printed 100 mm wide, 4 Mil thick blaze orange plastic tape with printing indicating type of service of buried pipe. Place tape at ±300 mm above buried pipe in backfill lifts.
- .2 Non-Metallic Piping: Provide detectable multi-ply tape consisting of aluminum foil core between two layers of 100 mm wide x 4 Mil blaze orange plastic tape with printing indicating type of service of buried pipe. Place tape at ±300 mm above buried pipe in backfill lifts.

- .3 Where multiple small pipes are buried in a common trench and does not exceed an overall width of 450 mm, install a single tape line marker.

## 2.4 DUCT IDENTIFICATION

- .1 Vinyl plastic similar to piping identification, or custom made with Mylar stencils with 50 mm (2") high lettering to accurately describe the duct service, i.e. "AHU-1 SUPPLY", complete with a directional arrow 150 mm long x 50 mm, and coloured ink with ink pads and roller applicators. Ink colour is generally to be black but must contrast with the lettering background.

## 2.5 VALVE AND CONTROLLER TAGS

- .1 Provide valve identification tags and secure them using non-ferrous chain, braided band or plastic band (suitable for temperature). Tags may be of brass, aluminum, metalphoto, lamicaid or fibreglass, stamped or engraved, of 25 mm minimum diameter.
- .2 Valves to be tagged include:
  - .1 Valves on main piping circuits.
  - .2 Valves on major branch lines.
  - .3 Valves on minor branch lines in horizontal service spaces, vertical service spaces and mechanical equipment rooms.
  - .4 DO NOT TAG valves on control valve stations, steam trap stations, fixture stops, or system drain valves.
  - .5 Drain valves and hose bibbs on systems containing glycol.
  - .6 Control valves
- .3 Schedule valve numbers using sequential numbering system indicating location, service and the normal position (open or closed). Numbers shall be prefixed by letter "P" or letter "H" indicating valve is on plumbing or heating service.
- .4 Provide Consultant with six (6) identification flow diagrams of approved size for each system. Include tag schedule, designating number, service, function, and location of each tagged item and normal operating position of valves.
- .5 Install where directed one (1) copy of flow diagram and valve schedule mounted in glazed frame. Provide one (1) copy in each operating and maintenance instruction manual.

## 2.6 CEILING ACCESS IDENTIFICATION

- .1 Secure 6.0 mm self-adhesive coloured dots (Brady Quik Dots or Avery Data Dots) to ceiling to identify location of access to equipment concealed above ceiling, according to the following schedule:

	Colour
Concealed equipment and cleaning access	Yellow
Control Equipment, including control valves, dampers and sensors	Black
Fire and smoke dampers	Red
Fire protection, including sprinkler equipment and drains	Red

Heating/Chilled water, DCW, DHW isolation valves	Green
Pipe mounted equipment, other than fire, smoke and sprinkler equipment	Green

- .2 When T-bar ceilings are installed, adhere coloured dots to T-bar framing, adjacent to panel to be removed.

## **PART 3 EXECUTION**

### **3.1 PREPARATION**

- .1 Degrease and clean surfaces to receive adhesive for identification materials.
- .2 Comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

### **3.2 TIMING**

- .1 Provide identification only after painting specified (Section 09 90 00 – Painting) has been completed.

### **3.3 INSTALLATION**

- .1 Perform work in accordance with CAN/CGSB-24.3 except as specified otherwise.
- .2 Nameplates:
  - .1 Nameplates for equipment suspended above floor level or generally not within easy viewing from floor level are to be increased in size so as to be easily readable from floor level.
  - .2 Fasten nameplates securely in conspicuous place, on cool surfaces. Where nameplates cannot be mounted on cool surface, provide standoffs.
  - .3 Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.
  - .4 Do not paint, insulate or cover.
- .3 Piping Identification:
  - .1 Locate markers and classifying colors on piping systems so they can be seen from floor or platform.
  - .2 Locations:
    - .1 Identify piping runs at least once in each room.
    - .2 Maximum 50 ft (15 m) between identifications in open areas.
    - .3 Both sides where piping passes through walls, partitions and floors.
    - .4 At point of entry and leaving, where piping is concealed in pipe chase or other confined space, and at each access opening.
    - .5 At start and end points of runs and at each piece of equipment.
    - .6 At major manual and automatic valves immediately upstream of valves.
    - .7 Identify branch, equipment or area served after valve.
- .4 Duct Identification:

.1 Locations:

- .1 Maintain maximum 50 ft (15 m) distance between markings.
- .2 Identify ducts each side of dividing walls or partitions and beside each access door.
- .3 Stencil on plenum doors, downstream from air filter bank, "Do not open when fan operating."
- .4 Identify ductwork in mechanical equipment rooms to denote system and/or zone served and air flow direction arrow.
- .5 Identify automatic control dampers concealed in ductwork. Identify "open" and "closed" position of operator arm on outside of duct or duct insulation.

.2 Stencil over final finish only.

.5 Valve and Controller Tags

- .1 Install tags with corrosion resistant chain or closed "S" hooks.

### **3.4 CLEANING**

- .1 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

**END OF SECTION**

## **PART 1- GENERAL**

### **1.1 GENERAL REQUIREMENTS**

- .1 Read and be governed by conditions of the *Contract Documents*, including sections of Division 01.

### **1.2 SUMMARY**

- .1 Application
  - .1 This Section specifies mechanical system testing, adjusting, and balancing requirements that are common to mechanical work Sections of the Specification and it is a supplement to each Section and is to be read accordingly.
- .2 Section Includes
  - .1 Testing, adjustment, and balancing of air systems.
  - .2 Testing, adjustment, and balancing of hydronic systems.
  - .3 Measurement of final operating condition of HVAC systems.
  - .4 Sound measurement of equipment operating conditions.
  - .5 Vibration measurement of equipment operating conditions.
- .3 Purpose
  - .1 Test to verify proper and safe operation, determine actual point of performance, evaluate qualitative and quantitative performance of equipment, systems and controls at design, average and low loads using actual or simulated loads
  - .2 Adjust and regulate equipment and systems to meet specified performance requirements and to achieve specified interaction with other related systems under normal and emergency loads and operating conditions.
  - .3 Balance systems and equipment to regulate flow rates to match load requirements over full operating ranges.

### **1.3 REFERENCES**

- .1 Definitions
  - .1 TAB: Means testing, adjusting and balancing to determine and confirm quantitative performance of equipment and systems and to regulate the specified fluid flow rate and air patterns at the terminal equipment, e.g., reduce fan speed, throttling, etc.
  - .2 Air systems: Includes all outside air, supply air, return air, exhaust air, and relief air systems
  - .3 Hydronic systems: Includes heating water, chilled water, glycol-water solution, condenser water, and any similar system.
  - .4 Flow rate tolerance: Means the allowable percentage variation, minus to plus, of actual flow rate values in the Contract Documents.
  - .5 Report forms: Means test data sheets arranged for collecting test data in logical order for submission and review, and these forms, when reviewed and accepted, should also form the permanent record to be used as the basis for required future testing, adjusting and balancing.



- .6 Terminal: Means the point where the controlled fluid enters or leaves the distribution system, and these are supply inlets on water terminals, supply outlets on air terminals, return outlets on water terminals, and exhaust or return inlets on air terminals such as registers, grilles, diffusers, louvers, and hoods.
- .7 Main: Means the duct or pipe containing the system's major or entire fluid flow.
- .8 Submain: Means the duct or pipe containing part of the systems' capacity and serving two or more branch mains.
- .9 Branch main: Means duct or pipe servicing two or more terminals.
- .10 Branch: Means duct or pipe serving a single terminal.

#### 1.4 SUBMITTALS

- .1 Submittals for Information
  - .1 Submit name of adjusting and balancing agency for approval within thirty (30) days after award of Contract.
  - .2 Submit sample test forms, if other than those standard forms prepared by the Associated Air Balance Council (AABC) or National Environmental Balancing Bureau (NEBB) are proposed for use.
- .2 Construction Submittals
  - .1 Drawing Evaluation: Submit a report by the Agency to indicate the Agency's evaluation of the mechanical drawings with respect to service routing and location, or lack of balancing devices. The set of drawings and mark-ups used by the Agency to prepare the report shall be included.
  - .2 Field Reports: Submit a report after each site visit made by the Agency during the construction phase of the project.
- .3 Close-Out Submittals
  - .1 Draft Report: Submit a draft report, as specified in Part 3 of this Section.
  - .2 Final Report: Submit a final report, as specified in Part 3 of this Section.
  - .3 Warranty: Submit a testing and balancing warranty, as specified in Part 3 of this Section.
  - .4 Post-Construction Site Visit Reports: Submit reports listing observations and results of post-construction site visits, as specified in Part 3 of this Section.

#### 1.5 QUALITY ASSURANCE

- .1 Qualifications of Tab Personnel
  - .1 The independent testing, adjusting, and balancing agency shall meet the qualifications specified below, and be the single source of responsibility to test, adjust, and balance the building mechanical systems to produce the design objectives. The testing, adjusting and balancing agency is to have successfully completed testing, adjusting and balancing of mechanical systems for a minimum of five projects similar to this Project within the past three years, and is to be certified as an independent agency in all required categories by one of the following:
    - .1 AABC - Associated Air Balance Council;

- .2 NEBB - National Environmental Balancing Bureau;
- .2 Standards
  - .1 Testing, adjusting and balancing of the complete mechanical systems is to be performed over the entire operating range of each system in accordance with one of the following publications:
    - .1 National Standards For A Total System Balance published by the Associated Air Balance Council;
    - .2 Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems published by the National Environmental Balancing Bureau;
    - .3 Chapter 37, Testing, Adjusting, and Balancing of ASHRAE Handbook HVAC Applications.

## **PART 2- PRODUCTS**

### **2.1 INSTRUMENTS**

- .1 Instruments for TAB of air and hydronic systems shall have been calibrated within six months and verified for accuracy before start of work.
- .2 Submit list of equipment to be used for balancing and calibration certificates for each instrument listed.

## **PART 3 - EXECUTION**

### **3.1 SCOPE OF WORK**

- .1 Perform total mechanical systems testing, adjusting, and balancing. Requirements include measurement and establishment of the fluid quantities of the mechanical systems as required to meet design specifications and comfort conditions and recording and reporting the results.
- .2 Mechanical systems to be tested, adjusted and balanced include:
- .3 Heating Systems: TAB of heating systems is to include all piping and equipment fluid temperatures, flows and control, and if TAB is not done during the heating season, a follow-up site visit during the heating season will be required to confirm proper flows and temperatures, and any required system "fine tuning".
- .4 Cooling Systems: TAB of cooling systems is also to include all piping and equipment fluid temperatures, flows and control, and if TAB is not done during the cooling season, a follow-up site visit during the cooling season will be required to confirm proper flows and temperatures, and any required system "fine tuning".
- .5 Air Handling Systems: TAB of air handling systems is to include all equipment and ductwork air temperatures, capacities and flows.

### **3.2 GENERAL REQUIREMENTS**

- .1 As soon as possible after award of Contract, the Agency is to carefully examine a white print set of mechanical drawings with respect to routing of services and location of balancing devices, and is to issue a report listing the results of the evaluation.

- .2 The set of drawings examined by the Agency is to be returned with the evaluation report, with red line mark-ups to indicate locations for duct system test plugs, and required revision work such as relocation of balancing devices and locations for additional devices.
- .3 After review of the mechanical work drawings and specification, the Agency is to visit the site at frequent, regular intervals during construction of the mechanical systems, to observe routing of services, locations of testing and balancing devices, workmanship, and anything else that will affect testing, adjusting and balancing.
- .4 After each site visit, the Agency is to report results of the site visit indicating the date and time of the visit, and detailed recommendations for any corrective work required to ensure proper adjusting and balancing.
- .5 Testing, adjusting and balancing is not to begin until:
  - .1 Building construction work is substantially complete and doors have been installed;
  - .2 Mechanical systems are complete in all respects, and have been checked, started, adjusted, and then successfully performance tested.
- .6 All mechanical systems to be tested, adjusted and balanced are to be maintained in full, normal operation during each day of testing, adjusting and balancing;
- .7 Obtain copies of reviewed shop drawings of all applicable mechanical plant equipment and terminals, and temperature control diagrams and sequences;
- .8 The Agency is to walk each system from the system "head end" equipment to terminal units to determine variations of installation from design, and the system installation trades shall accompany the Agency;
- .9 The Agency is to check all valves and dampers for correct and locked position, and temperature control systems for completeness of installation before starting equipment;
- .10 Wherever possible, the Agency is to lock all balancing devices in place at the proper setting, and permanently mark settings on all devices;
- .11 For belt-driven equipment, the Agency is to report to the Commissioning Agent who in turn is to inform the Contractor and Consultant of any situation where sheaves have to be replaced to suit testing and balancing, and replacements are to be done by the Contractor at no cost;
- .12 The Agency is to balance all systems with due regard to objectionable noise which is to be a factor when adjusting fan speeds and performing terminal work such as adjusting air quantities, and should objectionable noise occur at the design conditions, the Agency is to immediately report the problem and submit data, including sound readings, to permit an accurate assessment of the noise problem to be made;
- .13 The Agency is to check all supply air handling system mixing plenums for stratification, and where the variation of mixed air temperature across coils is found to be in excess of plus or minus 5 percent of design requirements, the Agency is to report the problem and issue a detail sketch of plenum baffle(s) required to eliminate the stratification;
- .14 Filters for all air handling systems equipped with air filters, test and balance the systems with simulated 50% loaded (dirty) filters by providing a false pressure drop;
- .15 Test, adjust and balance air conditioning systems during the summer season and heating systems during winter season, including at least a period of operation at outside conditions within 2.8°C (5°F) wet bulb temperature of maximum summer design condition, and within 5.5°C (10°C) dry bulb temperature of minimum winter design condition, and take final temperature readings during seasonal operation.

- .16 Mechanical Contractor to provide all required parts, belts and adjustments for all systems as deemed necessary to complete the required balancing.
- .17 Mechanical Contractor shall provide the required assistance to the TAB Contractor as deemed necessary by the Consultant.

### **3.3 EXAMINATION**

- .1 Verify that systems are complete and operable before commencing work. Ensure the following conditions:
  - .1 Systems are started and operating in a safe and normal condition.
  - .2 Temperature control systems are installed complete and operable.
  - .3 Proper thermal overload protection is in place for electrical equipment.
  - .4 Final filters are clean and in place. If required, install temporary media in addition to final filters.
  - .5 Duct systems are clean of debris.
  - .6 Fans are rotating correctly.
  - .7 Fire and volume dampers are in place and open.
  - .8 Air coil fins are cleaned and combed.
  - .9 Access doors are closed and duct end caps are in place.
  - .10 Air outlets are installed and connected.
  - .11 Duct system leakage is minimized.
  - .12 Hydronic systems are flushed, filled, and vented.
  - .13 Pumps are rotating correctly.
  - .14 Proper strainer baskets are clean and in place.
  - .15 Service and balance valves are open.
- .2 Submit field reports. Report defects and deficiencies noted during performance of services which prevent system balance.
- .3 Beginning of work means acceptance of existing conditions.

### **3.4 PREPARATION**

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

### **3.5 TOLERANCES**

- .1 Application Tolerances:
  - .1 Do TAB to following tolerances of design values:
    - .1 HVAC systems: plus 5%, minus 5%

.2 Hydronic systems: plus 5%, minus 5%

.2 Accuracy Tolerances:

.1 Measured values accurate to within plus or minus 2% of actual values

### **3.6 TESTS**

- .1 Give written 24 hour written notice of date for tests.
- .2 Do not externally insulate or conceal work until tested and approved. Follow construction schedule and arrange for tests.
- .3 Conduct tests in presence of Consultant. Arrange for Owner's Representative to be present.
- .4 Bear costs including retesting and making good.
- .5 Refer to Piping Sections for specific test requirements.
- .6 Prior to tests, isolate equipment or other parts which are not designed to withstand test pressures.

### **3.7 ADJUSTING**

- .1 Ensure recorded data represents actual measured or observed conditions.
- .2 Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.
- .3 After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.
- .4 Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.

### **3.8 AIR SYSTEM PROCEDURE**

- .1 Execute air systems balancing for each air system in accordance with AABC and NEBB specifications and as described herein.
- .2 Make tests with supply, return and exhaust systems operating and doors and windows closed or in normal operation condition.
- .3 Test and adjust blower r/min to design requirements.
- .4 Test and record motor full load amps.
- .5 Make air quantity measurements in supply and return ducts at each major air handling or rooftop system by pilot tube traverse of entire cross-sectional area. Take minimum of 16 readings on each air handler.
- .6 Test and record required and measured system static pressures, filter differential, coil differential and fan total static pressure.
- .7 Test and adjust systems for design recirculated airflows rates.
- .8 Test and adjust systems for design outdoor air quantities.
- .9 Test and record entering air temperatures (DB heating), (DB/WB cooling).
- .10 Test and record leaving air temperatures (DB heating), (DB/WB cooling).

- .11 Adjust main supply and return ducts to design flow rates.
- .12 Adjust zones to design, supply and return flow rates.
- .13 Test and adjust each diffuser, grille and register to within 5% of design requirements.
- .14 Identify each diffuser, grille and register as to location and area.
- .15 Identify and list size, type and Manufacturer of diffusers, grilles, registers and testing equipment. Use Manufacturer's rating on equipment to make required calculations.
- .16 Control and/or equipment Manufacturer shall set adjustments of automatically operated dampers to operate as indicated in cooperation with balancing firm.
- .17 Adjust diffusers, grilles and registers to minimize drafts.
- .18 Provide fire damper drop tests, in association with the Sheet Metal Contractor in accordance with Section 23 33 00.
- .19 Use volume control devices to regulate air quantities only to extent that adjustments do not create objectionable air motion or sound levels. Effect volume control by duct internal devices such as dampers and splitters.
- .20 Vary total system airflow rates by adjustments of fan speeds. Vary branch air quantities by damper regulation.
- .21 Provide system schematic with required and actual air flow rates at each outlet or inlet. Schematic shall include all fire dampers shown on drawings.
- .22 Record installed fan drive assemblies, fan sheaves, motor sheaves and belts.
- .23 Record each installed motor Manufacturer.
- .24 Final balanced condition of each area shall include testing and adjusting of pressure conditions. Test and record building pressurization levels in variable volume systems throughout full range of fan delivery rates under both heating and cooling conditions. Test pressure conditions at ground, intermediate and upper levels. Check front doors, exits and elevator shafts for airflow so that exterior conditions do not cause excessive or abnormal pressure conditions. Document abnormal building leakage conditions noted.
- .25 Complete TAB to achieve positive building pressure unless otherwise instructed. Positive pressure relative to outside pressure of 10 Pa minimum and 18 Pa maximum shall be achieved, measured with negligible outside wind velocity.

### **3.9 HYDRONIC SYSTEM PROCEDURE**

- .1 Preparation of System - Phase I: Hydronic system shall be prepared for TAB by Mechanical Contractor in the following manner:
  - .1 Open valves, close bypass valves.
  - .2 Determine water in system has been treated and is clean.
  - .3 Check pump rotation.
  - .4 Confirm expansion tanks are not air bound and system is full of water.
  - .5 Confirm air vents at high points are installed properly and are operating freely and air is removed from circulation system.
  - .6 Set temperature controls for full flow.

- .7 Check operation of automatic bypass valves.
- .8 Check and set operating temperature of equipment to design requirements.
- .2 TAB Procedure – Phase II:
  - .1 Set pumps to proper flow rate.
  - .2 Proportionally balance flow of water through equipment.
  - .3 Record leaving water temperatures and return water temperatures and pressure drops through equipment. Reset to design temperatures.
  - .4 Record water temperature at inlet side of terminals. Note rise or drop of temperatures from source.
  - .5 Proportionally balance each terminal or in the absence of flow measuring commissioning valves balance each terminal based on temperature differential.
  - .6 Upon completion of flow readings and adjustments, mark settings and record data.
  - .7 Coordinate shaving of pump impeller to pump operating condition on pumps larger than 1.5 KW
- .3 TAB Procedure – Phase III:
  - .1 After adjustments to terminals, recheck settings at pumps. Readjust if required.
  - .2 Read pressure drop through each terminal and set flow rate on call for full flow. Set pressure drop across bypass valve to match terminal full flow pressure drop.

### 3.10 TAB DATA

- .1 Measure and record the data required by referenced organization standards, including but not limited to, following:
- .2 Air Systems:
  - .1 Measurements:
    - .1 Air velocity
    - .2 Static pressure
    - .3 Velocity pressure
    - .4 Temperature
      - .1 Wet bulb
      - .2 Dry bulb
    - .5 Cross sectional area
    - .6 RPM
    - .7 Electric power:
      - .1 Voltage
      - .2 Amperage
      - .3 Phase

- .8 Noise and vibration
- .2 Location of equipment requirements:
  - .1 Inlet and outlet of:
    - .1 Fan
    - .2 Coil
    - .3 Filter
    - .4 Damper
    - .5 Other auxiliary equipment
  - .3 Location of system measurements at:
    - .1 Main ducts
    - .2 Main branch ducts
    - .3 Sub-branch ducts
    - .4 Each supply, exhaust and return air inlet and outlet
    - .5 Other auxiliary equipment
    - .6 All areas served by system
  - .4 In addition to the above, the TAB contractor shall set balancing dampers on return air sections to ensure return air volume and heat reclaim air volumes match the coil manufacturers suggested air flow requirements.
- .3 Hydronic Systems:
  - .1 Measurements:
    - .1 Flow
    - .2 Pressure
    - .3 Temperature
    - .4 Specific gravity
    - .5 RPM
    - .6 Electric power:
      - .1 Voltage
      - .2 Amperage
      - .3 Phase
    - .7 Noise and vibration
  - .2 Location of equipment measurements:
    - .1 Inlet and outlet of each:
      - .1 Coil
      - .2 Pump



- .3 PRV
- .4 Control valve
- .5 Make-up (water)
- .6 Other auxiliary equipment
- .2 Location of system measurements at:
  - .1 Supply and return of each primary and secondary loop of the following hydronic equipment:
  - .2 Glycol
- .3 Consider glycol systems as hydronic for purpose of this section.

### **3.11 OTHER MECHANICAL SYSTEM**

- .1 Plumbing:
  - .1 Flush valves: adjust for proper operation to suit actual site pressure conditions
  - .2 Mixing Valves: Adjust for specified discharge temperature
- .2 Building pressure conditions:
  - .1 Adjust HVAC systems, equipment, controls to ensure specified pressure conditions at all times coordinate with consultant.

### **3.12 PREPARATION OF REPORTS**

- .1 Draft Reports:
  - .1 Upon completion of testing, adjusting, and balancing procedures, prepare draft reports on AABC or NEBB forms.
  - .2 Draft reports may be hand written, but must be complete, factual, accurate, and legible.
  - .3 Organize and format draft reports in the same manner specified for the final reports.
  - .4 Submit two complete sets of draft reports. Only one complete set of draft reports will be returned.
- .2 Final Report:
  - .1 Upon verification and approval of draft reports, prepare final reports, type written, and organized and formatted as specified below.
  - .2 Submit 2 complete sets of final reports. Use units of measurement (SI or Imperial) as used on the Project Documents.
- .3 Report Format:
  - .1 Report forms are to be those standard forms prepared by the referenced standard for each respective item and system to be tested, adjusted, and balanced.
  - .2 Bind report forms complete with schematic systems diagrams and other data in reinforced, vinyl, three-ring binders. Provide binding edge labels with the project identification and a title descriptive of the contents. Divide the contents of the binder into the divisions listed below, separated by divider tabs:

- .1 General Information and Summary;
- .2 Hydronic Systems;
- .3 Air Systems;
- .4 Temperature Control Systems;
- .5 Special Systems.
- .4 Report Contents:
  - .1 The Agency is to provide the following minimum information, forms and data:
    - .1 Inside cover sheet to identify the Agency, the Contractor, and Project, including addresses, and contact names and telephone numbers and a listing of the instrumentation used for the procedures along with the proof of calibration;
    - .2 The remainder of the report is to contain the appropriate forms containing as a minimum, the information indicated on the standard AABC or NEBB report forms prepared for each respective item and system;
    - .3 The Agency is to include for each system to be tested, adjusted and balanced, a neatly drawn, identified (system designation, plant equipment location, and area served) schematic "as-built" diagram indicating and identifying all equipment, terminals, and accessories;
    - .4 The Agency is to include report sheets indicating building comfort test readings for all rooms.
  - .5 Verification of Reports:
    - .1 After the final testing and balancing report has been submitted, the Agency is to visit the site with the Contractor and Consultant to spot check results indicated on the balancing report.
    - .2 The Agency is to supply all labour, ladders, and instruments to complete spot checks.
    - .3 Note that if results of spot checks do not, on a consistent basis, agree with the final report, the spot check procedures will stop and the Agency is to then rebalance the systems involved, resubmit the final report, and again perform spot checks with the Contractor and Consultant.
  - .6 Certification and Warranty:
    - .1 The TAB Agency shall submit a written warranty from the Agency covering one full heating season and one full cooling season, during which time any balancing problems which occur, with the exception of minor revision work done during scheduled site visits, will, at no cost, be investigated by the Agency and reported on to the Owner, and if it is determined that the problems are a result of improper testing, adjusting and balancing, they are to be immediately corrected without additional cost to the Owner.

### **3.13 ACCEPTANCE**

- .1 Mechanical systems shall not be considered ready for final field review until TAB results are acceptable to Consultant.
- .2 If found that specified flows cannot be achieved on portions of system, actual conditions shall be reported to Consultant for consideration of correctable action before continuing TAB procedure.

- .3 If measured flow at final field review shows deviation of 10% at terminal devices, 5% at equipment or more or mean sound level deviation of 10 db or more from certified report listing, by more than 10% of selected areas, report shall be rejected.
- .4 If report is rejected, systems shall be re-balanced and certified report submitted at no extra cost.

### **3.14 POST BALANCING SITE VISITS**

- .1 After acceptance of the final report, the Agency is to perform post testing and balancing site visits in accordance with the following requirements:
  - .1 Post testing and balancing site visits are to be made:
    - .1 Once during the third month of building operation;
    - .2 Once between the fourth and tenth months in a season opposite to the first and third month visit.
  - .2 During each return visit and accompanied by the Owner's representative, the Agency is to spot rebalance terminal units as required to suit building occupants and eliminate complaints;
  - .3 The Agency is to schedule each visit with the Contractor and the Owner, and inform the Consultant;
  - .4 After each follow-up site visit, the Agency is to issue to the Contractor and Consultant a report indicating any corrective work performed during the visit, all abnormal conditions and complaints encountered, and recommended corrective action.

**END OF SECTION**

## **PART 1 GENERAL**

### **1.1 GENERAL REQUIREMENTS**

- .1 Read and be governed by conditions of the *Contract Documents*, including sections of Division 01.

### **1.2 SUMMARY**

- .1 Section Includes
  - .1 Duct work insulation.
  - .2 Duct Liner.
  - .3 Insulation jackets.

### **1.3 SCOPE OF WORK**

- .1 Supply and install insulation for duct systems in all areas, including:
  - .1 Intake and exhaust ducts and plenums between equipment and wall, soffit or roof penetrations.
  - .2 Heating/cooling supply air ductwork.
  - .3 Return air ductwork in unconditioned spaces.
  - .4 Insulate all duct penetrations through exterior wall to fan or ERV.
  - .5 Miscellaneous ducts and vents indicated on the drawing(s).

### **1.4 SUBMITTALS**

- .1 Product Data: Provide product description, thermal characteristics, list of materials and thickness for equipment scheduled.

## **PART 2 PRODUCTS**

### **2.1 PRE-MOULDED MINERAL FIBRE**

- .1 Manufacturers:
  - .1 Johns Manville;
  - .2 Knauf;
  - .3 Manson Insulation;
  - .4 Owens Corning.
- .2 Rigid, sectional, sleeve type insulation to ASTM Standard C 547-00, with a factory applied vapour barrier jacket.
  - .1 Use for round heating/cooling supply air ductwork and round exhaust/intake ductwork inside the building and above ground, except as noted.

### **2.2 ELASTOMERIC PIPE INSULATION**

- .1 Manufacturers:

- .1 Armacell;
- .2 Approved equal
- .2 Closed cell foam, preformed for round pipes/ducts with all longitudinal and circumferential joints sealed with manufacturer recommended adhesive or manufacturer's black lapseal tape, 25/50 flame/smoke rating to ASTM E84.
  - .1 Alternative insulation type for use for round exhaust/intake ductwork inside the building and above ground, except as noted.

## **2.3 RIGID FIBREGLASS BOARD**

- .1 Manufacturers:
  - .1 Johns Manville;
  - .2 Knauf;
  - .3 Approved equal
- .2 Rigid board insulation, 25/50 flame/smoke rating to ASTM E84 with a factory applied vapour barrier facing. Minimum 36 kg/m<sup>3</sup> density.
  - .1 For all rectangular heating/cooling ductwork up to 12" x 6" (300 mm x 150 mm) inside building.

## **2.4 RIGID MINERAL FIBRE BOARD**

- .1 Manufacturers:
  - .1 Knauf;
  - .2 Manson Insulation;
  - .3 Johns Manville;
  - .4 Owens Corning;
  - .5 Specialty Products & Insulation Co.
- .2 Preformed board type insulation to ASTM C612-00a, 48 kg/m<sup>3</sup> (3.0 lb/ft<sup>3</sup>) density, with a factory applied reinforced aluminum foil and kraft paper facing.
  - .1 For all rectangular heating/cooling ductwork inside building.

## **2.5 FLEXIBLE FOAM ELASTOMERIC SHEET**

- .1 Manufacturers:
  - .1 Armacell;
  - .2 K-Flex.
- .2 Sheet form, CFC free, closed cell, self-adhering elastomeric nitrile rubber insulation with a water vapour permeability rating of 0.08 in accordance with ASTM E96 Procedure A.
  - .1 Alternative insulation type for use for exhaust/intake ductwork inside the building and above ground, except as noted.

## **2.6 BLANKET MINERAL FIBRE**

- .1 Manufacturers:

- .1 Johns Manville;
- .2 Knauf;
- .3 Manson Insulation;
- .4 CertainTeed.
- .2 Blanket type roll form insulation to ASTM Standard C553-00, 24 kg/m<sup>3</sup> (1½ lb/ft<sup>3</sup>) density, 40 mm thick, with a factory applied vapour barrier facing.
  - .1 Alternative for concealed rectangular heating/cooling ductwork up to 12" x 6" (300 mm x 150 mm) and alternative for concealed round ducts up to 12" (300 mm) inside building.

## **2.7 FIRE RATED DUCT WRAP**

- .1 Manufacturers:
  - .1 3M Fire Barrier Duct Wrap 615+;
  - .2 CL4 Inc. "CL4Fire";
  - .3 Unifrax Corp. "FyreWrap Elite 1.5";
  - .4 Morgan Thermal Ceramics "FireMaster FastWrap XL".
  - .5 Multi-Glass Insulation Ltd. Pyroscat FP Type 6#F2E
- .2 Flexible, non-combustible, blanket type mineral fibre duct wrap completely encapsulated in reinforced foil, 40 mm thick, suitable for installation with zero clearance to combustibles, and ULC tested and listed (ULC Designs FRD-3 & 5 for ventilation ducts, ULC Design FRD-4 for kitchen exhaust duct) to facilitate a 1 or 2 hour fire resistance rating to kitchen grease exhaust duct in accordance with requirements of NFPA-96, and/or a 1 or 2 hour fire resistance rating to ventilation or pressurization ductwork in accordance with requirements of ISO 6944.
  - .1 For ducts such as kitchen exhaust, stairwell pressurization, etc., which require a fire rating and are not protected by rated construction

## **2.8 INSULATION FASTENINGS**

- .1 Duct Insulation Fasteners: Weld-on 2 mm (3/32") diameter zinc coated steel spindles of suitable length, complete with minimum 40 mm square plastic or zinc plated steel self-locking washers.
  - .1 For securing mineral fibre duct and casing insulation in place.
- .2 Tape Sealant: Equal to MACtac Canada Ltd. self-adhesive insulation tapes, types PAF, FSK, ASJ, or SWV as required to match the surface being sealed.
  - .1 For sealing and securing joints in mineral fibre duct insulation
- .3 Adhesive - Mineral Fibre Insulation: Clear, pressure sensitive, brush consistency adhesive, suitable for a temperature range of -20°C to 82°C (-4°F to 180°F), compatible with the type of material to be secured, and WHMIS classified as non-hazardous.
  - .1 For adhering board or blanket mineral fibre insulation to ducts and equipment
- .4 Adhesive – Flexible Elastomeric Insulation: Armacell "Armaflex" #520 air-drying contact adhesive.
- .5 Adhesive – Closed Cell Foamed Glass Insulation: Pittsburgh Corning PC88 multi-purpose two-component adhesive.
  - .1 For securing and finishing canvas jacket on exposed mineral fibre insulation
- .6 Aluminium Banding:

- .1 Equal to ITW Insulation Systems Canada "FABSTRAPS" minimum 12 mm wide, 0.6 mm (1/16") thick aluminium strapping.
- .2 For securing fiberglass insulation for tanks, shell and tube heat exchangers, etc., and for securing metal jacket on weather-proofed pipe insulation.
- .7 Stainless Steel Banding:
  - .1 Equal to ITW Insulation Systems Canada "FABSTAPS" minimum 12 mm wide, 0.6 mm (1/16") thick type 304 stainless steel strapping.
  - .2 For securing stainless steel insulation jacket in place.

## **2.9 INSULATION JACKETS AND FINISHES**

- .1 White PVC:
  - .1 Manufacturers:
    - .1 Proto Corp. "LoSMOKE";
    - .2 The Sure-Fit System "SMOKE-LESS 25/50";
    - .3 Johns Manville Inc. "Zeston" 300.
  - .2 Roll form sheet and fitting covers, minimum 15 mil thick white PVC, 25/50 rated, complete with manufacturer recommended installation and sealing accessories.
    - .1 For finishing exposed pipe insulation inside building
    - .2 For providing continuous vapour barrier around fittings.
- .2 Rigid Aluminium:
  - .1 Equal to ITW Insulation Systems Canada "Lock-on" 0.406 mm (0.016") thick embossed aluminum jacket material to ASTM B209, factory cut to size and complete with polysurlyn moisture barrier and continuous modified Pittsburgh Z-Lock, and "Fabstraps" and butt straps with weatherproof the end to end joints. Fittings are to be two-piece epoxy coated pressed aluminum with weather locking edges.
  - .2 For jacket on insulation outside building to protect from damage and provide additional weather-proofing. May also be used inside building alternate to PVC.
- .3 Adhesive Backed Flexible Aluminium:
  - .1 MFM Building Products Corp. "Flex-Clad 400" roll form sheet material with an aggressive rubberized asphalt adhesive backing, high density polyethylene reinforcement, and an embossed aluminum facing.
  - .2 For use as an alternative to rigid aluminum jacket material for exposed exterior pipe and duct insulation and for underground pipe insulation, where approved by Engineer. Note that ambient temp. must be 65°F or better for installation
- .4 Protective Coating - Flexible Foam Elastomeric Insulation:
  - .1 Equal to Armacell "WB Armaflex" weatherproof, water-based latex enamel finish.
  - .2 for Armacell "Armaflex" type flexible elastomeric insulation exposed to weather, underneath and in addition to protective jacketing such as aluminum jacketing or for small areas where the jacketing cannot be used.

## **PART 3 EXECUTION**

### **3.1 EXAMINATION**

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

### **3.2 INSTALLATION**

- .1 Rigid insulation:
  - .1 Apply according to the Fibreglass installation procedure using welded pins or perforated base metal fasteners adhered with Bakelite #230-35 and speed washers. These shall be located on maximum 12" (300 mm) centres with a minimum of two (2) rows per duct side. When the insulation has been placed on the metal spike, the speed washers shall be attached, and the excess spike cut off flush with the washer.
  - .2 Corners of insulation shall be provided with a pre-formed protective edge applied to insulation before canvassing.
- .2 Flexible insulation:
  - .1 Wrap tightly on the ductwork with all circumferential joints butted and longitudinal joints overlapped a minimum of 2" (50 mm). Adhere insulation with 4" (100 mm) strips of insulation bonding adhesive at 8" (200 mm) O.C.
  - .2 Where faced flexible insulation is used on concealed rectangular ducts, secure insulation to the bottom of ductwork with suitable mechanical fasteners on maximum 18" (450 mm) O.C.
  - .3 On circumferential joints the 2" (50 mm) flange on the facing shall be stapled with staples on 6" (150 mm) centres and taped with minimum 3" (80 mm) wide RFFRK tape.
  - .4 On longitudinal joints, the overlap shall be stapled with flare-door staples on 6" (150 mm) centres and taped with minimum 3" (80 mm) wide RFFRK tape. All pin penetrations or punctures in facing shall also be taped.
- .3 At duct connection flanges insulate the flanges with neatly cut strips of the rigid insulation material secured with adhesive to side surfaces of the flange with a top strip to cover the exposed edges of the side strips, then butt the flat surface duct insulation up tight to the flange insulation, or, alternatively, increase the insulation thickness to the depth of the flange and cover the top of the flanges with tape sealant.
- .4 For round duct fittings such as elbows use flexible insulation blanket, covered with PVC fitting jacket sealing all edges (including circumferential and longitudinal) of the PVC cover with PVC jacket manufacturer recommended solvent welding system adhesive (eg. Johns Manville Perma-Weld). For concealed spaces, PVC jacket tape (equal to Johns Manville Z-Tape) is acceptable for sealing all jacket edges and seams. Alternative for elastomeric insulated ductwork: Neatly custom-fashion insulation around fittings from closed-cell elastomeric sheets (refer to manufacturer instructions).
- .5 The installation of fastener pins and washers is to be concurrent with the duct insulation application;
- .6 Cut insulation fastener pins almost flush to the washer and cover with neatly cut pieces of tape sealant;
- .7 Accurately and neatly cut and fit insulation at duct accessories such as damper operators (with standoff mounting) and pitot tube access covers.
- .8 Prior to concealment of insulation by either construction finishes or canvas jacket material, patch all vapour barrier damage by means of tape sealant.



- .9 Insulate all exposed exterior ductwork (except fresh air intake ductwork) and associated plenums and/or casings outside the building with minimum 40 mm thick flexible elastomeric sheet insulation as required, applied in two minimum 20 mm thick layers with staggered tightly butted joints.
  - .1 Install with adhesive in strict accordance with the manufacturer's published instructions to produce a weather-proof installation. Ensure that sheet metal work joints are sealed watertight prior to applying insulation.
- .10 Insulated duct work conveying air below ambient temperature:
  - .1 Provide insulation with vapour barrier jackets.
  - .2 Finish with tape and vapour barrier jacket.
  - .3 Continue insulation through walls, sleeves, hangers, and other duct penetrations.
  - .4 Insulate entire system including fittings, joints, flanges, fire dampers, flexible connections, and expansion joints.
- .11 Insulated duct work conveying air above ambient temperature:
  - .1 Provide with or without standard vapour barrier jacket.
  - .2 Insulate fittings and joints. Where service access is required, bevel and seal ends of insulation.
- .12 Duct Work Exposed in Mechanical Equipment Rooms or Finished Spaces below 3 m (10 ft) above finished floor: Finish canvas jacket sized for finish painting.
- .13 Exterior Applications: Provide insulation with vapour barrier jacket. Cover with caulked aluminum jacket with seams located on bottom side of horizontal duct section.
- .14 External Duct Insulation Application:
  - .1 Secure insulation with vapour barrier with wires and seal jacket joints with vapour barrier adhesive or tape to match jacket.
  - .2 Secure insulation without vapour barrier with staples, tape, or wires.
  - .3 Install without sag on underside of duct work. Use adhesive or mechanical fasteners where necessary to prevent sagging. Lift duct work off trapeze hangers and insert spacers.
  - .4 Seal vapour barrier penetrations by mechanical fasteners with vapour barrier adhesive.
  - .5 Stop and point insulation around access doors and damper operators to allow operation without disturbing wrapping.
- .15 Plenum Liner, Duct Liner Application:
  - .1 Adhere insulation with adhesive for 100% coverage.
  - .2 Secure insulation with mechanical liner fasteners. Refer to SMACNA 1966 Standards for spacing.
  - .3 Seal and smooth joints. Seal and coat transverse joints.
  - .4 Seal liner surface penetrations with adhesive.
  - .5 Duct dimensions indicated are net inside dimensions required for air flow. Increase duct size to allow for insulation thickness.

### 3.3 SCHEDULES

- .1 Insulate the following ductwork systems inside the building and above ground with insulation of the thickness indicated. Insulation for casings, plenums, and exposed rectangular ductwork shall be

rigid board type and exposed round ductwork shall be rigid pre-formed type. Insulation for concealed round ductwork and concealed rectangular ductwork shall be pre-formed, rigid board or blanket type. Thickness of alternate products shall provide equivalent R-value to that of specified mineral fibre.

Duct Type	Temp. Difference (°C) between air inside and outside duct	Thickness (mm)
all outside air intake ductwork, casings and plenums from fresh air intakes to and including air handler	22 or greater	50 rigid or elastomeric
mixed supply air or preheated supply air casings, plenums and sections to and including the fan section where not factory insulated	5 - 22	25 rigid or elastomeric or 38 flexible blanket
supply air ductwork outward from fans, except for supply ductwork exposed in the area it serves	5 – 22	25 rigid or elastomeric or 38 flexible blanket
all exhaust discharge ductwork and plenums between heat recovery ventilation equipment and exhaust openings to atmosphere	5 – 22	25 rigid or elastomeric or 38 flexible blanket
other exhaust discharge ductwork and plenums within 4 m of exhaust openings to atmosphere	5 – 22	25 rigid or elastomeric or 38 flexible blanket
any other ductwork, casings, plenums or sections specified or detailed on the drawings to be insulated	5 – 22	as specified

### 3.4 INSULATION FINISH REQUIREMENTS

- .1 White PVC: Jacket exposed pipe insulation work inside the building with white sheet PVC and fitting covers. Install sheet PVC and fitting covers tightly in place with overlapped circumferential and longitudinal joints arranged to shed water. Seal all joints to produce a neat water-tight installation. Provide slip-type expansion joints where required by manufacturer's instructions.

- .2 Rigid Aluminum: Install aluminum jacket material tightly in place with overlapped circumferential joints positioned to shed water and covered with butt straps supplied with the jacket. Provide aluminum jacket for the following insulation:
  - .1 exposed refrigerant piping;
  - .2 exterior insulated ductwork.
- .3 Protective Coating – Flexible Elastomeric Insulation: Apply 2 coats (with 24 hr. between coats) of the specified coating to all insulation outside the building which cannot be covered with rigid aluminum jacket.

**END OF SECTION**

## **PART 1- GENERAL**

### **1.1 GENERAL REQUIREMENTS**

- .1 Read and be governed by conditions of the *Contract Documents*, including sections of Division 01.

### **1.2 SUMMARY**

- .1 Section Includes
  - .1 Equipment insulation.
  - .2 Covering.

### **1.3 SUBMITTALS**

- .1 Product Data: Provide product description, thermal characteristics, list of materials and thickness for equipment scheduled.

## **PART 2 – PRODUCTS**

### **2.1 BLANKET MINERAL FIBRE**

- .1 Manufacturers:
  - .1 Johns Manville;
  - .2 Knauf;
  - .3 Manson Insulation;
  - .4 CertainTeed.
- .2 Blanket type roll form insulation to ASTM Standard C553-00, 24 kg/m<sup>3</sup> (1½ lb/ft<sup>3</sup>) density, with factory applied vapour barrier facing.
  - .1 For “cold” equipment such as roof drain bodies, water meters, and “cold” pump casings”.

## **PART 3- EXECUTION**

### **3.1 EXAMINATION**

- .1 Verify existing conditions before starting work.
- .2 Verify that equipment has been tested before applying insulation materials.
- .3 Verify that surfaces are clean and dry, with foreign material removed.

### **3.2 INSTALLATION**

- .1 Install components to manufacturer's written instructions.
- .2 Factory Insulated Equipment: Do not insulate.
- .3 Exposed Equipment: Locate insulation and cover seams in least visible locations.

- .4 Apply insulation close to equipment by grooving, scoring, and bevelling insulation. Fasten insulation to equipment with studs, pins, clips, adhesive, wires, or bands.
- .5 Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapour barrier cement.
- .6 Insulated equipment containing fluids below ambient temperature: Insulate entire system.
- .7 Fibre glass insulated equipment containing fluids below ambient temperature: Provide vapour barrier jackets, factory-applied or field-applied. Finish with glass cloth and vapour barrier adhesive.
- .8 For hot equipment containing fluids 60 degrees C or less, do not insulate flanges and unions, but bevel and seal ends of insulation.
- .9 For hot equipment containing fluids over 60 degrees C, insulate flanges and unions with removable sections and jackets.
- .10 Fibre glass insulated equipment containing fluids above ambient temperature: Provide standard jackets, with or without vapour barrier, factory-applied or field-applied. Finish with glass cloth and adhesive.
- .11 Inserts and Shields:
  - .1 Application: Equipment 50 mm diameter or larger.
  - .2 Shields: Galvanized steel between hangers and inserts.
  - .3 Insert location: Between support shield and equipment and under the finish jacket.
  - .4 Insert configuration: Minimum 150 mm long, of same thickness and contour as adjoining insulation; may be factory fabricated.
  - .5 Insert material: Hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range.
- .12 Finish insulation at supports, protrusions, and interruptions.
- .13 Equipment in Mechanical Equipment Rooms or Finished Spaces: Finish with PVC jacket and fitting covers.
- .14 Exterior Applications: Provide vapour barrier jacket or finish with glass mesh reinforced vapour barrier cement. Cover with stainless steel jacket with seams located on bottom side of horizontal equipment.
- .15 Nameplates and ASME Stamps: Bevel and seal insulation around; do not insulate over.
- .16 Equipment Requiring Access for Maintenance, Repair, or Cleaning: Install insulation so it can be easily removed and replaced without damage.

### 3.3 SCHEDULES

- .1 Blanket Type Mineral Fibre:
  - .1 Insulate the following equipment with mineral fibre blanket type insulation of the thickness indicated:
    - .1 domestic cold water pump casings – 40 mm thick;
    - .2 roof drain sumps where inside the building – 25 mm thick;
    - .3 water meter(s) – 40 mm thick.

- .2 Unless otherwise noted, wrap the equipment to a thickness and insulating value equal to an equivalent thickness of rigid sectional pipe insulation. Laminate the insulation in place with a full coverage of adhesive and secure with wire. Apply a jacket of the insulation vapour barrier material secured in place with adhesive or sealant tape.
- .3 Cover roof drain sumps with purpose made PVC fitting covers.
- .4 Lay the fibreglass blanket on radiant ceiling panels after testing is complete.

**END OF SECTION**

## **PART 1 GENERAL**

### **1.1 GENERAL REQUIREMENTS**

- .1 Read and be governed by conditions of the *Contract Documents*, including sections of Division 01.

### **1.2 SUMMARY**

- .1 Section Includes
  - .1 Piping insulation.
  - .2 Jackets and accessories.

### **1.3 SCOPE OF WORK**

- .1 Supply and install insulation for piping systems in all areas, including:
  - .1 Domestic cold water, domestic hot water, and hot water re-circulating piping and fittings.
  - .2 Condensate drain piping and fittings serving refrigeration and cooling equipment.
  - .3 Refrigerant piping/tubing inside and outside the building.
  - .4 Roof drain sumps and storm piping inside the building.
  - .5 Miscellaneous piping indicated on the drawing(s).

### **1.4 SUBMITTALS**

- .1 Product Data: Provide product description, list of materials and thickness for each service, and locations.

## **PART 2 PRODUCTS**

### **2.1 PERFORMANCE**

- .1 Fire Hazard Ratings: Unless otherwise specified, all insulation system materials inside the building must have a fire hazard rating of not more than 25 for flame spread and 50 for smoke developed when tested in accordance with CAN/ULC-S102, Surface Burning Characteristics of Building Materials and Assemblies.
- .2 Thermal Performance: Unless otherwise specified, thermal performance of insulation is to meet or exceed the values given in the National Energy Code of Canada for Buildings 2011 or Tables 6.8.2.A, 6.8.2.B, 6.8.3.A, and 6.8.3.B of ASHRAE/IES Standard 90.1-2007.
  - .1 In the event of a contradiction between two specified requirements, the higher thermal performance requirement shall govern.

### **2.2 FLEXIBLE FOAM ELASTOMERIC**

- .1 Manufacturers:
  - .1 Armacell;
  - .2 K-Flex.

- .2 Closed cell, sleeve type, longitudinally split self-seal, foamed plastic pipe insulation with a water vapour transmission rating of 0.10 in accordance with ASTM E96-90, Procedure B, and all required installation accessories.

- .1 Use for refrigerant gas and liquid tubing/piping.

## **2.3 FIRE-RATED PREMOULDED MINERAL WOOL**

- .1 Manufacturers:

- .1 Roxul;
  - .2 Johns Manville;
  - .3 Paroc Group.

- .2 Non-combustible, fire-rated, rigid, sectional, longitudinally split mineral wool or basalt pipe insulation with a reinforced vapour barrier jacket and compatible with CAN4-S115 and CAN/ULC-S01 firestopping.

- .1 Use only where insulated piping penetrates fire-rated construction.
  - .2 Apply where the pipe penetrates the fire barrier and is required to form a component of the ULC firestop system at the penetration.
  - .3 Coordinate with firestopping work.

## **2.4 PRE-MOULDED MINERAL FIBRE**

- .1 Manufacturers:

- .1 Johns Manville;
  - .2 Knauf;
  - .3 Manson Insulation;
  - .4 Owens Corning.

- .2 Rigid, sectional, sleeve type insulation to ASTM Standard C 547-00, with a factory applied vapour barrier jacket.

- .1 Use for all piping inside the building and above ground, except as noted.
  - .2 Not acceptable for refrigerant piping.

## **2.5 BLANKET MINERAL FIBRE**

- .1 Manufacturers:

- .1 Johns Manville;
  - .2 Knauf;
  - .3 Manson Insulation;
  - .4 CertainTeed.

- .2 Blanket type roll insulation to CGSB 51-GP-11M, 24 kg/m<sup>3</sup> (1½ lb/ft<sup>3</sup>) density, with a factory applied vapour barrier facing.

- .1 Use in conjunction with premoulded mineral fibre for insulating valves and similar odd shaped items.



## 2.6 INSULATION FASTENINGS

- .1 Aluminium Banding: Equal to ITW Insulation Systems Canada "FABSTRAPS" minimum 12 mm wide, 0.6 mm (1/16") thick aluminium strapping.
  - .1 for securing fiberglass insulation for tanks, shell and tube heat exchangers, etc., and for securing metal jacket on weather-proofed pipe insulation
- .2 Stainless Steel Banding: Equal to ITW Insulation Systems Canada "FABSTAPS" 0.6 mm (1/16") thick, minimum 12 mm wide type 304 stainless steel strapping.
  - .1 for securing stainless steel insulation jacket in place
- .3 Duct Insulation Fasteners: Weld-on 2 mm (3/32") diameter zinc coated steel spindles of suitable length, complete with minimum 40 mm square plastic or zinc plated steel self-locking washers.
  - .1 for securing mineral fibre duct and casing insulation in place
- .4 Tape Sealant: Equal to MACtac Canada Ltd. self-adhesive insulation tapes, types PAF, FSK, ASJ, or SWV as required to match the surface being sealed.
  - .1 for sealing and securing joints in mineral fibre pipe and duct insulation
- .5 Adhesive - Mineral Fibre Insulation: Clear, pressure sensitive, brush consistency adhesive, suitable for a temperature range of -20°C to 82°C (-4°F to 180°F), compatible with the type of material to be secured, and WHMIS classified as non-hazardous.
  - .1 for adhering board or blanket mineral fibre insulation to pipe, ducts and equipment
- .6 Adhesive – Flexible Elastomeric Insulation: Armacell "Armaflex" #520 air-drying contact adhesive.
- .7 Adhesive – Closed Cell Foamed Glass Insulation: Pittsburgh Corning PC88 multi-purpose two-component adhesive.
- .8 Lagging Adhesive: White, brush consistency, ULC listed and labelled, 25/50 fire/smoke rated lagging adhesive for canvas jacket fabric, suitable for colour tinting, complete with fungicide and washable when dry.
  - .1 for securing and finishing canvas jacket on exposed mineral fibre insulation
- .9 Sheet Metal Screws: No. 10 stainless steel sheet metal screws.

## 2.7 INSULATION JACKETS AND FINISHES

- .1 White PVC:
  - .1 Manufacturers:
    - .1 Proto Corp. "LoSMOKE";
    - .2 The Sure-Fit System "SMOKE-LESS 25/50";
    - .3 Johns Manville Inc. "Zeston" 300.
  - .2 Roll form sheet and fitting covers, minimum 15 mil thick white PVC, 25/50 rated, complete with installation and sealing accessories.
    - .1 for finishing exposed pipe insulation inside building
- .2 Rigid Aluminium:

- .1 Equal to ITW Insulation Systems Canada "Lock-on" 0.406 mm (0.016") thick embossed aluminum jacket material to ASTM B209, factory cut to size and complete with polysurlyn moisture barrier and continuous modified Pittsburgh Z-Lock, and "Fabstraps" and butt straps with weatherproof the end to end joints. Fittings are to be two-piece epoxy coated pressed aluminum with weather locking edges.
- .2 For jacket on insulation outside building to protect from damage and provide additional weather-proofing. May also be used inside building as alternate to PVC.
- .3 Stainless Steel:
  - .1 Equal to ITW Insulation Systems Canada "Lock-on" 0.254 mm (0.010") thick type 304 embossed stainless steel to ASTM A240, factory cut to size and complete with moisture barrier and continuous modified Pittsburgh Z-Lock, and butt straps with "Fabstraps" to cover end to end joints. Fittings are to be two piece pressed stainless steel with weather locking edges.
  - .2 For use as a protective jacket as for rigid aluminum specified above but where a more corrosion-resistant material is required. May also be used inside building.
- .4 Adhesive Backed Flexible Aluminium:
  - .1 MFM Building Products Corp. "Flex-Clad 400" roll form sheet material with an aggressive rubberized asphalt adhesive backing, high density polyethylene reinforcement, and an embossed aluminum facing.
  - .2 For use as an alternative to rigid aluminum jacket material for exposed exterior pipe and duct insulation and for underground pipe insulation, where approved by Engineer. Note that ambient temp. must be 65°F or better for installation
- .5 Insulation Cement:
  - .1 Heat resistant, trowel consistency thermal insulating and finishing cement to CAN/CGSB 51.12, and suitable in all respects for the application.
- .6 Protective Coating - Foamed Glass Insulation:
  - .1 Pittsburgh Corning "PITTCOTE 404" flexible acrylic latex weather barrier coating, white unless otherwise specified.
  - .2 For "FOAMGLAS" insulation when used above ground and does not require a metal jacket or other jacket
- .7 Protective Coating - Flexible Foam Elastomeric Insulation:
  - .1 Equal to Armacell "WB Armaflex" weatherproof, water-based latex enamel finish.
  - .2 for Armacell "Armaflex" type flexible elastomeric insulation exposed to weather.

## **PART 3 EXECUTION**

### **3.1 EXAMINATION**

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

### **3.2 INSTALLATION**

- .1 Install materials to manufacturer's written instructions.
- .2 On exposed piping, locate insulation and cover seams in least visible locations.

- .3 Insulated dual temperature pipes or cold pipes conveying fluids below ambient temperature:
  - .1 Provide vapour barrier jackets, factory applied or field applied.
  - .2 Insulate fittings, joints, and valves with moulded insulation of like material and thickness as adjacent pipe.
  - .3 Finish with glass cloth and vapour barrier adhesive.
  - .4 PVC fitting covers may be used.
  - .5 Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations.
  - .6 Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, [pump bodies] and expansion joints.
- .4 For insulated pipes conveying fluids above ambient temperature:
  - .1 Provide standard jackets, with or without vapour barrier, factory applied or field applied.
  - .2 Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe.
  - .3 Finish with glass cloth and adhesive.
  - .4 PVC fitting covers may be used.
  - .5 For hot piping conveying fluids 60 degrees C (140 degrees F) or less, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation.
  - .6 For hot piping conveying fluids over 60 degrees C (140 degrees F), insulate flanges and unions at equipment.
- .5 Inserts and Shields:
  - .1 Application: Piping 40 mm (1-1/2 inch) diameter or larger.
  - .2 Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.
  - .3 Insert Location: Between support shield and piping and under the finish jacket.
  - .4 Insert Configuration: Minimum 150 mm >(6 inches) long, of same thickness and contour as adjoining insulation; may be factory fabricated.
  - .5 Insert Material: hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range.
- .6 Finish insulation at supports, protrusions, and interruptions.
- .7 For pipe exposed in mechanical equipment rooms or in finished spaces finish with PVC jacket and fitting covers.
- .8 For exterior applications, provide vapour barrier jacket. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass mesh reinforced vapour barrier cement. Cover with aluminum jacket with seams located on bottom side of horizontal piping.
- .9 For buried piping, provide factory fabricated assembly with inner all-purpose service jacket with self-sealing lap, and asphalt impregnated open mesh glass fabric, with 0.025 mm (1.0 mil) thick aluminum foil sandwiched between three layers of bituminous compound; outer surface faced with a polyester film.
- .10 For heat traced piping, insulate fittings, joints, and valves with insulation of like material, thickness, and finish as adjoining pipe. Size large enough to enclose pipe and heat tracer. Cover with aluminum jacket with seams located on bottom side of horizontal piping.

### 3.3 TOLERANCE

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

### 3.4 SCHEDULES

- .1 Insulate piping as per the following table, using insulation K factor of 0.034 W/m·°C at 24°C (0.24 BTU·in/hr·ft² at 75°F). Thickness of alternate products shall provide equivalent R-value.

PIPING SYSTEM / Piping Diameter	MINIMUM INSULATION THICKNESS	
	32 mm diameter & smaller	38 mm diameter & larger
Domestic Hot Water Supply, Recirculation, and Tempered	25 mm	38 mm
Domestic Cold Water	25 mm	25 mm
Roof Drainage and Piping within building	25 mm	25 mm
Plumbing Vents	38 mm	38 mm
Heating Water and Glycol Supply & Return	25 mm	38 mm
Chilled Water Supply & Return	25 mm	25 mm
Refrigerant Lines within building	25 mm	38 mm
Refrigerant Lines outside building	38 mm	38 mm
Steam Lines from humidifier	38 mm	50 mm
Condensate Line from humidifier	25 mm	38 mm
Miscellaneous Piping and Fittings	25 mm	25 mm

**END OF SECTION**

## **2.1 GENERAL**

### **3.1. APPLICABLE STANDARDS**

- .1 Applicable Standards are listed below:
  - .1 2015 ASHRAE Handbook – HVAC Applications Chapter 43 HVAC Commissioning
  - .2 ASHRAE Guideline 1.1 – 2007 – The HVAC&R Technical Requirements for the Commissioning Process
  - .3 ASHRAE Guideline 0 – 2013 – The Commissioning Process
  - .4 ASHRAE 202 – 2013 – Commissioning Process for Buildings and Systems
  - .5 ASHRAE Guideline 4-2008 – Preparation of O&M Documentation
  - .6 ATSM E2813 – Standard Practice for Building Enclosure Commissioning
  - .7 ATSM E2947 – Standard Guide for Building Enclosure Commissioning
  - .8 CSA Z320-11 Building Commissioning Standard & Check Sheets
  - .9 CSA C282-15 – Emergency Power Supply for Buildings
  - .10 NIBS Guideline 3-2012 – Building Enclosure Commissioning Process

### **3.2. GENERAL**

- .2 The purpose of this section is to specify Division 23 responsibilities in the commissioning process.
- .3 Commissioning requires the participation of Division 23 to ensure that all systems are operating in a manner consistent with the Contract Documents. The general commissioning requirements and coordination are detailed in Section 01 91 00. Division 23 shall be familiar with all parts of Section 01 91 00 and the commissioning plan issued by the CxA and shall execute all commissioning responsibilities assigned to them in the Contract Documents.

### **3.3. SYSTEMS TO BE COMMISSIONED**

- .4 Systems to be commissioned as part of this contract include, but may not be limited to the following:
  - .1 Mechanical, including HVAC & R equipment and controls

### **3.4. COMMISSIONING TEAM**

- .5 The Commissioning Team shall consist of representatives of the following as appropriate:
  - .1 Owner and the Owner's FM Staff
  - .2 Consultant
  - .3 Commissioning Authority (CxA)
  - .4 General Contractor (GC)
  - .5 Subcontractors (Mechanical, Electrical, Controls, TAB)
  - .6 Specialized third-party for verification

## **2.2 PRODUCTS**

Not Used.

## **2.3 EXECUTION**

### **3.5. COMMISSIONING AUTHORITY RESPONSIBILITIES**

- .6 The Commissioning Authority shall:
  - .1 Plan, organize and implement the commissioning process as specified herein;
  - .2 Prepare the commissioning plan, ensure its distribution for review and comment;
  - .3 Revise the commissioning plan as required during construction;
  - .4 Chair commissioning meetings, and prepare and distribute minutes to all commissioning team members, whether or not they attended the meeting;
  - .5 In conjunction with the GC, coordinate commissioning activities;
  - .6 Monitor system verification checks, and ensure the results are documented as the checks are done;
  - .7 Observe select start-ups and initial system operations tests and checks;
  - .8 Direct the GC to operate equipment and systems as required to ensure that all required functional performance tests are carried out for verification purposes;
  - .9 Witness functional performance tests and document the results;
  - .10 Prepare and submit a commissioning report which documents all checks and tests done throughout the commissioning process, and the results obtained from each;
  - .11 Ensure all required O&M manuals, instructions and demonstrations are provided to the Owner's designated facility operating staff.

### **3.6. CONSULTANT RESPONSIBILITIES**

- .7 The Consultant commissioning responsibilities are outlined below:
  - .1 Review the commissioning plan, proposed test procedures, and participate (as appropriate) in on-site commissioning meetings.
  - .2 At their discretion during the acceptance phase of the commissioning process, be on site to review commissioning documentation, to witness functional performance tests, and to analyze the installation and its performance

### **3.7. OWNER RESPONSIBILITIES**

- .8 The Owner shall have the following commissioning responsibilities
  - .1 Ensure the availability of facility operations staff for all scheduled instructions and demonstration sessions (training).
  - .2 At their discretion, witness commissioning performance tests.

### **3.8. SUBCONTRACTOR RESPONSIBILITIES**

- .9 The responsibilities of the Subcontractor, during construction and acceptance phases in addition to those listed above are (all references apply to commissioned equipment only)
  - .1 Documentation of all procedures performed shall be provided and forwarded to the engineer/ consultant. Written documentation must contain recorded test values of all tests performed per the individual product specification.
  - .2 The start-up service company shall be present during energization of the mechanical equipment. Jobsite and equipment access must be provided by the Subcontractor.

- .3 The subcontractor shall supply a power source, specified by the start-up service company, for on-site test equipment.
- .4 The subcontractor is to attend all factory witness testing required within the respective specification sections. The contractor is responsible to cover all their costs and include them in their bid.
- .5 Perform tests using qualified personnel. Provide necessary instruments and equipment.
- .6 Include the cost of commissioning in the contract price, if not yet included.
- .7 In each purchase order or subcontract written, include requirements for submittal data, O&M data and training.
- .8 Attend a commissioning scoping meeting and other necessary meetings scheduled by the CxA to facilitate the Cx process.
- .9 Contractors shall provide normal cut sheets and shop drawing submittals to the CxA of commissioned equipment. Provide additional requested documentation, prior to normal O&M manual submittals, to the CxA for development of pre-functional and functional testing procedures.
  - .1 Typically this will include detailed manufacturer installation and start-up, operating, troubleshooting and maintenance procedures, full details of any owner-contracted tests, fan and pump curves, full factory testing reports, if any, and full warranty information, including all responsibilities of the Owner to keep the warranty in force clearly identified. In addition, the installation and checkout materials that are actually shipped inside the equipment and the actual field checkout sheet forms to be used by the factory or field technicians shall be submitted to the Commissioning Authority.
  - .2 The Commissioning Authority may request further documentation necessary for the commissioning process. This data request may be made prior to normal submittals.
- .10 Provide a copy of the O&M manuals submittals of commissioned equipment, through normal channels, to the CxA for review.
- .11 Contractors shall assist (along with the Consultant) in clarifying the operation and control of commissioned equipment in areas where the specifications, control drawings or equipment documentation is not sufficient for writing detailed testing procedures.
- .12 Provide assistance to the CxA in preparation of the specific functional performance test procedures specified in Section 23. Subs shall review test procedures to ensure feasibility, safety and equipment protection and provide necessary written alarm limits to be used during the tests.
- .13 Develop a full start-up and checkout plan using manufacturer's start-up procedures and the pre-functional test sheets from the CxA. Submit manufacturer's detailed start-up procedures and the full start-up plan and procedures and other requested equipment documentation to CxA for review.
- .14 During the startup and checkout process, execute and document the mechanical-related portions of the pre-functional test sheets provided by the CxA for all commissioned equipment.
- .15 Perform and clearly document all completed startup and system operational checkout procedures, providing a copy to the CxA.
- .16 Provide skilled technicians to execute starting of equipment and to execute the functional performance tests. Ensure that they are available and present during the agreed upon schedules and for sufficient duration to complete the necessary tests, adjustments and problem-solving.

- .17 Perform functional performance testing under the direction of the CxA for specified equipment to be commissioned. Assist the CxA in interpreting the monitoring data, as necessary.
- .18 Correct deficiencies (differences between specified and observed performance) as interpreted by the CxA, GC and Consultant and retest the equipment.
- .19 Prepare O&M manuals according to the Contract Documents, including clarifying and updating the original sequences of operation to as-built conditions.
- .20 During construction, maintain as-built red-line drawings for all drawings and final CAD as-builts for subcontractor-generated coordination drawings. Update after completion of commissioning (excluding deferred testing). Prepare red-line as-built drawings for all drawings and final as-builts for subcontractor-generated coordination drawings
- .21 Provide training of the Owner's operating personnel as specified.
- .22 Coordinate with equipment manufacturers to determine specific requirements to maintain the validity of the warranty.
- .23 Execute seasonal or deferred functional performance testing, witnessed by the CxA, according to the specifications.
- .24 Correct deficiencies and make necessary adjustments to O&M manuals and as-built drawings for applicable issues identified in any seasonal testing.
- .10 Assist and cooperate TAB subcontractor and CxA by:
  - .1 Putting all HVAC equipment and systems into operation and continuing the operation during each working day of TAB and commissioning, as required.
  - .2 Including cost of sheaves and belts that may be required by TAB.
  - .3 Providing test holes in ducts and plenums where directed by TAB to allow air measurements and air balancing. Providing an approved plug.
  - .4 Providing temperature and pressure taps according to the Construction Documents for TAB and commissioning testing.
- .11 Install a P/T plug at each water sensor which is an input point to the control system.
- .12 List and clearly identify on the as-built drawings the locations of applicable sensors and meters
- .13 Prepare a preliminary schedule for Division 23 pipe and duct system testing, flushing and cleaning, equipment start-up and TAB start and completion for use by the CxA. Update the schedule as appropriate.
- .14 Notify the PM/GC or CxA depending on protocol, when pipe and duct system testing, flushing, cleaning, startup of each piece of equipment and TAB will occur. Be responsible to notify the PM/GC or CxA, ahead of time, when commissioning activities not yet performed or not yet scheduled will delay construction. Be proactive in seeing that commissioning processes are executed and that the CxA has the scheduling information needed to efficiently execute the commissioning process.

### **3.9. TESTING, ADJUSTING, AND BALANCING (TAB) SUBCONTRACTOR RESPONSIBILITIES**

- .15 The duties of the TAB subcontractor are as follows:
  - .1 Six weeks prior to starting TAB, submit to the PM/GC the qualifications of the site technician for the project, including the name of the contractors and facility managers of recent projects the technician on which was lead. The Owner will approve the site technician's qualifications for this project.
  - .2 Submit the outline of the TAB plan and approach for each system and component to the CxA, PM/GC and the Controls Subcontractor six weeks prior to starting the TAB. This plan



will be developed after the TAB has some familiarity with the control system. The submitted plan will include:

- .1 Certification that the TAB subcontractor has reviewed the construction documents and the systems with the design engineers and contractors to sufficiently understand the design intent for each system.
- .2 An explanation of the intended use of the building control system. The Controls Subcontractor will comment on feasibility of the plan.
- .3 All field checkout sheets and logs to be used that list each piece of equipment to be tested, adjusted and balanced with the data cells to be gathered for each.
- .4 Discussion of what notations and markings will be made on the duct and piping drawings during the process.
- .5 Final test report forms to be used.
- .6 Detailed step-by-step procedures for TAB work for each system and issue: terminal flow calibration (for each terminal type), diffuser proportioning, branch / submain proportioning, total flow calculations, rechecking, diversity issues, expected problems and solutions, etc. Criteria for using air flow strengtheners or relocating flow stations and sensors will be discussed. Provide the analogous explanations for the water side.
- .7 List of all air flow, water flow, sound level, system capacity and efficiency measurements to be performed and a description of specific test procedures, parameters, formulas to be used.
- .8 Details of how total flow will be determined (Air: sum of terminal flows via BAS calibrated readings or via hood readings of all terminals, supply (SA) and return air (RA) pilot traverse, SA or RA flow stations. Water: pump curves, circuit setter, flow station, ultrasonic, etc.).
- .9 The identification and types of measurement instruments to be used and their most recent calibration date.
- .10 Specific procedures that will ensure that both air and water side are operating at the lowest possible pressures and provide methods to verify this.
- .11 Confirmation that TAB understands the outside air ventilation criteria under all conditions.
- .12 Details of whether and how minimum outside air cfm will be verified and set and for what level (total building, zone, etc.).
- .13 Details of how building static and exhaust fan / relief damper capacity will be checked.
- .14 Proposed selection points for sound measurements and sound measurement methods.
- .15 Details of methods for making any specified coil or other system plant capacity measurements.
- .16 Details of any TAB work to be done in phases (by floor, etc.), or of areas to be built out later.
- .17 Details regarding specified deferred or seasonal TAB work.
- .18 Details of any specified false loading of systems to complete TAB work.
- .19 Details of all exhaust fan balancing and capacity verifications, including any required room pressure differentials.
- .20 Details of any required interstitial cavity differential pressure measurements and calculations.

- .21 Plan for hand-written field technician logs of discrepancies, deficient or uncompleted work by others, contract interpretation requests and lists of completed tests (scope and frequency).
- .22 Plan for formal progress reports (scope and frequency).
- .23 Plan for formal deficiency reports (scope, frequency and distribution).
- .16 A running log of events and issues shall be kept by the TAB field technicians. Submit hand-written reports of discrepancies, deficient or uncompleted work by others, contract interpretation requests and lists of completed tests to the CxA and PM/GC at least twice a week.
- .17 Communicate in writing to the Controls Subcontractor all setpoint and parameter changes made or problems and discrepancies identified during TAB which affect the control system setup and operation.
- .18 Provide a draft TAB report within two weeks of completion. A copy will be provided to the CxA. The report will contain a full explanation of the methodology, assumptions and the results in a clear format with designations of all uncommon abbreviations and column headings. The report should follow the latest and most rigorous reporting recommendations by AABC, NEBB.
- .19 Provide the CxA with any requested data, gathered, but not shown on the draft reports.
- .20 Provide a final TAB report for the CxA with details, as in the draft.
- .21 Conduct functional performance tests and checks on the original TAB as specified for TAB in Section 23 08 00

### **3.10. SUBMITTALS**

- .22 Section 23 Contractors shall provide submittal documentation relative to commissioning to the CxA as requested by the CxA. Refer to Section 01 91 00 for additional Division 23 requirements.

### **3.11. START-UP OF EQUIPMENT**

- .23 The HVAC contractors shall follow the start-up and initial checkout procedures listed in the Responsibilities list in this section and in 01 91 00, part 3.10. Division 23 has start-up responsibility and is required to complete systems and sub-systems so they are fully functional, meeting the design objectives of the Contract Documents. The commissioning procedures and functional testing do not relieve or lessen this responsibility or shift that responsibility partially to the CxA or Owner.
- .24 Functional testing is intended to begin upon completion of a system. Functional testing may proceed prior to the completion of systems or sub-systems at the discretion of the CxA and GC. Beginning system testing before full completion does not relieve the Subcontractor from fully completing the system, including all pre functional checklists as soon as possible.
- .25 Prior to the startup of equipment, the Division 23 Subcontractor shall arrange to have the Manufacturer of all major equipment inspect the installation to ensure their equipment has been installed in accordance with their recommendations.
- .26 The Supplier shall submit a written report of their findings.
- .27 Upon confirmation that the equipment has been installed in accordance with the Manufacturers Recommendations the equipment may be started.
- .28 All equipment shall be started by the Manufacturer's representative.

### **3.12. PRE-FUNCTIONAL TEST SHEETS**

- .29 Pre-functional test sheets contain items for Section 23 Contractors to perform. On each checklist, a column is provided that is to be completed by the contractor assigning responsibility for that line item to a trade. Those executing the test sheets are only responsible to perform items that apply to the specific application at hand. These test sheets do not take the place of the manufacturer's recommended checkout and start-up procedures or report. Some checklist procedures may be redundant in relation to checkout procedures that will be documented on typical factory field checkout sheets. Double documenting may be required in those cases.
- .30 Refer to Section 01 91 00 for additional requirements regarding pre-functional test sheets, startup and initial checkout. Items that do not apply should be noted along with the reasons on the form. If this form is not used for documenting, one of similar rigor and clarity shall be used pending approval from the CxA.

### **3.13. FUNCTIONAL TESTING, DOCUMENTATION, NON-CONFORMANCE AND ACCEPTANCE**

- .31 Refer to Specification 01 91 00 for more information in addition to this 23 08 00.

### **3.14. OPERATION AND MAINTENANCE MANUALS**

- .32 Section 23 Contractors shall compile and prepare documentation for all equipment and systems covered in Section 23 and deliver to the GC for inclusion in the O&M manuals.
- .33 ASHRAE Guideline 4-2008 is the recommended format.
- .34 The CxA shall receive a copy of the O&M manuals for review.

### **3.15. TRAINING OF OWNER PERSONNEL**

- .35 The GC shall be responsible for training coordination and scheduling and ultimately to ensure that training is completed. Refer to Section 01 91 00 for additional details.
- .36 The CxA shall be responsible for overseeing and approving the content and adequacy of the training of Owner personnel for commissioned equipment. Refer to Section 01 91 00 for additional details.
- .37 The Mechanical Subcontractor shall have the following training responsibilities:
  - .1 Provide the CxA with a training plan two weeks before the planned training according to the outline described in Section 01 91 00, Part 3.14.
  - .2 Provide designated Owner personnel with comprehensive orientation and training in the understanding of the systems and the operation and maintenance of each piece of HVAC equipment including, but not limited to, pumps, boilers, furnaces, chillers, heat rejection equipment, air conditioning units, air handling units, fans, terminal units, controls and water treatment systems, etc.
  - .3 Training shall normally start with classroom sessions followed by hands-on training on each piece of equipment, which shall illustrate the various modes of operation, including startup, shutdown, fire/smoke alarm, power failure, etc.
  - .4 During any demonstration, should the system fail to perform in accordance with the requirements of the O&M manual or sequence of operations, the system will be repaired or adjusted as necessary and the demonstration repeated.
  - .5 The appropriate trade or manufacturer's representative shall provide the instructions on each major piece of equipment. This person may be the start-up technician for the piece of equipment, the installing subcontractor or manufacturer's representative. Practical building operating expertise as well as in-depth knowledge of all modes of operation of the specific piece of equipment is required. More than one party may be required to execute the training.

- .6 The controls subcontractor shall attend sessions other than the controls training, as requested, to discuss the interaction of the controls system as it relates to the equipment being discussed.
- .7 The training sessions shall follow the outline in the Table of Contents of the operation and maintenance manual and illustrate whenever possible the use of the O&M manuals for reference.
- .8 Training shall include:
  - .1 Use of the printed installation, operation and maintenance instruction material included in the O&M manuals.
  - .2 A review of the written O&M instructions emphasizing safe and proper operating requirements, preventative maintenance, special tools needed and spare parts inventory suggestions. The training shall include start-up, operation in all modes possible, shut-down, seasonal changeover and any emergency procedures.
  - .3 Discussion of relevant health and safety issues and concerns.
  - .4 Discussion of warranties and guarantees.
  - .5 Common troubleshooting problems and solutions.
  - .6 Explanatory information included in the O&M manuals and the location of all plans and manuals in the facility.
  - .7 Discussion of any peculiarities of equipment installation or operation.
- .38 The format and training agenda in The HVAC Commissioning Process, ASHRAE Guideline 1, latest edition is recommended.
- .39 Classroom sessions shall include the use of overhead projections, slides, video/audio-taped material as might be appropriate.
- .40 Hands-on training shall include start-up, operation in all modes possible, including manual, shut-down and any emergency procedures and preventative maintenance for all pieces of equipment.
- .41 The mechanical subcontractor shall fully explain and demonstrate the operation, function and overrides of any local packaged controls, not controlled by the central control system.
- .42 Training shall occur after functional testing is complete, unless approved otherwise by the Project Manager.

### **3.16. DEFERRED TESTING**

- .43 Refer to Section 01 91 00, Part 3.15 for requirements of deferred testing.

### **3.17. WRITTEN WORK PRODUCTS**

- .44 Written work products of Section 23 Contractors will consist of the startup and initial checkout plan as described in Section 01 91 00, as well as completed startup, initial checkout and pre-functional test sheets. Refer to Section 01 91 00 Part 3.16.

**END OF SECTION**

## **PART 1 – GENERAL**

### **1.1 General Requirements**

- .1 Read and be governed by conditions of the *Contract Documents*, including sections of Division 01.

### **1.2 Summary**

- .1 Provide all metering equipment required to monitor consumption by end use type.

### **1.3 Related Section**

- .1 Division 22 09 00 Instrumentation and Control Devices for Plumbing
- .2 Division 26 09 23 Metering and Switchboard Instruments
- .3 Division 01 91 00 Commissioning

### **1.4 Submittals**

- .1 Submittals for review
  - .1 Submit shop drawings in accordance with Section 20 05 00 – Mechanical General Provisions.
  - .2 Product Data: Prior to ordering any products, the Contractor shall submit the product data sheets, installation manuals, operation manuals, and shop drawings for all equipment specified herein for review and comment. This includes:
    - .1 Natural Gas Meter (GM-1)

### **1.5 Delivery, Storage, and Handling**

- .1 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .2 All equipment must be in new condition, and packaging free of dust, moisture, and physical damage. Any equipment not satisfying these requirements will be rejected at the Engineer's discretion.
- .3 All equipment once onsite must be stored in secure, rigid, dry, weather tight locations free from damage by dust, moisture or physical abrasion. Equipment stored onsite during construction is the responsibility of the Contractor.
- .4 Where practicable, all packaging materials shall be reused and recycled at the end of their useful life.

### **1.6 Warranty**

- .1 The energy meters shall include a full five (5) year manufacturer warranty which repairs the devices at no cost to the owner or replaces them with a model of equal or better quality. In the event that the devices cannot be repaired or replaced, and refund of equal (or greater) than the depreciated purchase price of the product shall be paid to the Owner. All shipping costs with repair or replacement shall be paid for by the manufacturer.

- .2 The Contractor shall prepare and submit all warranty information and registration documentation required by product manufacturers on behalf of the Owner. Copies of all Manufacturer Warranty Documentation shall be included (as specified) in the Operation & Maintenance Manual.

## **PART 2– PRODUCTS**

### **2.1 End Uses to be Monitored**

- .1 Provide gas meters for all end uses, including but not limited to:
  - .1 Facility incoming natural gas line.

### **2.2 Metering Equipment**

- .1 Meters
  - .1 Provide gas meters for:
    - .1 Facility incoming gas
  - .2 Metering Equipment
    - .1 Coordinate with local Gas Utility for gas meter installation.
    - .2 Provide gas meters complete with bypass piping arrangement or other means to remove or isolate for service without interruption to gas flow.
    - .3 Materials shall be compatible with the systems in which they are installed at all potential operating temperatures and pressures.
    - .4 Meters requiring power shall be hard-wired to an emergency power circuit. Battery powered units are not acceptable.
    - .5 Provide meters with readout of totalized volume.
    - .6 Accuracy +/- 1.5% in expected operating flow range.

## **PART 3– EXECUTION**

### **3.1 Installation requirements**

- .1 Meters to be supplied and installed by the mechanical contractor.
- .2 Provide optical isolation/safety devices as required by the local gas utility or other authorities having jurisdiction.

### **3.2 Identification and Labeling**

- .1 The natural gas meter shall be clearly identified and labeled with the Meter # (GM-1) to facilitate future troubleshooting, maintenance and/or expansion. Labels shall be of the lamacoid or laser etched (or stamped) enameled metallic type and be permanently affixed to the meter in accordance with manufacturer recommendations.

**END OF SECTION**

## **PART 1 GENERAL**

### **1.1 GENERAL REQUIREMENTS**

- .1 Read and be governed by conditions of the Contract Documents, including sections of Division 01.

### **1.2 SUMMARY**

- .1 Section Includes:
  - .1 Gas Detection System
- .2 Shop Drawings / Product Data
  - .1 Submit shop drawings in accordance with Section 20 05 00 – Mechanical General Provisions.
  - .2 Submit product data sheets for gas detection system. Include wiring diagrams.

## **PART 2 PRODUCTS**

### **2.1 GAS DETECTORS**

- .1 Stand-alone gas detector shall provide continuous monitoring in ambient air and two factory-set alarm levels and outputs for control of fans and dampers. BAS integration is possible by sending analog relay signal to record CO gas concentration.
- .2 The transmitter will be capable of sending signal through two onboard DPDT relay 5 A, 30 VDC or 250 VAC and will be activated at programmable set points.
- .3 LCD display for local gas concentration readings and “one man” calibration.
- .4 Transmitter shall be capable of operating within relative humidity ranges of 5 to 95% non-condensing and temperature ranges of -20°C to 40°C.
- .5 The transmitter shall have a plug-in capability for a field replaceable gas sensor cartridge. The replaceable gas sensor cartridge shall be factory calibrated and certified to the target gas ready for operation without the requirement for onsite calibration.
- .6 Sensor cell shall have a continuous self-test to ensure operation and to provide EOL notification.
- .7 LED indicator lights for power, alarm 1 and alarm 2 levels. For local activation of audible alarms, the transmitter shall have an on-board device able to generate an audible output of 85 dB at 3 m (10 ft).
- .8 Radius of gas sensor coverage shall be at least 15 m (50 ft).
- .9 Ratings and certifications:
  - .1 Conforms to International Electrical Code: IEC No. 61010
  - .2 EMI/RFI complies with EMC Directive 89/336/EEC
  - .3 CSA Certification
- .10 Product equal to Honeywell Analytics E3SA-E3SCO and E3SRMNO2. Acceptable manufacturers:
  - .1 Honeywell Analytics
  - .2 Or equal

### **PART 3 EXECUTION**

#### **3.1 INSTALLATION**

- .1 Install to manufacturer's written instructions.

#### **3.2 TESTING**

- .1 After installation, schedule test to demonstrate operation of functions described under sequence of operation by manufacturers certified technician. Issue certificate of operational and installation compliance to facility operators.

**END OF SECTION**



## **PART 1 GENERAL**

### **1.1 GENERAL REQUIREMENTS**

- .1 Read and be governed by conditions of the Contract Documents, including sections of Division 01.

### **1.2 SUMMARY**

- .1 Section Includes:
  - .1 Materials and installation for piping, valves and fittings for gas fired equipment.
  - .2 Pressure regulators.
- .2 Shop Drawings / Product Data
  - .1 Submit shop drawings / product data for all products specified in Part 2 of this Section except for pipe and fittings.

### **1.3 REFERENCES**

- .1 American Society of Mechanical Engineers (ASME)
  - .1 ASME B16.5, Pipe Flanges and Flanged Fittings.
  - .2 ASME B16.18, Cast Copper Alloy Solder Joint Pressure Fittings.
  - .3 ASME B16.22, Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings.
  - .4 ASME B18.2.1, Square and Hex Bolts and Screws Inch Series.
- .2 American Society for Testing and Materials International (ASTM)
  - .1 ASTM A47/A47M, Standard Specification for Ferritic Malleable Iron Castings.
  - .2 ASTM A53/A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated, Welded and Seamless.
  - .3 ASTM B75M, Standard Specification for Seamless Copper Tube [Metric].
  - .4 ASTM B837, Standard Specification for Seamless Copper Tube for Natural Gas and Liquefied Petroleum (LP) Gas Fuel Distribution Systems.
- .3 Canadian Standards Association (CSA International)
  - 1. CSA W47.1, Certification of Companies for Fusion Welding of Steel.
- .4 Canadian Standards Association (CSA)/Canadian Gas Association (CGA)
  - .1 CAN/CSA B149.1, Natural Gas and Propane Installation Code.
  - .2 CAN/CSA B149.1HB, Natural Gas and Propane Installation Code Handbook.
  - .3 CAN/CSA B149.2, Propane Storage and Handling Code.
  - .4 CAN/CSA C282, Emergency Electrical Power Supply for Buildings
- .5 National Fire Protection Association (NFPA)
  - .1 NFPA 54, National Fuel Gas Code

### **1.4 QUALITY ASSURANCE**

- .1 Gas system work shall be in accordance with CAN/CSA B149.1, Natural Gas and Propane Installation code, and CAN/CSA B149.2, Propane Storage and Handling Code, and local authority.

- .2 Gas system work shall be completed by G1 Gas Technician 1 licensed gas pipe fitter, authorized by TSSA.
- .3 Obtain approval of gas system design by TSSA prior to work on site and prior to ordering materials. The Contractor shall be responsible for any review fees and associated costs.

## **1.5 SUBMITTALS**

- .1 Product data
  - .1 Submit manufacturer's printed product literature, datasheet for piping, fittings, and equipment.
- .2 Test reports
  - .1 Submit pressure testing reports and photos.
- .3 Inspection report / Approval by Authority
  - .1 Submit a copy of the inspection certificate prior to applying for Substantial performance.
- .4 Closeout Submittals
  - .1 Submit maintenance and engineering data for incorporation into O&M manual. Ensure to include monitoring gas valves and pressure regulator maintenance information.

## **1.6 PERFORMANCE REQUIREMENTS**

- .1 Minimum Operating Pressure Ratings:
  - .1 Piping and Valves: 100 psig minimum.
  - .2 Service Regulators: 65 psig minimum.

## **PART 2 PRODUCTS**

### **2.1 NATURAL GAS PIPING, BELOW GROUND**

- .1 Medium-density polyethylene, PE 2708: ASTM D 2513, CSA B137.4, SDR 11. Continuous length, no connections underground except where connecting to anodeless riser.
  - .1 PE Fittings: ASTM D 2683, socket-fusion type or ASTM D 3261, butt-fusion type with dimensions matching PE pipe.
  - .2 PE Transition Fittings: Factory-fabricated fittings with PE pipe complying with ASTM D 2513, SDR 11; and steel pipe complying with ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
  - .3 Service-Line Risers: Factory fabricated and leak tested.
    - .1 Underground Portion: PE pipe complying with ASTM D 2513, SDR 11 inlet.
    - .2 Casing: Steel pipe complying with ASTM A 53 / A 53M, Schedule 40, black steel, Type E or S, Grade B, with corrosion-protective coating covering. Refer to manufacturer instructions for venting casing aboveground.
    - .3 Tracer wire connection, UV shield, stake supports with factory finish.
    - .4 Anodeless, where no easy access to factory-connected anode. Confirm use of factory-connected anode with Client prior to installation.

## **2.2 NATURAL GAS PIPING, ABOVE GROUND**

- .1 Steel Pipe: ASTM A53, Schedule 40, Grade B mild black carbon steel pipe, electric resistance welded.
- .2 Fittings: ASME B16.3, malleable iron threaded fittings for pipe diameters up to 50mm (2") and ASME B16.9, wrought steel butt welding fittings for pipe diameters over 50mm (2").
- .3 Joints: Steel flanges and fittings to ASME B16.5; unions malleable iron, brass to iron seat, ground joint to ASME B16.9, ASTM A47/A47M; nipples to schedule 40, ASTM A53/A53M.
- .4 Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
- .5 Bolts and nuts: to ASME B18.2.1, carbon steel.
- .6 Couplings: buna-nitrile seals.
- .7 Joint compound and tape: suitable for natural gas.
- .8 Welding Filler Metals: to CSA W47.1 and AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- .9 Brazing Filler Metals: Alloy with melting point greater than 540°C (1000°F) complying with AWS A5.8/A5.8M, and ASTM B837. Brazing alloys containing more than 0.05% phosphorus are prohibited.

## **2.3 PIPING SPECIALTIES**

- .1 Appliance Flexible Connectors:
  - .1 Indoor, Fixed-Appliance Flexible Connectors: Comply with ANSI Z21.24.
  - .2 Indoor, Movable-Appliance Flexible Connectors: Comply with ANSI Z21.69.
  - .3 Outdoor, Appliance Flexible Connectors: Comply with ANSI Z21.75.
  - .4 Corrugated stainless-steel tubing with polymer coating.
  - .5 Operating-Pressure Rating: 0.5 psig (3.45 kPa).
  - .6 End Fittings: Zinc-coated steel.
  - .7 Threaded Ends: Comply with ASME B1.20.1.
  - .8 Maximum Length: 72 inches (1830 mm.)
- .2 Weatherproof Vent Cap:
  - .1 Cast- or malleable-iron increaser fitting with corrosion-resistant wire screen, with free area at least equal to cross-sectional area of connecting pipe and threaded-end connection.
- .3 Valves:
  - .1 CSA-approved, Provincial Code approved, full-port ball type.
  - .2 Comply with ASME B16.33 or ASME B16.38.
  - .3 862 kPa (125 psig) minimum rated working pressure.
  - .4 Provide with locking wing as required.
  - .5 Provide position-indicating limit switch as required.
  - .6 Tamperproof Feature: Locking feature for valves indicated.
  - .7 Service Mark: Initials "WOG" shall be permanently marked on valve body.

.4 Y-Pattern Strainers:

- .1 Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
- .2 End Connections: Threaded ends for 50 mm (2") and smaller; flanged ends for 65 mm (2-1/2") and larger.
- .3 Strainer Screen: 60-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
- .4 CWP Rating: 125 psig (862 kPa).

**2.4 PRESSURE REGULATORS**

- .1 Single stage and suitable for natural gas.
- .2 Steel jacket and corrosion-resistant components.
- .3 Elevation compensator.
- .4 End Connections: Threaded for regulators 50 mm (2") and smaller; flanged for regulators 65 mm (2-1/2") and larger.
- .5 Lock-up (positive shut-off) type.
- .6 Suitably rated for inlet and outlet pressures required.
- .7 Outdoor vent termination shall have means to prevent entry of water, insects or foreign material.
- .8 Line Pressure Regulators: Comply with ANSI Z21.80.
  - .1 Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - .1 Actaris.
    - .2 American Meter Company.
    - .3 Eclipse Innovative Thermal Technologies.
    - .4 Fisher Control Valves & Instruments; a brand of Emerson Process Management.
    - .5 Invensys.
    - .6 Itron Gas.
    - .7 Maxitrol Company.
    - .8 Richards Industries.
  - .2 Body and Diaphragm Case: Cast iron or die-cast aluminum.
  - .3 Springs: Zinc-plated steel; interchangeable.
  - .4 Diaphragm Plate: Zinc-plated steel.
  - .5 Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
  - .6 Orifice: Aluminum; interchangeable.
  - .7 Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
  - .8 Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
  - .9 Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.

- .10 Includes factory-mounted overpressure protection device or leak limiting system as required per Code and suitable for type of fuel.
- .11 Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
- .9 Appliance Pressure Regulators: Comply with ANSI Z21.18
  - .1 Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - .1 Canadian Meter Company Inc.
    - .2 Eaton.
    - .3 Harper Wyman Co.
    - .4 Maxitrol Company.
    - .5 SCP, Inc.
  - .2 Body and Diaphragm Case: Die-cast aluminum.
  - .3 Springs: Zinc-plated steel; interchangeable.
  - .4 Diaphragm Plate: Zinc-plated steel.
  - .5 Seat Disc: Nitrile rubber.
  - .6 Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
  - .7 Factory-Applied Finish: Minimum three-layer polyester and polyurethane paint finish.
  - .8 Regulator may include vent limiting device, instead of vent connection, if approved by authorities having jurisdiction.

## **2.5 LABELING AND IDENTIFYING**

- .1 Detectable Warning tape:
  - .1 Acid- and alkali-resistant, PE film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches (150 mm) wide and 4 mils (0.1 mm) thick, continuously inscribed with a description of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches (750 mm) deep; colored yellow.

## **PART 3 EXECUTION**

### **3.1 EXAMINATION**

- .1 Verify existing conditions before starting work.
- .2 Verify that excavations are to required grade, dry, and not over-excavated.
- .3 Examine roughing-in for natural-gas piping system to verify actual locations of piping connections before equipment installation.
- .4 Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 PREPARATION**

- .1 Ream pipe and tube ends. Remove burrs.

- .2 Piping shall be free of scale and defects. Remove scale, slag, debris and dirt, on inside and outside, before assembly.
- .3 Prepare piping connections to equipment with flanges or unions.
- .4 Close equipment shutoff valves before turning off natural gas to premises or piping section.
- .5 Inspect natural-gas piping according to NFPA 54 to determine that natural-gas utilization devices are turned off in piping section affected.
- .6 Comply with NFPA 54 requirements for prevention of accidental ignition.

### **3.3 INSTALLATION**

- .1 Only include the following paragraph if a manufacturer actually publishes installation instructions - many do not. If the manufacturer does NOT publish such a document, ensure all install criteria that is important to the project, is specified below.
- .2 No gas piping shall be installed below ground beneath the building or through the foundation of the building.
- .3 Install to CAN/CSA B149.1 and generator piping to CSA C282.
- .4 Provide manual shut-off upstream of pressure regulator.
- .5 Provide clearance from gas vent discharge from regulator to building openings, appliance vent outlets, moisture exhaust ducts, mechanical air intake, appliance air intakes and sources of ignition as required by CAN/CSA B149.1.
- .6 Locate regulator a minimum of 3 m (10 ft) upstream of connection to equipment.
- .7 Install to manufacturer's written instructions.
- .8 Comply with NFPA 54 for installation and purging of natural gas piping.
- .9 Install underground PE natural-gas piping according to ASTM D 2774, in continuous length (no joints except at riser). Provide containment conduit where shown on drawings.
- .10 Provide pressure gauge downstream of each service regulator.
- .11 Locate valves for easy access by authorized personnel. Provide access (doors) where valves and fittings are not exposed.
- .12 Install sleeves for piping penetrations of walls and slabs.
- .13 Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.
- .14 Install piping to maintain headroom, conserve space, and not interfere with use of space.
- .15 Group piping whenever practical at common elevations.
- .16 Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. Refer to Section 23 05 16.
- .17 Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings. Refer to Section 23 07 19.
- .18 Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.
- .19 Provide support for utility meters to requirements of utility companies.
- .20 Prepare exposed, unfinished pipe, fittings, supports, and accessories ready for finish painting.
- .21 Pipe vents from gas pressure reducing valves to outdoors and terminate in weather proof hood.

.22 Inserts:

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

.23 Install piping free of sags and bends.

.24 Extend indoor relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap.

.25 Install manual gas shutoff valve for each gas appliance upstream of connectors.

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

.27 Install unions downstream of valves and at equipment or apparatus connections.

.28 Provide non-conducting dielectric connections wherever jointing dissimilar metals..

### 3.4 HANGER AND SUPPORT INSTALLATION

.1 Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Section 230549 "Seismic and Wind Restraint."

.2 Comply with requirements for pipe hangers and supports specified in Section 23 05 29 " Supports and Anchors."

.3 Install to OBC, CAN/CSA B149.1, ASME B31.9 and local Authority.

.4 Install hangers to provide minimum 13mm (1/2") space between finished covering and adjacent work.

.5 Place hangers within 300mm (12") of each horizontal elbow.

.6 Use hangers with 40mm (1-1/2") minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.

.7 Support vertical piping at every floor. Support riser piping independently of connected horizontal piping.

.8 Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.

.9 Provide copper plated hangers and supports for copper piping, or provide electrolytic action tape or equivalent if copper pipe attachment is not provided.

.10 Manufactured hangers are normally supplied in black steel.

.11 Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

.12 Provide hangers adjacent to motor driven equipment with vibration isolation; refer to Section 23 05 48.

.13 Support horizontal piping as scheduled.

.14 Pipe Hanger Schedule:

- .1 Metal Piping:
  - .1 Pipe size: 13mm to 32mm (1/2" to 1-1/4"):
    - .1 Maximum hanger spacing: 2m (6.5').
    - .2 Hanger rod diameter: 9mm (3/8").
  - .2 Pipe size: 40mm to 50mm (1-1/2" to 2"):
    - .1 Maximum hanger spacing: 3m (10').
    - .2 Hanger rod diameter: 10mm (3/8").
  - .3 Pipe size: 65mm to 75mm (2-1/2" to 3"):
    - .1 Maximum hanger spacing: 3m (10').
    - .2 Hanger rod diameter: 13mm (1/2").
  - .4 Pipe size: 100mm to 150mm (4" to 6"):
    - .1 Maximum hanger spacing: 3m (10').
    - .2 Hanger rod diameter: 15mm (5/8").
- .2 Plastic Piping:
  - .1 All Sizes:
    - .1 Conform to pipe manufacturer's recommended support spacing.
    - .2 Hanger rod diameter: 9mm (3/8").

### **3.5 IDENTIFICATION**

- .1 Install tracer wire beside the natural gas piping and secure at both ends where underground piping come up out of ground.
- .2 Install yellow flagging tape 250 mm (10") directly above gas piping.

### **3.6 FIELD QUALITY CONTROL**

- .1 Install tracer wire beside the natural gas piping and secure at both ends where underground piping come up out of ground.
- .2 Install yellow flagging tape 250 mm (10") directly above gas piping.
- .3 Site Tests/Inspection:
  - .1 Test system in accordance with CAN/CSA B149.1 and requirements of authorities having jurisdiction.
- .4 Purging: purge after pressure test in accordance with CAN/CSA B149.1.
- .5 Pre-Start-Up Inspections:
  - .1 Check vents from regulators, control valves, terminate outside building in approved location, protected against blockage, damage.
  - .2 Check gas trains, entire installation is approved by authority having jurisdiction.

**END OF SECTION**



## **PART 1- GENERAL**

### **1.1 GENERAL REQUIREMENTS**

- .1 Read and be governed by conditions of the *Contract Documents*, including sections of Division 01.

### **1.2 SUMMARY**

- .1 Section Includes
  - .1 Furnace
  - .2 Condensing unit.

## **PART 2- PRODUCTS**

### **2.1 MODEL NUMBER**

- .1 Alternate Manufacturers:
  - .1 York
  - .2 Trane

### **2.2 FURNACE**

- .1 Variable speed condensing 2-stage gas furnace with 96.5% AFUE, ECM blower motor, 4-way installation flexibility, direct vented.
- .2 Alternate Manufacturers:
  - .1 Carrier (basis of design)
  - .2 York
  - .3 Trane
- .3 Quality Assurance:
  - .1 Unit will be designed, tested and constructed to the current ANSI Z 21.47/CSA 2.3 design standard for gas-fired central furnaces.
  - .2 Unit will be third party certified by CSA to the current ANSI Z 21.47/CSA 2.3 design standard for gas-fired central furnaces. Unit will carry the CSA Blue Star and Blue Flame labels. Unit efficiency testing will be performed per the current DOE test procedure as listed in the Federal Register.
  - .3 Unit will be certified for capacity and efficiency and listed in the latest AHRI Consumer's Directory of Certified Efficiency Ratings.
  - .4 Unit will carry the current Federal Trade Commission Energy Guide efficiency label.
- .4 Standard features:
  - .1 Variable-speed ECM blower motor, two-speed inducer motor. Centrifugal type blower wheel
  - .2 96.3% Annual Fuel Utilization Efficiency (AFUE) for upflow orientation.
  - .3 Two-stage gas valve.

- .4 Fully-insulated casing including blower section.
- .5 Aluminized-steel primary heat exchanger.
- .6 Stainless-steel condensing secondary heat exchanger.
- .7 Adjustable blower speed for heating, cooling, continuous fan and dehumidification.
- .8 Direct vented.
- .9 Sealed combustion system.
- .10 Insulated casing.
- .11 Furnace package shall include: flame-proving sensor, hot surface igniter, pressure switch assembly, flame rollout switch, drain tubing and installed condensate drain trap, blower and inducer assembly, transformer, low voltage heating/cooling thermostat, mixing box, filter, pre-painted galvanized steel casing, micro-processor based integrated electronic control board.
- .12 CSA design certified.
- .13 AHRI efficiency rating certified.
- .14 Energy Star rated.
- .15 Allows BAS communication. Able to enable furnace, monitor status and generate alarm to BAS if furnace fails. Fan, heating, cooling status is viewable through BAS. BAS able to view and control setpoint .

## **2.3 CONDENSING UNIT**

- .1 Outdoor-mounted, air-cooled, split-system air conditioner unit suitable for ground or rooftop installation. Unit consists of a hermetic compressor, an air-cooled coil, propeller-type condenser fan, and a control box. Unit will discharge supply air upward as shown on contract drawings. Unit will be used in a refrigeration circuit to match up to a packaged fan coil or coil unit. Contained within the unit enclosure is all factory wiring, piping, controls, compressor, refrigerant charge Puronr (R-410A), and special features required prior to field start-up.
- .2
- .3 Alternate Manufacturers:
  - .1 Carrier (basis of design)
  - .2 York
  - .3 Trane
- .4 Quality Assurance:
  - .1 Unit will be rated in accordance with the latest edition of ARI Standard 210.
  - .2 Unit will be certified for capacity and efficiency, and listed in the latest AHRI directory.
  - .3 Unit construction will comply with latest edition of ANSI/ ASHRAE and with NEC.
  - .4 Unit will be constructed in accordance with UL standards and will carry the UL label of approval. Unit will have c-UL approval.
  - .5 Unit cabinet will be capable of withstanding Federal Test Method Standard No. 141 (Method 6061) 500-hr salt spray test.
  - .6 Air-cooled condenser coils will be leak tested at 150 psig and pressure tested at 450 psig.
  - .7 Unit constructed in ISO9001 approved facility.

- .5 Unit cabinet
  - .1 Unit cabinet will be constructed of galvanized steel, bonderized, and coated with a powder coat paint.
- .6 Efficiency
  - .1 Minimum 16 SEER at ARI conditions.
  - .2 Minimum 13 EER at ARI conditions.
- .7 Fans
  - .1 Condenser fan will be direct-drive propeller type, discharging air upward.
  - .2 Condenser fan motors will be totally enclosed, 1-phase type with class B insulation and permanently lubricated bearings. Shafts will be corrosion resistant.
  - .3 Fan blades will be statically and dynamically balanced.
  - .4 Condenser fan openings will be equipped with coated steel wire safety guards.
- .8 Compressor
  - .1 Compressor will be hermetically sealed.
  - .2 Compressor will be mounted on rubber vibration isolators.
- .9 Condenser Coil
  - .1 Condenser coil will be air cooled.
  - .2 Coil will be constructed of aluminum fins mechanically bonded to copper tubes which are then cleaned, dehydrated, and sealed.
- .10 Evaporator Coil
  - .1 Upsized evaporator coil (one size larger than condenser) for increased latent removal.
- .11 Refrigeration Components
  - .1 Refrigeration circuit components will include liquid-line shutoff valve with sweat connections, vapor-line shutoff valve with sweat connections, system charge of Puron (R-410A) refrigerant, and compressor oil.
  - .2 Unit will be equipped with filter drier for Puron refrigerant.

## **PART 3– EXECUTION**

### **3.1 INSTALLATION**

- .1 Coordinate with architectural trades that concrete pads for condenser units will be suitably sized and located.
- .2 Verify that floors are ready for installation of units and openings are as indicated on shop drawings.
- .3 Verify that proper power supply is available for furnace and condenser. Verify that proper fuel supply is available for connection.
- .4 Install venting as required by engineering drawings, local authority and manufacturer instructions.
- .5 Pipe condensate to nearest floor drain complete with condensate neutralizer.

**END OF SECTION**

## **PART 1- GENERAL**

### **1.1 GENERAL REQUIREMENTS**

- .1 Read and be governed by conditions of the *Contract Documents*, including sections of Division 01.

### **SUMMARY**

- .2 Section Includes
  - .1 Piping.
  - .2 Refrigerant.
  - .3 Moisture and liquid indicators.
  - .4 Valves / Check Valves / Pressure Relief Valves
  - .5 Filter-driers.
  - .6 Expansion Valves & Strainers.
  - .7 Pressure Regulators.
  - .8 Solenoid valves.
  - .9 Expansion valves.
  - .10 Electronic expansion valves.
  - .11 Flexible connections.

### **1.2 SUBMITTALS**

- .1 Shop Drawings
  - .1 Submit shop drawings or product data sheets for all products specified in Part 2 of this Section, except for pipe and fittings. Ensure that shop drawings and product data sheets confirm that products meet all requirements of the Contract Documents.
- .2 Refrigerant Piping Schematics
  - .1 Submit in shop drawing form a refrigerant piping schematic for each refrigerant piping system. Include pipe sizes, slopes, valves, traps, and piping specialties. Piping schematics must be reviewed and approved by the refrigeration equipment manufacturers prior to being submitted to the Consultant for review.
- .3 Certification Reports
  - .1 Submit letters from equipment suppliers certifying proper installation and start-up of the piping systems and equipment as specified in Part 3 of this Section.

## **PART 2– PRODUCTS**

### **2.1 PIPING**

- .1 Line sets:
  - .1 Equal to Great Lakes Copper Inc. “EZ-Roll” soft annealed copper to ASTM B280, suitable for use with the refrigerant involved, factory cleaned and capped, and with sizes and lengths as required.
- .2 Copper Tubing: Type ACR hard drawn seamless copper tubing to ASTM B280.
  - .1 Fittings: Wrought copper soldering fittings to ASME B16.22. Joints: Brazed joints made with high melting point silver brazing alloy conforming to AWS Classification BcuP-5.

### **2.2 MOISTURE AND LIQUID INDICATORS**

- .1 Manufacturers:
  - .1 Mueller Industries Inc.;
  - .2 Sporlan Valve Co.;
  - .3 Superior Refrigeration Products – Sherwood Valve.
- .2 Indicators: Forged brass, triple sealed, CSA certified indicators. Each indicator shall:
  - .1 Be suitable for a maximum working pressure of 3445 kPa (500 psi) and complete with a liquid indicator that shows ‘FULL’ when system is fully charged and remains blank when there is a restriction or shortage of refrigerant.
  - .2 Contain a moisture indicator that changes colour from blue to pink when moisture is present in the system.
  - .3 Contain a plastic dust cover and extended copper tube brazing connections.

### **2.3 BALL VALVES**

- .1 Manufacturers:
  - .1 Mueller Industries Inc.;
  - .2 Sporlan Valve Co.;
  - .3 Superior Refrigeration Products – Sherwood Valve.
- .2 CSA certified forged brass ball valves, each suitable for a maximum working pressure of 3445 kPa (500 psi) and complete with carbon filled Teflon ball seals, two O-ring stem seals, a gasketed seal cap, a flow direction arrow cast into the body, a ball position indicator on the stem, and extended copper tube connections to permit brazing the valve into the line without disassembling the valve.

### **2.4 CHECK VALVES**

- .1 Manufacturers:
  - .1 Mueller Industries Inc.;
  - .2 Sporlan Valve Co.;
  - .3 Superior Refrigeration Products – Sherwood Valve.
- .2 Straight Through Type:

- .1 Application: For valves 6.4 mm to 16 mm (1/4" to 5/8") diameter.
- .2 Complete with a brass gasketed body, phosphor-bronze spring, neoprene seat, and extended tubing for brazing connections.
- .3 Globe Type:
  - .1 Application: For valves 22 mm (7/8") diameter and larger.
  - .2 Complete with a cast bronze body, forged brass cap, phosphor-bronze spring, Teflon seat disc, neoprene O-ring seal, and extended tubing for brazing connections.

## **2.5 PRESSURE RELIEF VALVES**

- .1 Manufacturers:
  - .1 Mueller Industries Inc.;
  - .2 Sporlan Valve Co.;
  - .3 Superior Refrigeration Products – Sherwood Valve.
- .2 Straight Through or Angle Type, as required. Constructed in accordance with the requirements of ANSI Code B9.1 and the ASME Code for Unfired Pressure Vessels, and each complete with a brass body, neoprene seat disc, and lead seal and locking wire.

## **2.6 FILTER-DRIERS**

- .1 Manufacturers:
  - .1 Mueller Industries Inc.;
  - .2 Sporlan Valve Co.;
  - .3 Superior Refrigeration Products – Sherwood Valve.
- .2 CSA certified filter-driers, each suitable for a maximum 3445 kPa (500 psi) working pressure and complete with a combination of desiccants in a fluted briquette for drying, and a fluted briquette type filter.

## **2.7 EXPANSION VALVES**

- .1 Manufacturers:
  - .1 Mueller Industries Inc.;
  - .2 Sporlan Valve Co.;
  - .3 Superior Refrigeration Products – Sherwood Valve.
- .2 Factory tested, balanced port design thermostatic expansion valves. Exact selection to suit the application and refrigerant used. Each complete with a replaceable stainless-steel diaphragm and welded element construction thermostatic element charged with hydraulic fluid and removable inlet strainer.

## **2.8 FLEXIBLE CONNECTORS**

- .1 Manufacturers:
  - .1 Senior Flexonics Canada;
  - .2 The Metraflex Co.

- .2 Phosphor-bronze construction, factory cleaned, dried, and sealed flexible piping connections with copper tube brazing end.

## **PART 3- EXECUTION**

### **3.1 PREPARATION**

- .1 Ream pipe and tube ends. Remove burrs.
- .2 Remove scale and dirt on inside and outside before assembly.
- .3 Prepare piping connections to equipment with flanges or unions.

### **3.2 INSTALLATION**

- .1 Install refrigeration specialties to manufacturer's written instructions.
- .2 Route piping in orderly manner, with plumbing parallel to building structure, and maintain gradient.
- .3 Install piping to conserve building space and not interfere with use of space.
- .4 Group piping whenever practical at common elevations and locations. Slope piping 1% in direction of oil return.
- .5 Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- .6 Inserts:
  - .1 Provide inserts for placement in concrete formwork.
  - .2 Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
  - .3 Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 100 mm.
  - .4 Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
  - .5 Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut recessed into and grouted flush with top of slab.
- .7 Pipe Hangers and Supports:
  - .1 Install to ASME B31.5.
  - .2 Support horizontal piping as scheduled.
    - .1 Install hangers to provide minimum 13 mm space between finished covering and adjacent work.
  - .3 Place hangers within 300 mm of each horizontal elbow.
  - .4 Support vertical piping at every floor. Support riser piping independently of connected horizontal piping.
  - .5 Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
  - .6 Provide copper plated hangers and supports for copper piping.
- .8 Arrange piping to return oil to compressor. Provide traps and loops in piping and provide double risers as required. Slope horizontal piping 0.40% in direction of flow.

- .9 Provide clearance for installation of insulation and access to valves and fittings.
- .10 Provide access to concealed valves and fittings.
- .11 Flood piping system with nitrogen when brazing.
- .12 Where pipe support members are welded to structural building frame, brush clean, and apply one coat of zinc rich primer to welding.
- .13 Prepare unfinished pipe, fittings, supports, and accessories ready for finish painting. Refer to Section 09 91 10.
- .14 Insulate piping; refer to Section 23 07 19.
- .15 Follow ASHRAE 15 procedures for charging and purging of systems and for disposal of refrigerant.
- .16 Provide replaceable cartridge filter-driers, with isolation valves and valved bypass.
- .17 Locate expansion valve sensing bulb immediately downstream of evaporator on suction line.
- .18 Provide external equalizer piping on expansion valves with refrigerant distributor connected to evaporator.
- .19 Install flexible connectors at right angles to axial movement of compressor, parallel to crankshaft.
- .20 Fully charge completed system with refrigerant after testing.
- .21 Provide electrical connection to solenoid valves. Refer to Section 26 05 80.
- .22 Where piping insulation surface is installed in a wall within 65 mm (2.5") from surface of interior wall, the pipe shall be protected by steel shield plates with a minimum thickness of 1.463 mm (0.0575", 16-ga), concealed behind the drywall. Plates shall cover the piping and bottom and top plates it penetrates to protect piping during drywall installation, and at least 2" beyond each side of the pipe.

### **3.3 FIELD QUALITY CONTROL**

- .1 Test refrigeration system to ASME B31.5.
- .2 Pressure test system with dry nitrogen to 1470 kPa (200 psig). Perform final tests at 92 kPa (27 inches) vacuum and 1470 kPa (200 psig) using electronic leak detector. Test to no leakage.

**END OF SECTION**



## **PART 1 – GENERAL**

### **1.1 GENERAL REQUIREMENTS**

- .1 Read and be governed by conditions of the *Contract Documents*, including sections of Division 01.

### **1.2 SUMMARY**

- .1 Section Includes
  - .1 Energy recovery ventilators

### **1.3 PERFORMANCE REQUIREMENTS**

- .1 No variation of unit performance, duct configuration, or sizes permitted except by written permission.

### **1.4 SUBMITTALS**

- .1 Submit shop drawings or product data sheets for all products specified under this Section indicating airflow and static pressure capacities, recovery efficiency, dimensions, required clearances, weights, location and size of field connections, electrical requirements.

### **1.5 DELIVERY, STORAGE, AND HANDLING**

- .1 All materials and products shall be inspected upon delivery to the site to ensure there is no pre-existing damage due to dust, moisture, or physical impact.
- .2 All duct inlets and outlets shall be protected with plastic wrap when not actively being worked on and at the end of every day.

### **1.6 MAINTENANCE MATERIAL SUBMITTALS**

- .1 Extra stock materials: provide one set of extra filters.

### **1.7 QUALITY ASSURANCE**

- .1 Maximum flame spread index (FSI) of 25 and a maximum smoke developed index (SDI) of 50 thereby meeting NFPA90A and NFPA 90B requirements for materials in a compartment handling air intended for circulation through a duct system.
- .2 Certified by HVI under CSA 439.
- .3 Listed under UL 1812 Standard for Ducted Air to Air Heat Exchangers. The unit must pass commercial flammability requirements and shall not be labeled "For Residential Use Only".

## **PART 2– PRODUCTS**

### **2.1 ACCEPTABLE MANUFACTURERS**

- .1 The following manufacturers are approved for use:
  - .1 Renewaire (basis of design)
  - .2 Or approved equal

.2 General description

- .1 Fully assembled at the factory, consisting of fixed-plate cross-flow heat exchanger, insulated single wall G90 galvanized painted 24-gauge steel cabinet, filter assemblies for both intake and exhaust air, enthalpy core, supply air blower assembly, exhaust air blower assembly and electrical control box with all specified components and internal accessories factory installed and tested and prepared for single-point high voltage connection.
- .2 Unit must be mountable in various orientations.
- .3 Ability to set supply and exhaust airflows independently of each other.
- .4 Capable of transferring both sensible and latent energy between airstreams.
- .5 Water vapour transfer through molecular transport by hygroscopic resin not "porous plate" mechanisms. Mixing of airstreams shall not occur.

.3 Unit Construction

- .1 Formed single-wall insulated metal cabinet, fabricated to permit access to internal components for maintenance.
- .2 Casing walls and doors fully insulated with 1" expanded polystyrene foam faced with cleanable foil face on all exposed surfaces.
- .3 Access door shall provide easy access to blowers, ERV cores, filters. Access door shall be hinged with airtight closed cell foam gaskets with airtight compression seal.
- .4 Passive frost control: ERV core shall perform without condensing or frosting under normal operating conditions (defined as outside air temperature above -10°F and inside relative humidity below 40%). Occasional more extreme conditions shall not affect the usual function, performance or durability of the core. Unit shall have capacity to operate continuously without the need for bypass, recirculation, pre-heaters or defrost cycles under normal operating conditions.

.4 Blower Section

- .1 Supply and exhaust fans shall be electronically commutated (EC) motors with multispeed capability.
- .2 Statically and dynamically balanced and designed for continuous operation at maximum rated fan speed and horsepower.

.5 Filter Section

- .1 MERV 8 spun polyester disposable filter in both airstreams with capability to incorporate an optional 1" thick MERV 13 disposable pleated filter in outdoor airstream.

.6 Unit Controls

- .1 Unit shall have internal 24 VAC transformer and relay.

## **PART 3– EXECUTION**

### **3.1 EXAMINATION**

- .1 Prior to starting installation, examine area and conditions to verify correct location for compliance with installation tolerances and other conditions affecting unit performance. Proceed with installation only after all unsatisfactory conditions have been corrected.

### **3.2 INSTALLATION**

- .1 Install in accordance with manufacturer's Installation & Maintenance instructions.
- .2 Provide flexible duct connections at or near unit duct flanges.
- .3 Provide vibration isolation and/or seismic isolation as per related specifications sections 23 05 48 and 23 05 49.
- .4 Allow room for manufacturer recommended clearances, ductwork and its insulation, and heater. Ensure unit is oriented for easy maintenance access.
- .5 Complete manufacturer's start-up checklist as found in manufacturer's IOM with manufacturer's representative.

### **3.3 DEMONSTRATION AND TRAINING**

- .1 Contractor shall train Owner and Owner's personnel to adjust, operate and maintain the ERV.

**END OF SECTION**

## **PART 1 GENERAL**

### **1.1 GENERAL REQUIREMENTS**

- .1 Read and be governed by conditions of the *Contract Documents*, including sections of Division 01.

### **1.2 SUMMARY**

- .1 Section Includes
  - .1 Metal duct work.
  - .2 Casing and plenums.
  - .3 Duct cleaning.

### **1.3 PERFORMANCE REQUIREMENTS**

- .1 No variation of duct configuration or sizes permitted except by written permission. Size round ducts installed in place of rectangular ducts to ASHRAE table of equivalent rectangular and round ducts.

### **1.4 SUBMITTALS**

- .1 Submit shop drawings or product data sheets for all products specified under this Section, except shop fabricated ductwork and fittings.

### **1.5 DELIVERY, STORAGE, AND HANDLING**

- .1 All materials and products shall be inspected upon delivery to the site to ensure there is no pre-existing damage due to dust, moisture, or physical impact.
- .2 Once on the site, all materials and products shall be stored according to 3.01A.
- .3 All materials used to protect (e.g., skids, tarps etc.) materials and products shall be reused as practicable and recycled at the end of their useful life.

### **1.6 ENVIRONMENTAL REQUIREMENTS**

- .1 Ambient Conditions:
  - .1 Do not install duct sealants when temperatures are less than those recommended by sealant manufacturers.
  - .2 Maintain temperatures during and after installation of duct sealants.

## **PART 2 PRODUCTS**

### **2.1 MATERIALS**

- .1 Galvanized Steel Ducts:
  - .1 Galvanizing: ASTM A653 hot dipped galvanized steel sheet, lock-forming quality. Bare uncovered ducts to be finish painted shall G60 satin coat to ASTM A90, all other galvanized ducts shall be G90 zinc coated to ASTM A90.
  - .2 Rectangular: Lock forming grade hot dip galvanized steel, ASTM A653, shop fabricated, minimum #26 gauge.

- .3 Round: Factory machine fabricated, spiral, mechanically locked flat seam, single wall duct, fittings and couplings.
- .4 Flat Oval: Factory machine fabricated, single wall, 4-ply spiral lock seam duct, fittings and couplings.
- .2 Aluminum Ducts: ASTM B209 aluminum sheet, alloy 3003-H14. Application: for shower room exhaust.
- .3 Aluminum Connectors and Bar Stock: Alloy 6061- T6 or of equivalent strength.
- .4 Flexible Metallic Ducts:
  - .1 Uninsulated (return air): Spirally wound, semi-rigid, self-supporting corrugated aluminum duct with continuous triple lock seams, SMACNA Form "M-UN", ULC-S110 listed and labelled as a Class 1 Air Duct, constructed of dead soft aluminum strip, and supplied in 3 m (10') lengths.
  - .2 Insulated (supply air): Spirally wound, semi-rigid, self-supporting corrugated aluminum duct with continuous triple lock seams, SMACNA Form "M-I", ULC-S110 listed and labelled as a Class 1 Air Duct, constructed of dead soft aluminum strip, supplied in 3 m (10') lengths and factory covered with 40 mm (1½") thick, 12 kg/m<sup>3</sup> (0.75 lb/ft<sup>3</sup>) density fibreglass insulation with a vinyl jacket meeting flame spread and smoke developed requirements of CAN/ULC-S102.
- .5 Fasteners: Rivets, bolts, or sheet metal screws.
- .6 Sealant: ULC listed and labelled, premium grade, grey colour, water base, non-flammable duct sealer, brush, or gun applied, with a CAN/ULC S102 maximum flame spread rating of 5 and smoke developed rating of 0.
- .7 Hanger Rod: ASTM A36, galvanized steel; threaded both ends, threaded one end, or continuously threaded.

## **2.2 DUCTWORK FABRICATION**

- .1 Fabricate and support to SMACNA 1966, and as indicated. Provide duct material, gauges, reinforcing, and sealing for operating pressures indicated.
- .2 Supply air ductwork shall be medium pressure class ductwork.
- .3 Construct T's, bends, and elbows with radius of not less than 1-1/2 times width of duct on centreline (long radius elbows). Where not possible and where rectangular elbows are used, provide air foil turning vanes. Where acoustical lining is indicated, provide turning vanes of perforated metal with glass fibre insulation.
- .4 Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.
- .5 Fabricate continuously welded round and oval duct fittings two gauges heavier than duct gauges indicated in 100 mm (4 inch) Standard. Joints: minimum cemented slip joint, brazed or electric welded. Prime coat welded joints.
- .6 Provide standard 45 degree lateral wye takeoffs unless otherwise indicated where 90 degree conical tee connections may be used.
- .7 Unless otherwise specified, construct and install ductwork in accordance with ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible to suit the duct pressure class designation of minimum 500 Pa (2" w.c.) positive or negative as applicable. All flat surfaces of rectangular ductwork are to be cross-broken.

- .8 Ducts to 450mm wide shall have plain "S" slips on the long sides, and drive cleats on the short sides, folded over. Maximum end joint spacing is 3000mm. Ducts over 450mm wide shall have angle reinforced joints and gaskets, equal to Ductmate or TDS.

## **2.3 ACOUSTIC LINING**

- .1 Minimum 25 mm (1") thick acoustic lining material meeting NFPA 90A requirements and flame spread and smoke developed fire hazard ratings of CAN/ULC-S102, flexible for round ducts, board type for rectangular ducts, consisting of a flexible, closed-cell elastomeric insulation equal to Armacell AP Armaflex.
- .2 Materials shall be manufactured without the use of CFCs, HFCs, or HCFCs and shall be formaldehyde-free, low VOC, fibre free, dust free and resistant to mold and mildew with Microban coating.
- .3 Materials shall have a maximum 0.27 Btu-in./h-ft<sup>2</sup>-oF at a 75oF mean temperature when tested in accordance with ASTM 177 or ASTM C 518.
- .4 Materials shall have a maximum water absorption of 0.2% by volume when tested in accordance with ASTM C 209.
- .5 Materials shall be approved for air plenums.

## **PART 3 EXECUTION**

### **3.1 IAQ MEASURES AND PROCEDURES**

- .1 Ductwork Protection
  - .1 Stockpiled ductwork not yet installed shall be stored in an area that is clean, dry and has minimum exposure to dust. Ductwork shall be elevated a minimum of 4" above the floor and covered using tarps or plastic sheets.
  - .2 During ductwork installation, the working area shall be clean, dry and protected from the exterior elements.
  - .3 Wipe internal surfaces of ductwork immediately prior to installation to remove dust that has accumulated.
  - .4 All open ductwork must be covered at the end of each day or when not being worked on to prevent the entry of debris into the duct. This can be done using plastic sheets or duct end caps.
  - .5 If after inspection by the Project Architect and/or Region Project Manager the ductwork systems is deemed to be unacceptable, the Contractor shall prior to operation or test and balance, clean systems and equipment including but not limited to ductwork (supply/return/exhaust), air handling equipment, plenums, terminal units, fans, dampers, grilles/registers/diffusers with high power vacuum machines. Cleaning shall be performed in accordance with National Duct Cleaners Association (NADCA) standards, and by agent specializing in this field of work, and a member in good standing with NADCA. Protect equipment which may be harmed by excessive dirt with filters, or bypass during cleaning. Submit report, verified by TAB Agent, identifying the extent of duct system cleaning and certifying that NADCA standards have been met.
- .2 HVAC Equipment Protection
  - .1 HVAC equipment not yet installed shall be stored in an area that is clean, dry and has minimum exposure to dust. Equipment shall be elevated a minimum of 4" above the floor and covered using tarps or plastic sheets.

- .2 Seal supply diffusers and return grills with plastic during construction operations. Ensure that plastic covers remain in place until final building cleaning and prior to HVAC equipment start-up.
- .3 Provide temporary exhaust to areas where heavy construction and dust generating activities are expected to take place. Exhaust systems shall be independent of the building HVAC system to minimize ductwork and equipment contamination.
- .4 HVAC equipment should not be operated during construction. If temporary heating, cooling or ventilation is required, this should be done using temporary equipment. Equipment with firing sections located outside the building (e.g. indirect furnaces) should be given preference over standard propane fired construction heaters.

### **3.2 INSTALLATION OF RIGID DUCTWORK**

- .1 Install and seal ducts to manufacturer's written instructions and to SMACNA 1966.
- .2 Duct Sizes are inside clear dimensions. For lined ducts, maintain sizes inside lining.
- .3 Provide openings in duct work where required to accommodate thermometers and controllers. Provide pilot tube openings where required for testing of systems, complete with metal can with spring device or screw to ensure against air leakage. Where openings are provided in insulated duct work, install insulation material inside a metal ring.
- .4 Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
- .5 Provide access doors in locations of manual dampers, fire dampers, turning vanes, and coils to allow for inspection.
- .6 Provide adequate access into ductwork for cleaning purposes.
- .7 Joints:
  - .1 Use crimp joints with or without bead for joining round duct sizes 200 mm (8 inch) and smaller with crimp in direction of air flow.
  - .2 Where flanged duct joints are used, do not locate the joints in wall or slab openings, or immediately at wall or slab openings. Do not use flanged joints for exposed uninsulated ducts in finished areas.
- .8 Connections:
  - .1 Connect terminal units to supply ducts with 300 mm (12 inches) maximum length of flexible duct. Do not use flexible duct to change direction.
  - .2 Connect diffusers or light troffer boots to low pressure ducts with 2 m (6.5 ft) maximum length of flexible duct held in place with strap or clamp.
  - .3 Connect flexible ducts to metal ducts with adhesive plus sheet metal screws.
- .9 Provide residue traps in kitchen hood exhaust ducts at base of vertical risers with provisions for clean out. Use stainless steel for duct work exposed to view and where concealed.
- .10 During construction provide temporary closures of metal or taped polyethylene on open duct work to prevent construction dust from entering duct work system.
- .11 For all supply air grilles mounted directly to side of duct, make duct connection complete with 45 degree entry. Where round ducts connect to supply grilles or square neck diffusers, provide proper rectangular to round transition or provide plenum on back of grille / diffuser and connect round supply duct to side of plenum (not end directly opposite grille).

- .12 After final adjustments are made for air handling systems, lock each control device in position and visually indicate required setting. For balancing dampers, provide additional locking screw or bolt to approval.
- .13 Ducts Run Within or Through OWSJ: Refer to structural drawings. Where ductwork is to be run within or through open web steel joists, note that ductwork shown on the mechanical drawings is schematic only and is to be altered as required to suit the steel joist configuration, spacing, panel points, and cross-bridging at no additional cost.

### **3.3 INSTALLATION OF FLEXIBLE DUCTWORK**

- .1 Flexible ductwork for connections between duct branches and ceiling grilles or diffusers shall be no longer than 2 m. Do not install flexible ductwork through walls, even if shown on the drawings.
- .2 Install flexible ducts as straight as possible and support in accordance with requirements of ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible, and secure at each end with nylon or stainless steel gear type clamps, and seal joints. Do not make 90 deg bends with flex duct. Provide long radius sheet metal duct bends where they are required, e.g. at diffuser neck.
- .3 Do not penetrate fire barriers with flexible duct.

### **3.4 INSTALLATION OF ACOUSTIC LINING**

- .1 Provide acoustic lining in ductwork in these locations
  - .1 wherever shown and/or specified on the drawings;
  - .2 in all transfer air ducts.
- .2 Install lining in accordance with requirements of ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible, however, for all installations regardless of velocity, at leading and trailing edges of duct liner sections, provide galvanized steel nosing channel as per the detail entitled Flexible Duct Liner Installation found in the ANSI/SMACNA manual referred to above.
- .3 Where thermal insulation is specified, it is acceptable to provide an increased thickness of acoustic duct liner to meet the thermal insulation requirement.
- .4 Increase the outside diameter of lined ducts so that the interior dimension is as specified on drawings.

### **3.5 DUCT SUPPORT**

- .1 Rectangular Ducts Inside Building
  - .1 Support round and flat oval ducts inside the building in accordance with ANSI/SMACNA HVAC Duct Construction Standards – Metal and Flexible.
  - .2 For both uninsulated and insulated ducts exposed in finished area, use bands and secure at the top of the duct to a hanger rod, all similar to Ductmate Canada Ltd. type "BA" unless otherwise specified.
  - .3 If the duct is insulated, size the strap to suit the diameter of the insulated duct.
  - .4 Vertical circular duct to have 2-piece band clamps of 16 ga (1.6mm or heavier galvanized strap fastened on each side of duct and using 2 galvanized rods per clamp.
  - .5 Cable stay duct supports equal to Ductmate or DuroDyne are an acceptable alternate.
  - .6 Use double nuts and lock washers on threaded rod supports.
- .2 Round and Flat Oval Duct Support Inside Building:



- .1 Support round and flat oval ducts inside the building in accordance with ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible
- .2 for both uninsulated and insulated ducts exposed in finished area, use bands and secure at the top of the duct to a hanger rod, all similar to Ductmate Canada Ltd. type "BA" unless otherwise specified.
- .3 If the duct is insulated, size the strap to suit the diameter of the insulated duct.
- .4 Vertical circular duct to have 2-piece band clamps of 16 ga (1.6mm or heavier galvanized strap fastened on each side of duct and using 2 galvanized rods per clamp.
- .5 Cable stay duct supports equal to Ductmate or DuroDyne are an acceptable alternate.

### **3.6 DUCT SEALING**

- .1 Duct system sealing is to meet ANSI/SMACNA Seal Class A and Leakage Classification 6 in accordance with SMACNA 2012 HVAC Air Duct Leakage Test Manual requirements.
- .2 All transverse and longitudinal joints, seams, branch and duct connections, taps, end joints, access doors, connections to equipment, fittings for all heating/cooling and ventilation systems shall be sealed with low-odour, non-solvent base, low VOC duct sealant, such as Carlisle Hardcast Duct-Seal 321 or approved equal, combined with fiberglass mesh tape for larger gaps, applied to the thickness recommended by manufacturer.
- .3 Seal joints after assembly except for exposed ductwork where joints shall be interior sealed before assembly, for a neat finished appearance.
- .4 Apply sealants by brush or gun to cleaned metal surfaces. Where bare ductwork is exposed apply neat uniform lines of sealant. Randomly brushed, sloppy looking sealant applications will be rejected and must be repaired or replaced with a neat application of the sealant.
- .5 Duct sealer is not required for fully gasketted joints.
- .6 Seal all seams and edges of equipment serving ductwork (e.g. fan coil unit, filter boxes) but not access panels, and not if sealing could damage equipment or void the warranty.
- .7 Duct sealing and leak testing shall be conducted before ductwork is insulated or concealed by drywall or T bar ceiling to allow for re-sealing or repairing duct sections.
- .8 If duct leakage testing shows leakage criteria were not met using the sealing method specified above, Aeroseal duct sealing technology shall be used to achieve them. Alternatively, contractor can consider forgoing most duct sealing and duct leakage testing during construction and instead using Aeroseal technology at end of ductwork construction.

### **3.7 DUCT PRESSURE TESTING**

- .1 To test for duct sealing workmanship, leakage test at 500 Pa (2 in w.g.) for maximum 5% leakage, the following ductwork systems when about 25% have been completed:
  - .1 Furnace F-1 supply and return system
  - .2 ERV supply, return, intake, exhaust systems
- .2 If duct leakage testing shows leakage well within 5%, duct sealing practices can continue, and leakage rate shall be retested at the end of the project.
- .3 Ductwork leak testing shall be witnessed by the Commissioning Authority of a Regional Municipality of York representative.
- .4 Provide all test reports to Owner and Consultant.

- .5 The maximum allowable leakage in pressure testing for exterior or medium pressure ductwork shall be:

$$F = C_L * P^{0.65}$$

where

F = measured duct leakage (cfm/ft<sup>2</sup>)

CL = leakage classification, 6, and

P = duct operating pressure ("w.g.)

### **3.8 CLEANING AND START-UP**

- .1 Clean duct system and force air at high velocity through duct to remove accumulated dust. To obtain sufficient air, clean half the system at a time. Protect equipment which may be harmed by excessive dirt with temporary filters, or bypass during cleaning.
- .2 Clean duct systems with high power vacuum machines. Protect equipment which may be harmed by excessive dirt with filters, or bypass during cleaning. Provide adequate access into duct work for cleaning purposes.
- .3 Prior to starting any supply air handling system provide 50 mm thick glass fibre construction filters at fan equipment in place of permanent filters.
- .4 Provide cheesecloth over all duct system inlets and outlets and run the system for twenty-four hours, after which remove the cheesecloth, the construction filters, and install new permanent filters.
- .5 Include all labour for a complete site walk-through with testing and balancing personnel following the route of all duct systems to be tested, adjusted and balanced for the purpose of confirming the proper position and attitude of dampers, the location of pitot tube openings, and any other work affecting the testing and balancing procedures. Perform all corrective work required as a result of this walk-through.

**END OF SECTION**

## **PART 1- GENERAL**

### **1.1 GENERAL REQUIREMENTS**

- .1 Read and be governed by conditions of the *Contract Documents*, including sections of Division 01.

### **1.2 SUMMARY**

- .1 Section Includes
  - .1 Air turning devices/extractors.
  - .2 Backdraft dampers.
  - .3 Combination fire and smoke dampers.
  - .4 Duct access doors.
  - .5 Duct test holes.
  - .6 Fire dampers.
  - .7 Smoke Dampers.
  - .8 Flexible duct connections.
  - .9 Volume control dampers.

### **1.3 SUBMITTALS**

- .1 Shop Drawings/Product Data:
  - .1 Submit shop drawings/product data sheets for shop fabricated assemblies including hardware used, volume control dampers, duct access doors and duct test holes. Include electrical characteristics and connection requirements.
  - .2 Fire Dampers: Provide a schedule listing type, size, rating, location and verifying inspection for proper operation.
  - .3 Colour Chart(s): Submit manufacturer's colour chart(s) for all items for which a finish colour is to be selected.
- .2 Maintenance Material Submittals
  - .1 Extra Stock Materials: Provide two (2) of each size and type of fusible link.
  - .2 Record Documentation: Record actual locations of access doors and test holes.

## **PART 2- PRODUCTS**

### **2.1 SPLITTER DAMPERS**

- .1 Minimum #20 gauge damper blade constructed of the same material as the duct, reinforced as required to suit blade size, system velocity, and to prevent "chatter", and complete with operating hardware equal to Dyn Air Inc. #Q-50 "DYN-A-QUAD S-S" quadrant regulator with RW-50 backup washers to prevent leakage, long square bearing pin, and slide pin.

### **2.2 AIR TURNING VANES**

- .1 For square elbows – single thickness turning vanes, interconnected with bars, adequately reinforced to suit the pressure and velocity of the system, constructed of the same material as the duct they are associated with, and in accordance with ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible.
- .2 For short branch ducts at grille and diffuser connections - air extractor type, each equipped with a matching bottom operated 90 degree opposed blade volume control damper, constructed of the same material as the duct it is associated with and in accordance with requirements and details in ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible.

## **2.3 MANUAL BALANCING (VOLUME) DAMPERS**

- .1 Flanged and drilled, single or parallel blade (depending on damper size) manual balancing dampers, each constructed of the same material as the connecting ductwork unless otherwise specified, each designed to maintain the internal free area of the connecting duct, and each complete with:
  - .1 a hexagonal or square shaft extension through the frame;
  - .2 non-stick, non-corrosive synthetic bearings for rectangular dampers, flange stainless steel bearings for round dampers;
  - .3 blade stops for single blade dampers, designed to prevent the blade from moving more than 90°;
  - .4 linkage for multiple blade dampers;
  - .5 a locking hand quadrant damper operator with, for insulated ducts 50 mm standoff mounting.
- .2 Rectangular Dampers: Nailor Industries Inc. #SP1010 FF 16G LC BS NS, maximum size 1.2 m x 1.2 m (4' x 4') for a single damper.
- .3 Round Dampers: Nailor Industries Inc. #1090 BS, maximum 600 mm (24") diameter, equipped with a minimum 200 mm (8") deep frame, and blade stiffeners where required.
- .4 Multiple Rectangular Damper Section Assembly: Rectangular assembly supplied with the dampers or site constructed, of the same material as the damper and designed for tight and secure mounting of the individual dampers.
- .5 Acceptable manufacturers are:
  - .1 Nailor Industries Inc.;
  - .2 T.A. Morrison & Co. Inc. "TAMCO";
  - .3 NCA Manufacturing Ltd.;
  - .4 Greenheck Fan Corp.;
  - .5 Ruskin Co.;
  - .6 Alumavent.

## **2.4 BACKDRAFT DAMPERS**

- .1 T. A. Morrison & Co. Inc. "TAMCO" counterbalanced backdraft dampers, Series 7000 WT for vertical mounting, Series 7000 CW for down (horizontal) mounting, 65 mm (2½") deep, sized as shown and complete with:

- .1 extruded aluminum frame and blades, minimum 1.58 mm (1/16") thick, with captive extruded silicone blade gaskets and side seals in slots integral with the aluminum extrusions;
  - .2 damper blade counterweights internal to the frame and consisting of adjustable weights fastened to brackets which are riveted to the blades;
  - .3 dual PVC linkage tracks at each end of the blades, and non-corrosive linkage with hard alloy aluminum pivot arm and Ticona "Celcon" acetal copolymer bearings.
- .2 Acceptable manufacturers are:
- .1 T.A. Morrison & Co. Inc. "TAMCO";
  - .2 Nailor Industries Inc.;
  - .3 NCA Manufacturing Ltd.;
  - .4 Greenheck Fan Corp.;
  - .5 Ruskin Co.;
  - .6 Ventex.

## **2.5 FUSIBLE LINK DAMPERS**

- .1 Curtain blade type, dynamic, galvanized steel (unless otherwise specified) fusible link dampers, ULC classified to Standard CAN/ULC-S112 and in accordance with NFPA 90A requirements, factory tested for closure under airflow, 1 1/2 hour or 3 hour rated as required, and complete with a constant force type 301 stainless steel closure spring, a blade lock assembly, a steel sleeve, retaining angles, and, unless otherwise specified, a 74°C (165°F) rated standard fusible link.
- .2 Fusible link dampers are to be Type "B" or Type "C" (as required) with the folded curtain blade out of the air stream.
- .3 Fusible link dampers in ductwork other than galvanized steel are to be as specified above but constructed of Type 316 stainless steel.
- .4 Acceptable fusible link damper manufacturers are:
  - .1 Nailor Industries Inc.;
  - .2 Greenheck Fan Corp.;
  - .3 NCA Manufacturing Ltd.;
  - .4 Ruskin Co.;
  - .5 Alumavent.

## **2.6 FLEXIBLE CONNECTION MATERIAL**

- .1 Waterproof, indoor-outdoor type flexible connection material meeting requirements of NFPA 90A, consisting of woven glass fibre fabric coated on both sides with synthetic rubber. Acceptable products are:
  - .1 Duro Dyne Canada Inc. "DUROLON";
  - .2 Dyn Air Inc. "HYPALON".
- .2 For kitchen exhaust fans or in other high heat ductwork: Waterproof, flameproof, high temperature flexible connection material meeting requirements of NFPA 90A, consisting of a woven glass fibre fabric coated on both sides with silicone rubber. Acceptable products are:

- .1 Duro-Dyne Canada Inc. "THERMAFAB";
- .2 Dyn Air Inc. "SILICON HI-T".

## **2.7 ROOF DUCT SUPPORTS**

- .1 Equal to Lexcor (Lexsuo Corp.) Series SS-A215 "Flash-Tite" adjustable height, insulated aluminum structural supports, each complete with two-piece telescoping flashing, a aseplate to suit the application, a threaded cap with plate, and a 12 mm x 40 mm ( $\frac{1}{2}$ " x  $1\frac{1}{2}$ ") threaded stainless steel top stud.

## **2.8 DUCT ACCESS DOORS**

- .1 In accordance with ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible, with sizes suitable in all respects for the purpose for which they are provided, and, unless otherwise specified, constructed of the same material as the duct they are associated with.

## **2.9 DUCTWORK DRAIN POINTS**

- .1 Equal to Ductmate Canada Ltd. "DUCTMATE MOISTURE DRAIN", 20 mm ( $\frac{3}{4}$ ") diameter moisture drains with galvanized sheet metal funnel, and chrome plated brass threaded drain, nut and cap.

## **2.10 INSTRUMENT TEST PORTS**

- .1 Equal to Duro-Dyne of Canada Ltd. #IP1 or #IP2 (to suit insulation thickness where applicable) gasketed, leakproof instrument test ports for round or rectangular ducts as required, each complete with a neoprene expansion plug and a plug securing chain.

## **2.11 WIRE MESH (BIRDSCREEN)**

- .1 Heavy-gauge galvanized steel or aluminum mesh, 12 mm x 12 mm ( $\frac{1}{2}$ " x  $\frac{1}{2}$ ") secured in a rigid galvanized steel or aluminum framework, sized as indicated on the drawings, and constructed so as to be removable.

## **2.12 LOUVERS**

- .1 Price Industries Inc. DE439 or DE63 100 mm (4") or 150 mm (6") deep (to suit wall thickness) factory assembled stationary, drainable, storm-proof louvres sized as indicated on the drawings, each AMCA water penetration and air performance certified, constructed of welded, extruded, alloy 6063-T5 aluminum with drainable blades, extended sill, mounting and securing hardware to suit the application, and 12 mm ( $\frac{1}{2}$ ") mesh aluminum birdscreen in an aluminum frame.
- .2 Louvres are to be factory finished with a finish equal to PPG Industries "Duranar" fluoropolymer powder coating over primer with colour as selected from the manufacturer's standard colour range.
- .3 Acceptable manufacturers are:
  - .1 Price Industries Inc.;
  - .2 The Airolite Co. LLC;
  - .3 Construction Specialties;
  - .4 Nailor Industries Inc.;
  - .5 Greenheck Fan Corp.;
  - .6 Ventex.

## **PART 3- EXECUTION**

### **3.1 INSTALLATION OF ROUND TO RECTANGULAR DUCT CONNECTIONS**

- .1 Cut round holes in rectangular ducts and provide round to rectangular lock-in fittings with dampers for connection of flexible round ductwork.

### **3.2 INSTALLATION OF SPLITTER DAMPERS**

- .1 Provide splitter dampers in supply ductwork at branch duct connections off supply air mains, and wherever else shown and/or specified on the drawings. Install splitter dampers so they cannot vibrate and rattle and so that the damper operation mechanisms are in an easily accessible and operable location. Ensure that operators for dampers in insulated ducts are equipped with stand-off mounting brackets.

### **3.3 INSTALLATION OF TURNING VANES**

- .1 Provide turning vanes in ductwork elbows where shown on the drawings and wherever else required where, due to site installation routing and duct elbow radius, turning vanes are recommended in accordance with ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible.
- .2 Provide volume extractor type turning vanes in short branch supply duct connections off mains to grilles and diffusers where shown and/or specified.

### **3.4 INSTALLATION OF MANUAL BALANCING (VOLUME) DAMPERS**

- .1 Provide manual balancing dampers in all open-end ductwork, in all duct mains, and wherever else shown and/or specified.
- .2 Install the dampers so that the operating mechanism is accessible and positioned for easy operation, and so that the dampers cannot move or rattle. Ensure that operating mechanisms for dampers in insulated ducts are complete with stand-off mounting brackets.
- .3 Confirm exact damper locations with personnel doing air quantity balancing testing work and install dampers to suit. Include for providing five additional dampers at no additional cost.

### **3.5 INSTALLATION OF BACKDRAFT DAMPERS**

- .1 Provide backdraft dampers where shown.
- .2 Install and secure the dampers so that they cannot move or rattle.

### **3.6 INSTALLATION OF FUSIBLE LINK DAMPERS**

- .1 Provide fusible link dampers where shown and/or specified on the drawings. Ensure that the damper rating (1½ or 3 hr.) is suitable for the fire barrier it is associated with.
- .2 Install dampers with retaining angles on all four sides of the sleeve on both sides of the damper and connect with ductwork in accordance with the damper manufacturer's instructions and details to meet Code requirements.
- .3 Provide expansion clearance between the damper or damper sleeve and the opening in which the damper is required. Ensure that the openings are properly sized and located, and that all voids between the damper sleeve and the opening are properly sealed to maintain the rating of the fire barrier.

- .4 Provide a schedule listing all fire dampers by size, type, rating, location, and verifying inspection for proper installation. Submit with job completion documents.

### **3.7 INSTALLATION OF FLEXIBLE CONNECTION MATERIAL**

- .1 Provide a minimum of 100 mm (4") of flexible connection material where ducts, plenums, and/or easings connect to fans and any equipment with fans, and wherever else shown or specified.
- .2 Rigidly secure a minimum of 75 mm (3") of duct material (minimum #24 gauge) to each edge of the flexible fabric and to the fan, duct, plenum, etc., in accordance with ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible. Ensure that connections to the flexible fabric material are arranged and supported so as to not impose any external forces on the fabric.

### **3.8 INSTALLATION OF ROOF MOUNTED DUCT SUPPORTS**

- .1 Supply supports for roof mounted ductwork as indicated.
- .2 Hand the adjustable structural supports to the roofing trade on the roof for installation and flashing into roof construction as part of the roofing work. Accurately mark the exact locations and spacing of the structural supports and supervise installation. Provide properly sized hot dip galvanized structural steel angles between structural supports and secure in place on support studs. Support ductwork on the angles and provide galvanized steel banding to secure ducts to the angles.

### **3.9 INSTALLATION OF DUCT ACCESS DOORS**

- .1 Provide access doors in ductwork for access to all components which will or may need maintenance and/or repair, including fire dampers and reheat coils. Install in accordance with requirements of ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible.
- .2 Identify access doors provided for fusible link fire damper maintenance with "FIRE" stencil painted or marker type red lettering and ensure that the doors are properly located for damper maintenance.
- .3 When requested, submit a sample of proposed duct access doors for review.
- .4 Where sectionalized fusible link dampers and/or balancing dampers are provided in large ducts, provide a plenum type access door to suit, and adequately reinforce the ductwork to suit the access door installed.

### **3.10 INSTALLATION OF INSTRUMENTS TEST PORTS**

- .1 Provide instrument test ports in all main ducts at connections to fans, plenums or casings, in all larger branch duct connections to mains, and wherever else required for proper air quantity balancing and testing.
- .2 Locate test ports where recommended by personnel performing air quantity testing and balancing work.

### **3.11 INSTALLATION OF WIRE MESH (BIRDSCREEN)**

- .1 Provide framed, removable wire mesh panels over openings in ducts and/or walls where shown and/or specified on the drawings. Rigidly secure in place but ensure the panels are removable.
- .2 Provide wire mesh panels for open-end return air ducts in ceiling spaces whether shown on the drawings or not.



### **3.12 INSTALLATION OF LOUVRES**

- .1 Provide louvres for wall openings where shown.
- .2 Install louvre assemblies and secure in place in accordance with the manufacturer's instructions and details.
- .3 Confirm exact louvre sizes and finish prior to ordering.

**END OF SECTION**

## **PART 1- GENERAL**

### **1.1 GENERAL REQUIREMENTS**

- .1 Read and be governed by conditions of the *Contract Documents*, including sections of Division 01.

### **1.2 SUMMARY**

- .1 Section Includes
  - .1 Ceiling mounted fans;
  - .2 Axial fans;
  - .3 HVLS fans.

### **1.3 SUBMITTALS**

- .1 Shop Drawings/Product Data:
  - .1 Submit shop drawings/product data sheets for ceiling fans. Shop drawings/product data sheets must confirm that the fans conform to requirements of the Contract Documents. Include the following:
    - .1 certified fan performance curves;
    - .2 product data for all accessories;
    - .3 product data for fan motors.

### **1.4 QUALITY ASSURANCE**

- .1 Ceiling fan manufacturers are to be current members of the Air Movement and Control Association International Inc. (AMCA), and the fans are to be rated (capacity and sound performance) and certified in accordance with requirements of the following standards:
  - .1 ANSI/AMCA Standard 210, Laboratory Method of Testing Fans for Certified Aerodynamic Performance Rating.
  - .2 AMCA Standard 211, Product Rating Manual for Fan Air Performance;
  - .3 ANSI/AMCA Standard 300, Reverberant Room Method for Sound Testing of Fans;
  - .4 AMCA Standard 311, Product Rating Manual for Fan Sound Performance;
  - .5 AMCA Standard 99-2408, Operating Limits for Centrifugal Fans.

## **PART 2- PRODUCTS**

### **2.1 CEILING MOUNTED FANS**

- .1 ULC listed and labelled ceiling mounted centrifugal, exhaust fans as per the drawing schedule, complete with:
  - .1 ENERGY STAR certification with built-in speed selector (or as indicated on equipment schedule)
  - .2 ECM or DC motor engineered to run continuously;
  - .3 26-gauge or thicker housing;

- .4 Minimum 2-year warranty;
- .5 exhaust grille: for ceiling mounted fans as indicated and/or scheduled, a white exhaust grille;
- .6 accessories: factory supplied accessories as per the drawing schedule, as follows:
  - .1 rectangular to round duct transitions as required on drawings;
  - .2 a wall cap or louver as per schedule with backdraft damper and birdscreen.
- .7 Acceptable manufacturers are:
  - .1 Panasonic;
  - .2 Canarm Ltd.;
  - .3 Or approved equal.

## **2.2 INLINE CENTRIFUGAL FANS**

- .1 ULC listed and labelled fans as per the drawing schedule, complete with:
  - .1 Mixed-flow impeller
  - .2 100% speed controllable
  - .3 Integral thermal contacts
  - .4 Air stream temperatures up to 140°F
  - .5 EC motor with potentiometer
  - .6 Compact galvanized steel housing
  - .7 2-year factory warranty minimum
  - .8 Acceptable manufacturers are:
    - .1 Systemair Fantech;
    - .2 Greenheck;
    - .3 Or approved equal.

## **2.3 PROPELLER WALL FANS**

- .1 ULC listed and labelled propeller exhaust fan, balanced in accordance with AMCA 204-05, exhaust fans as per the drawing schedule, complete with:
  - .1 housing: minimum #20 gauge galvanized steel housing equipped with duct connection collar(s);
  - .2 OSHA wire guard;
  - .3 NEMA 1 for indoor or NEMA 3R for exterior disconnect switches;
  - .4 Motor shall be NEMA Design B with Class B insulation rated for continuous duty;
  - .5 Propeller shall have aluminum blades riveted to a painted steel hub securely fastened to the motor shaft utilizing two setscrews.
  - .6 EC motors.
  - .7 Acceptable manufacturers are:

- .1 Loren Cook Co.;
- .2 Canarm Ltd.;
- .3 Greenheck Fan Corp.;
- .4 PennBarry;
- .5 Twin City Fan and Blower;
- .6 Soler & Palau.

## **2.4 HIGH VOLUME LOW SPEED (HVLS) FANS**

- .1 ULC listed and labelled as per the drawing schedule, complete with:
  - .1 Powerfoil winglets to eliminate wind noise
  - .2 Industrial-grade motor and gearbox lubricated for life
  - .3 UV-resistant materials
  - .4 IP55 rating
  - .5 Controls: on/off and variable speed control
  - .6 BAS connectivity through controller
  - .7 Acceptable manufacturers are:
    - .1 Big Ass;
    - .2 Canarm HVAC;
    - .3 or approved equal.

## **PART 3- EXECUTION**

### **3.1 INSTALLATION**

- .1 Provide ceiling exhaust fans where shown.
- .2 Secure suspended units in place from the structure, level, and plumb, by means of vibration isolation hangers and galvanized steel hanger rods.
- .3 Plug fan motors into housing receptacles.
- .4 Supply exterior wall/roof discharge caps as indicated.
- .5 Hand roof caps to the roof trade for installation and flashing into roof construction as part of the roofing work.
- .6 Install wall caps and secure in place. Caulk the perimeter of each wall cap in accordance with caulking requirements specified in Division 07.
- .7 Connect fan housings and discharges with ductwork.
- .8 Provide seismic restraints as required.
- .9 Start-Up: Refer to the article entitled Equipment and System Start-up in the mechanical work Section entitled Mechanical Work General Instructions.

**END OF SECTION**

## **PART 1- GENERAL**

### **1.1 GENERAL REQUIREMENTS**

- .1 Read and be governed by conditions of the *Contract Documents*, including sections of Division 01.

### **1.2 SUMMARY**

- .1 Section Includes
  - .1 Diffusers.
  - .2 Registers/grilles.
  - .3 Door grilles.
  - .4 Louvers.
  - .5 Goosenecks.

### **1.3 SUBMITTALS**

- .1 Submittals for Review
  - .1 Product Data: Provide data for equipment required for this project. Review outlets and inlets as to size, finish, and type of mounting prior to submission. Submit schedule of outlets and inlets showing type, size, location, application, and noise level.
- .2 Submittals for Information
  - .1 Installation Data: Manufacturer's special installation requirements.
- .3 Construction Submittals
- .4 Close-Out Submittals
  - .1 Record Documentation: Record actual locations of air outlets and inlets.

### **1.4 DELIVERY, STORAGE, AND HANDLING**

- .1 All materials and products shall be inspected upon delivery to the site to ensure there is no pre-existing damage due to dust, moisture, or physical impact.
- .2 All materials used to protect (e.g., skids, tarps etc.) materials and products shall be reused as practicable and recycled at the end of their useful life.

## **PART 2- PRODUCTS**

### **2.1 GRILLES, REGISTERS, DIFFUSERS**

- .1 Grilles and diffusers of the type, size, capacity, finish, and arrangement as shown on the drawings and as per the drawing schedule, each equipped with all required mounting and connection accessories to suit the mounting location and application.
- .2 Manufacturers:

- .1 Price Industries Inc.;
- .2 Anemostat Air Distribution;
- .3 Krueger - HVAC;
- .4 Titus- HVAC;
- .5 Nailor Industries Inc.;
- .6 Metalaire.

## **2.2 LOUVERS**

- .1 Grilles and diffusers of the type, size, capacity, finish, and arrangement as shown on the drawings and as per the drawing schedule, each equipped with all required mounting and connection accessories to suit the mounting location and application.
- .2 Manufacturers:
  - .1 Price Industries Inc.;
  - .2 Alumavent Ventex Inc;
  - .3 The Airolite Co.LLC.;
  - .4 Construction Specialties;
  - .5 Nailor Industries Inc.;
  - .6 Greenheck Fan Corp.

## **2.3 GOOSENECKS**

- .1 Fabricate to SMACNA, of minimum 1.2 mm (18 ga) galvanized steel.
- .2 Mount on minimum 300 mm (12 inch) high curb base.

## **PART 3– EXECUTION**

### **3.1 INSTALLATION**

- .1 Install to manufacturer's written instructions.
- .2 Check location of outlets and inlets and make necessary adjustments in position to conform with architectural features, symmetry, and lighting arrangement.
- .3 Install diffusers to duct work with air tight connection.
- .4 Provide balancing dampers on duct take-off to diffusers, and grilles and registers, despite whether dampers are specified as part of the diffuser, or grille and register assembly.
- .5 Paint ductwork visible behind air outlets and inlets matte black. Refer to Section 09 91 10.
- .6 Provide grilles and diffusers where shown on the drawings. Wherever possible, grilles and diffusers are to be the product of one manufacturer.
- .7 Unless otherwise specified connect grilles and diffusers in accordance with requirements of SMACNA HVAC Duct Construction Standards Metal and Flexible.
- .8 Exactly locate grilles and diffusers to conform to the final architectural reflected ceiling plans and detailed wall elevations, and to conform to the final lighting arrangement, ceiling layout, ornamental and other wall treatment.

- .9 Equip supply diffusers having a basic four-way or all round air pattern for operation in one, two, or three way pattern where indicated on the drawings.
- .10 Provide sheet metal plenums, constructed of the same material as the connecting duct, for linear grilles and/or diffusers where shown. Construct and install the plenums in accordance with requirements of SMACNA HVAC Duct Construction Standards Metal and Flexible. Where individual sections of linear grilles or diffusers are not equipped with a volume control device, equip the duct connection collar(s) with volume control device(s).
- .11 Where linear type diffusers/grilles are installed in suspended T-bar ceilings, clip the diffusers/grilles in place using clip supplied by the diffuser/grille manufacturer.
- .12 Confirm grille and diffuser finishes prior to ordering.

### **3.2 SUPPLY OF DOOR GRILLES**

- .1 Supply door grilles.
- .2 Hand the grilles to the appropriate trade at the site for installation.

**END OF SECTION**



## **PART 1- GENERAL**

### **1.1 GENERAL REQUIREMENTS**

- .1 Read and be governed by conditions of the *Contract Documents*, including sections of Division 01.

### **1.2 SUMMARY**

- .1 Section Includes
  - .1 Infra-Red Heaters – Fuel Fired
- .2 General Requirements
  - .1 Comply with General Requirements of Section 20 05 00

## **PART 2 - PRODUCTS**

### **2.1 MANUFACTURERS**

- .1 Acceptable Manufacturers:
  - .1 Brant Radiant;
  - .2 Roberts Gordon;
  - .3 Schwank;
  - .4 Other manufacturers offering equivalent products equal or better will only be accepted as equals.
- .2 Unit Construction
  - .1 Units: Packaged, partially factory assembled, pre-wired unit consisting of cabinet, burner, heat exchanger, radiant tube, reflector, controls; for natural gas.
  - .2 Heat Exchanger: Aluminized tubular steel combustion chamber with aluminized steel tube with aluminum reflector.
  - .3 Gas Burner:
    - .1 Forced draft type with adjustable combustion air supply.
    - .2 Gas valve provides 100 percent safety gas shut-off; 24 volt combining pressure regulation, safety pilot, manual set (On-Off), pilot filtration, automatic electric valve.
    - .3 Electronic pilot ignition, with electric spark igniter.
    - .4 Non-corrosive burner air blower with permanently lubricated motor.
    - .5 2-stage capacity output.
  - .4 Gas Burner Safety Controls: Thermo-couple sensor prevents opening of solenoid gas valve until pilot flame is proven and stops gas flow on ignition failure.
  - .5 Premium User Interface module capable of connection to BAS and modulating control of the heaters.
  - .6 Provide install kits as required by installation design.

## **PART 3 EXECUTION**

### **3.1 INSTALLATION**

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

### **3.2 ENVIRONMENTAL REQUIREMENTS**

- .1 Do not operate units for any purpose, temporary or permanent, until equipment is clean, and fan has been test-run under observation.

**END OF SECTION**

## **PART 1 GENERAL**

### **1.1 GENERAL REQUIREMENTS**

- .1 Read and be governed by conditions of the Contract Documents, including sections of Division 01.

### **1.2 SUMMARY**

- .1 Section Includes
  - .1 Server Room Air Conditioning Units

### **1.3 SUBMITTALS**

- .1 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for air conditioning components and accessories and include product characteristics, performance criteria, physical size, finish and limitations.
- .2 Shop Drawings:
  - .1 Indicate on drawings:
    - .1 Details of Major components and accessories including sound power levels of units.
    - .2 Type of refrigerant used.

### **1.4 CLOSEOUT SUBMITTALS**

- .1 Operation and Maintenance Data: submit operation and maintenance data for air conditioning components for incorporation into manual.

### **1.5 DELIVERY, STORAGE, AND PROTECTION**

- .1 Deliver, store and handle materials in accordance with Section 01 60 00 - Product Requirements and manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
  - .1 Store materials indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 The wireless remote controller, for the wall mounted and floor standing indoor units, shall be shipped inside the carton and packaged with the indoor unit and shall be able to withstand 105°F storage temperatures and 95% relative humidity without adverse effect.
  - .3 The remote controller, for the ceiling suspended, ceiling recessed and ducted indoor units, either wireless or wired, shall be shipped separately.
  - .4 Store and protect air conditioning components from nicks, scratches, and blemishes.
  - .5 Replace defective or damaged materials with new.

### **1.6 QUALITY ASSURANCE**

- 1. The system components shall be tested by a Nationally Recognized Testing Laboratory (NRTL) and shall bear the ETL label.

2. All wiring shall be in accordance with the National Electrical Code (N.E.C.).
3. The units shall be rated in accordance with Air-conditioning, Heating and Refrigeration Institute's (AHRI) Standard 240 and bear the AHRI Certification label.
4. The units shall be manufactured in a facility registered to ISO 9001 and ISO 14001, which is a set of standards applying to product and manufacturing quality and environmental management and protection set by the International Standard Organization (ISO).
5. A dry air holding charge shall be provided in the indoor section.

## **1.7 SYSTEM DESCRIPTION**

- .1 The air conditioning system basis of design is a Mitsubishi Electric split system with Variable Speed Inverter Compressor technology. The system shall consist of a horizontal discharge, single phase outdoor unit, a matched capacity indoor section that shall be equipped with a wired wall-mounted controller.

## **PART 2 PRODUCTS**

### **2.1 GENERAL**

- .1 All units shall be listed and rated by ANSI/AHRI Standard 1360-2017 and meet all minimum IEER performance requirements as scheduled.
- .2 The units shall be CSA approved, ANSI/UL STD 1995 listed and listed by Electrical Testing Labs (ETL) and bear the cETL label.
- .3 All wiring shall be in accordance with the National Electric Code (NEC).
- .4 The system will be produced in an ISO 9001 and ISO 14001 facility, which are standards set by the International Standard Organization (ISO). The system shall be factory tested for safety and function.
- .5 The units and the design shall be in compliance with CSA B52 Mechanical Refrigerant Code including the March 2009 Supplement.
- .6 Acceptable alternative manufacturers, assuming compliance with these equipment specifications, are Daikin, Panasonic, LG, and Fujitsu.
- .7 Other Alternate manufacturers shall send approval requests to consultant 14 days prior to bid day, and include all information relevant to the alternate system, including but not limited to: unit selections, refrigerant piping layout, refrigerant charge with CSA B52 analysis, heating and cooling capacities at design temperatures and including capacity losses from piping lengths, defrost cycles, and combination ratios, dimensional and weight differences, and any other aspect of the system that differs from the system specified. Contractor bidding an alternate manufacturer does so with full knowledge that that manufactures product may not be acceptable or approved and that contractor is responsible for all specified items and intents of this document without further compensation.

### **2.2 OUTDOOR UNIT (BASIS OF DESIGN MITSUBISHI PUY)**

- .1 General
  - .1 The connected indoor unit shall be of the same capacity as the outdoor unit. The outdoor units must have a thermally fused powder coated finish. The outdoor unit shall be completely factory assembled, piped and wired. Each unit shall be run tested at the factory.

- .2 If an alternate manufacturer is selected, any additional material, cost, and labor to install additional lines shall be incurred by the contractor. Contractor responsible for ensuring alternative brand compatibility in terms of availability, physical dimensions, weight, electrical requirements, etc.
- .3 Outdoor unit shall have a sound rating no higher than 53 dB(A). If an alternate manufacturer is selected, any additional material, cost, and labor to meet published sound levels shall be incurred by the contractor.
- .4 Refrigerant lines from the outdoor unit to the indoor units shall be insulated in accordance with the installation manual.
- .5 The outdoor unit shall meet performance requirements per schedule and be within piping limitations & acceptable ambient temperature ranges as described in respective manufacturers' published product catalogs. Non-published product capabilities or performance data are not acceptable.
- .6 Four-legged outdoor unit mounting systems shall be equal to Ecofoot Ecoframe, minimum 600 mm (24") above grade. Stand shall be made from 7 gauge plate steel with thermally fused polyester powder coat finish that meets ASTM D3451-06 standards. Stands shall be provided with galvanized mounting hardware and meets all ASCE 7 overturning safety requirement.
- .7 The outdoor unit shall be provided with a manufacturer supplied 20 gauge hot dipped galvanized wind baffle. The wind baffle shall allow for continuous cooling to 0FDB without any additional modifications to the unit.
- .2 Unit Cabinet:
  - .1 The casing shall be fabricated of galvanized steel, bonderized, finished with an electrostatically applied, thermally fused acrylic or polyester powder coating for corrosion protection. Assembly hardware shall be cadmium plated for weather resistance.
  - .2 Easy access shall be afforded to all serviceable parts by means of removable panel sections.
  - .3 Two (2) mild steel mounting feet, traverse mounted across the cabinet base pan, welded mount, providing four (4) slotted mounting holes shall be furnished. Assembly shall withstand lateral wind gust up to 155 MPH to meet applicable weather codes. The casing(s) shall be fabricated of galvanized steel, bonderized and finished.
- .3 Fan:
  - .1 1, 1.5, 2 and 2.5 ton units shall be furnished with a single direct drive propeller type fan. 3, 3.5 ton units shall be furnished with a two (2) direct drive propeller type fans.
  - .2 The outdoor unit fan motor(s) shall be a direct current (DC) motor and have permanently lubricated bearings.
  - .3 The fan motor shall be mounted for quiet operation.
  - .4 The fan shall be provided with a raised guard to prevent contact with moving parts.
  - .5 The outdoor unit shall have horizontal discharge airflow.
- .4 Refrigerant and Refrigerant Piping:
  - .1 R410A refrigerant shall be required for systems.
  - .2 Polyolester (POE) oil—widely available and used in conventional domestic systems—shall be required. Prior to bidding, manufacturers using alternate oil types shall submit material safety data sheets (MSDS) and comparison of hygroscopic properties for alternate oil with list of local suppliers stocking alternate oil for approval at least two weeks prior to bidding.

- .3 Refrigerant piping shall be phosphorus deoxidized copper (copper and copper alloy seamless pipes) of sufficient radial thickness as defined by the equipment manufacturer and installed in accordance with manufacturer recommendations.
- .4 All refrigerant piping must be insulated with ½" closed cell, CFC-free foam insulation with flame-Spread Index of less than 25 and a smoke-development Index of less than 50 as tested by ASTM E 84 and CAN / ULC S-102. R value of insulation must be at least 3.
- .5 Refrigerant line sizing shall be in accordance with manufacturer specifications.
- .5 Coil:
  - .1 The outdoor unit coil shall be of nonferrous construction with lanced or corrugated plate fins on copper tubing.
  - .2 The coil shall be protected with an integral metal guard.
  - .3 Refrigerant flow from the outdoor unit shall be regulated by means of an electronically controlled, precision, linear expansion valve.
  - .4 All refrigerant lines between outdoor and indoor units shall be of annealed, refrigeration grade copper tubing, ARC Type, meeting ASTM B280 requirements, individually insulated in twin-tube, flexible, closed-cell, CFC-free (ozone depletion potential of zero), elastomeric material for the insulation of refrigerant pipes and tubes with thermal conductivity equal to or better than 0.27 BTU-inch/hour per Sq Ft / °F, a water vapor transmission equal to or better than 0.08 Perm-inch and superior fire ratings such that insulation will not contribute significantly to fire and up to 1" thick insulation shall have a Flame-Spread Index of less than 25 and a Smoke-development Index of less than 50 as tested by ASTM E 84 and CAN / ULC S-102.
  - .5 All refrigerant connections between outdoor and indoor units shall be flare type.
- .6 Compressor:
  - .1 The compressor shall be a high performance, hermetic, inverter driven, variable speed, dual rotary type manufactured by Mitsubishi Electric Corporation.
  - .2 The compressor motor shall be direct current (DC) type equipped with a factory supplied and installed inverter drive package.
  - .3 The compressor will be equipped with internal thermal overload protection.
  - .4 To prevent liquid from accumulating in the compressor during the off cycle, a minimal amount of current shall be automatically, intermittently applied to the compressor motor windings to maintain sufficient heat to vaporize any refrigerant. No crankcase heater is to be used.
  - .5 Filters, sight glasses, and traps shall not be used, and no additional refrigerant oil shall be required.
  - .6 The compressor shall be mounted so as to avoid the transmission of vibration.
  - .7 The outdoor unit shall have an accumulator and high-pressure safety switch.
- .7 Operating Range:
  - .1 Operating Range shall be in accord with the Table below:

Operating Range		Indoor Intake Air Temp	Outdoor Intake Air Temp
Cooling	Maximum	95°F (35°C) DB, 71°F(21°C) WB	115°F (46°C) DB
	Minimum	67°F (19°C) DB, 57°F(14°C) WB	-40°F (-40°C) DB

.8 Electrical

- .1 The outdoor unit electrical power supply shall be 208/230 volts, 1-phase, 60 hertz.
- .2 The unit shall be capable of satisfactory operation within voltage limits of 198 volts to 253 volts.
- .3 The outdoor unit shall be controlled by microprocessors located in the indoor unit and outdoor unit. A 12-to-24-volt DC data stream shall communicate between the units providing all necessary information for full function control.
- .4 The outdoor unit shall be equipped with Pulse Amplitude Modulation (PAM) compressor inverter drive control for maximum efficiency with minimum power consumption.

**2.3 INDOOR UNITS (BASIS OF DESIGN MITSUBISHI PKA WALL MOUNTED INDOOR UNIT)**

.1 General

- .1 The wall-mounted indoor unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, electronic modulating linear expansion device, control circuit board and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, an auto restart function, and a test run switch. Indoor unit and refrigerant pipes shall be charged with dehydrated air before shipment from the factory.

.2 Unit Cabinet

- .1 All casings, regardless of model size, shall have the same white finish
- .2 Multi directional drain and refrigerant piping offering four (4) directions for refrigerant piping and two (2) directions for draining are required.
- .3 There shall be a separate back plate which secures the unit firmly to the wall.

.3 Fan

- .1 The indoor fan shall be statically and dynamically balanced to run on a single motor with permanently lubricated bearings.
- .2 A manual adjustable guide vane shall be provided with the ability to change the airflow from side to side (left to right).
- .3 An integral, motorized, multi-position, horizontal air sweep vane shall provide for uniform air distribution, up and down. Vane shall have 5 selectable positions plus AUTO (Controls position based upon mode, microprocessor shall automatically determine the vane angle to provide the optimum room temperature distribution) and SWING (Continuously moves up and down). In OFF mode the horizontal vane shall return to the closed position.
- .4 The indoor unit shall include an AUTO fan setting capable of maximizing energy efficiency by adjusting the fan speed based on the difference between controller set-point and space temperature. The indoor fan shall be capable of five (5) speed settings, Low, Mid1, Mid2, High and Auto.

.4 Filter

- .1 Return air shall be filtered by means of an easily removable, washable filter.

.5 Coil

- .1 The indoor unit coil shall be of nonferrous construction with smooth plate fins on copper tubing.
- .2 The tubing shall have inner grooves for high efficiency heat exchange.
- .3 All tube joints shall be brazed with silver alloy.

- .4 The coils shall be pressure tested at the factory.
- .5 A sloped, corrosion resistant condensate pan with drain shall be provided under the coil.
- .6 A drain pan level switch (SS610E), designed to connect to the control board, shall be provided, if required, and installed in the condensate pan to prevent condensate from overflowing.
- .6 Electrical
  - .1 The unit electrical power shall be 208-230 volts, 1-phase, 60 hertz.
  - .2 The system shall be equipped with A-Control – a system directing that the indoor unit be powered directly from the outdoor unit using a 3-wire, 14 gauge AWG connections plus ground.
  - .3 The indoor unit shall not have any supplemental electrical heat elements.
- .7 Controls
  - .1 The unit shall include an IR receiver for wireless remote control flexibility
  - .2 Indoor unit shall compensate for the higher temperature sensed by the return air sensor compared to the temperature at level of the occupant when in HEAT mode. Disabling of compensation shall be possible for individual units to accommodate instances when compensation is not required.
  - .3 Control board shall include contacts for control of external heat source. External heat may be energized as second stage when the space temperature is 1.8°F from set point.
  - .4 Full BACnet communication, control and monitoring of the indoor unit shall be provided (for Mitsubishi via one IntesisBox each per fan coil).

## 2.4 CONTROLS

- .1 Overview
  - .1 The control system shall consist of a minimum of one microprocessor on each indoor unit and one in the outdoor unit, communicating via A-Control data over power transmission. The microprocessor located in the indoor unit shall have the capability of monitoring return air temperature and indoor coil temperature, receiving and processing commands from the wired controller, providing emergency operation and controlling the outdoor unit. The control signal between the indoor and outdoor unit shall be pulse signal 24 volts DC. Indoor units shall have the ability to control supplemental heat via connector CN24 and a 12 VDC output.
  - .2 For A-Control, a three (3) conductor 14 gauge AWG wire with ground shall provide power feed and bi-directional control transmission between the outdoor and indoor units. If code requires a disconnect mounted near the indoor unit, a TAZ-MS303 3-Pole Disconnect shall be used – all three conductors must be interrupted.
  - .3 The system shall be capable of automatic restart when power is restored after power interruption. The system shall have self-diagnostics ability, including total hours of compressor run time. Diagnostics codes for indoor and outdoor units shall be displayed on the wired controller panel.
  - .4 A remote controller needs to be selected and ordered separately from the unit unless the indoor unit is a wall mounted (excludes PKA), floor mounted or one-way ceiling recessed unit.
- .2 Remote Controller
  - .1 Equal to Mitsubishi Deluxe Wired MA Remote Controller:



- .1 On wall mount (excludes PKA), floor mount and one-way ceiling recessed units the Deluxe Wired MA Remote Controller shall require a MAC-334IF-E Interface for communication.
- .2 The Deluxe Wired MA Remote Controller shall be capable of controlling up to 16 indoor units (defined as 1 group). When grouping M-Series units each unit requires a MAC-334IF-E Interface.
- .3 The Deluxe Wired MA Remote Controller shall only be used in same group with another Deluxe Wired MA Remote Controller, with up to two remote controllers per group.

<b>Wired MA Remote Controller</b>			
<b>Item</b>	<b>Description</b>	<b>Operation</b>	<b>Display</b>
ON/OFF	Run and stop operation for a single group	Each Group	Each Group
Operation Mode	Switches between Cool/Drying/Auto/Fan/Heat.  Operation modes vary depending on the air conditioner unit.	Each Group	Each Group
Temperature Setting	Sets the temperature from 40°F – 87°F depending on operation mode and indoor unit.	Each Group	Each Group
Fan Speed Setting	Available fan speed settings depending on indoor unit.	Each Group	Each Group
Air Flow Direction Setting	Air flow direction settings vary depending on the indoor unit model.	Each Group	Each Group
Permit / Prohibit Local Operation	Individually prohibit operation of each local remote control function (Start/Stop, Change operation mode, Set temperature, Vane, Reset filter).  *1: Centrally Controlled is displayed on the remote controller for prohibited functions.	N/A	Each Group *1
Display Indoor Unit Intake Temp	Measures and displays the intake temperature of the indoor unit when the indoor unit is operating.	N/A	Each Group
Display Backlight	Pressing a button lights up a backlight. The light automatically turns off after a certain period of time. (The brightness settings can be selected from Bright, Dark, and Light off.)	N/A	Each Unit

<b>Wired MA Remote Controller</b>			
<b>Item</b>	<b>Description</b>	<b>Operation</b>	<b>Display</b>
Error	When an error is currently occurring on an air conditioner unit, the afflicted unit and the error code are displayed	N/A	Each Unit
Test Run	Operates air conditioner units in test run mode.  *2 The display for test run mode will be the same as for normal start/stop (does not display "test run").	Each Group	Each Group *2
Ventilation Equipment	Up to 16 indoor units can be connected to an interlocked system that has one LOSSNAY unit.	Each Group	N/A
Set Temperature Range Limit	Set temperature range limit for cooling, heating, or auto mode.	Each Group	Each Group
Schedule	Set up to 8 operations per day, 7 days per week. Operations include time on/off, mode and room temperature set point.	Each Group	Each Group

### **PART 3 EXECUTION**

#### **3.1 EXAMINATION**

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for air conditioning components installation in accordance with manufacturer's written instructions.
  - .1 Visually inspect substrate in presence of Departmental Representative.
  - .2 Inform Departmental Representative and Consultant of unacceptable conditions immediately upon discovery.
  - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed Consultant.

#### **3.2 GENERAL**

- .1 Install as indicated, to manufacturer's recommendations, and to EPS 1/RA/2.
- .2 Manufacturer to certify installation.
- .3 Run drain line from cooling coil condensate drain pan to terminate over nearest floor drain. If a gravity line all the way to the nearest floor drain is not possible, provide a condensate pump complete with vibration isolation (neoprene pads).

#### **3.3 EQUIPMENT PREPARATION**

- .1 Provide services of manufacturer's field engineer to set and adjust equipment for operation as specified.

#### **3.4 CLEANING**

- .1 Progress Cleaning:

- .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Contract Closeout Procedures and Submittals.
  - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

### **3.5 PROTECTION**

- .1 Protect installed products and components from damage during construction.
- .2 Repair damage to adjacent materials caused by computer room air conditioning installation.

**END OF SECTION**

## **PART 1 GENERAL**

### **1.1 GENERAL REQUIREMENTS**

- .1 Read and be governed by conditions of the Contract Documents, including sections of Division 01.

### **1.2 SUMMARY**

- .1 Section Includes
  - .1 Electric Unit Heaters

### **1.3 SUBMITTALS**

- .1 Product Data: Provide typical catalogue of information including arrangements.
- .2 Shop Drawings:
  - .1 Indicate cross sections of cabinets, grilles, bracing and reinforcing, and typical elevations.
  - .2 Submit schedules of equipment and enclosures typically indicating length and number of pieces of element and enclosure, corner pieces, end caps, cap strips, access doors, pilaster covers, and comparison of specified heat required to actual heat output provided.
  - .3 Indicate mechanical and electrical service locations and requirements.
  - .4 Heating capacity at voltage provided.

### **1.4 CLOSEOUT SUBMITTALS**

- .1 Operation and Maintenance Data: Include start-up instructions, maintenance instructions, parts lists, controls, and accessories.

### **1.5 MAINTENANCE MATERIAL SUBMITTALS**

- .1 Maintenance and extra material requirements.

### **1.6 QUALITY ASSURANCE**

- .1 Products of This Section: Manufactured to ISO 9000 certification requirements.
- .2 Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three (3) years documented experience.
- .3 Installer Qualifications: Company specializing in performing the work of this section with minimum three (3) years documented experience and approved by the manufacturer.

### **1.7 REGULATORY REQUIREMENTS**

- .1 Products Requiring Electrical Connection: Listed and classified by CSA testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

### **1.8 DELIVERY, STORAGE, AND PROTECTION**

- .1 Transport, handle, store, and protect products.
- .2 Protect coil fins from crushing and bending by leaving in shipping cases until installation, and by storing indoors.
- .3 Protect coils from entry of dirt and debris with pipe caps or plugs.

## **PART 2 PRODUCTS**

### **2.1 WALL FAN HEATERS**

#### **.1 General**

- .1 Assembly: CSA listed and labelled.
- .2 Heating Elements: High-quality nickel-chrome resistance wire.
- .3 Cabinet: 20 gauge steel with 18-gauge steel grille.
- .4 Element Hangers: Quiet operating, ball bearing cradle type providing unrestricted longitudinal movement, on enclosure brackets.
- .5 Fan: Quiet helicoidal fan, single or multiple.
- .6 Motor: Totally enclosed, permanently lubricated.
- .7 Thermal protection with automatic reset.
- .8 Control: Remote thermostat with relay for connection to BAS as required by controls sequences.
- .9 Electrical Characteristics:
  - .1 208 volts, single phase, 60 Hz.
  - .2 Disconnect Switch: Factory mount disconnect switch.

#### **.2 Acceptable Manufacturers**

- .1 Stelpro;
- .2 Ouellet;
- .3 Reznor.

### **2.2 ELECTRIC UNIT HEATERS**

#### **.1 General**

- .1 Assembly: CSA listed and labelled, with terminal control box and cover, splice box, coil, casing, and controls.
- .2 Heating Elements: Exposed helical coil of nickel-chrome resistance wire with refractory ceramic support bushings.
- .3 Cabinet: 20 gauge steel with easily removed front panel with integral air outlet and inlet grilles.
- .4 Element Hangers: Quiet operating, ball bearing cradle type providing unrestricted longitudinal movement, on enclosure brackets.
- .5 Fan: Direct drive propeller type, statically and dynamically balanced, with fan guard.
- .6 Motor: Permanently lubricated, sleeve bearings for horizontal models, ball bearings for vertical models.
- .7 Control: Separate fan speed switch and thermostat, factory wired, with switches built-in behind cover. Provide thermal overload.
- .8 Electrical Characteristics:
  - .1 208 volts, single phase, 60 Hz.
  - .2 Disconnect Switch: Factory mount disconnect switch.

.2 Acceptable Manufacturers

- .1 Stelpro;
- .2 Ouellet;
- .3 Chromalox;
- .4 Reznor;
- .5 Modine.

**PART 3 EXECUTION**

**3.1 INSTALLATION**

- .1 Install to manufacturer's written instructions.
- .2 Install equipment exposed to finished areas after walls and ceiling are finished and painted. Avoid damage.
- .3 Protection: Provide finished cabinet units with protective covers during balance of construction.
- .4 Unit Heaters: Hang from building structure, with pipe hangers anchored to building, not from piping. Mount as high as possible to maintain greatest headroom unless otherwise indicated.
- .5 Install electric heating equipment including devices provided by manufacturer but not factory-mounted. Provide copy of manufacturer's wiring diagram submittal. Install electrical wiring to manufacturer's submittals.
- .6 Install units on vibration isolation and seismic isolation/bracing. Refer to sections 23 05 48 and 23 05 49.
- .7 Provide heating season start-up, cooling season shut-down service, for first year of operation.
- .8 Shut-down system if initial start-up and testing takes place in summer and units are to remain inoperative. Repeat start-up and testing operation at beginning of first heating season.

**END OF SECTION**

## **PART 1 GENERAL**

### **1.1 GENERAL REQUIREMENTS**

- .1 Read and be governed by conditions of the Contract Documents, including sections of Division 01.

### **1.2 SUMMARY**

- .1 Section Includes
  - .1 Gas Unit Heaters

### **1.3 SUBMITTALS**

- .1 Product Data: Provide typical catalogue of information including arrangements.
- .2 Shop Drawings:
  - .1 Indicate dimensions, piping/ gas train diagrams, connection sizes and locations.
  - .2 Indicate mechanical and electrical service locations and requirements.
  - .3 Heating capacity at voltage provided.

### **1.4 CLOSEOUT SUBMITTALS**

- .1 Operation and Maintenance Data: Include start-up instructions, maintenance instructions, parts lists, controls, and accessories.

### **1.5 MAINTENANCE MATERIAL SUBMITTALS**

- .1 Maintenance and extra material requirements.

### **1.6 QUALITY ASSURANCE**

- .1 Products of This Section: Manufactured to ISO 9000 certification requirements.
- .2 Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three (3) years documented experience.
- .3 Installer Qualifications: Company specializing in performing the work of this section with minimum three (3) years documented experience and approved by the manufacturer.

### **1.7 REGULATORY REQUIREMENTS**

- .1 Products Requiring Electrical Connection: Listed and classified by CSA testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

### **1.8 DELIVERY, STORAGE, AND PROTECTION**

- .1 Transport, handle, store, and protect products.
- .2 Protect coil fins from crushing and bending by leaving in shipping cases until installation, and by storing indoors.
- .3 Protect connections from entry of dirt and debris with pipe caps or plugs.

## **PART 2 PRODUCTS**

### **2.1 GAS-FIRED UNIT HEATERS**

- .1 General

- .1 Description: Self-contained, packaged, factory assembled, consisting of cabinet, supply fan, heat exchanger, burner, controls, and accessories, piped and wired, and complying with ANSI Z83.8.
  - .1 Fuel Type: Natural gas.
- .2 Supply Fan: Axial Propeller type.
- .3 Heat Exchanger: 409 stainless steel.
- .4 Separated Combustion.
- .5 Electrical: Built-in disconnect switch.
- .6 Controls: Regulated redundant gas valve containing pilot solenoid valve, electric gas valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff all in one body.
  - .1 Gas Control Valve: Two stage.
  - .2 Interlock Door Switch
  - .3 Ignition System: Electronically controlled electric spark with flame sensor.
  - .4 Vent Flow Verification: Differential pressure switch to verify open vent.
  - .5 High Limit: Thermal switch or fuse to stop burner.
  - .6 Control via the Building Automation System.

## **PART 3 EXECUTION**

### **3.1 INSTALLATION**

- .1 Install to manufacturer's written instructions.
- .2 Install equipment exposed to finished areas after walls and ceiling are finished and painted. Avoid damage.
- .3 Protection: Provide finished cabinet units with protective covers during balance of construction.
- .4 Unit Heaters: Hang from building structure, with pipe hangers anchored to building, not from piping. Mount as high as possible to maintain greatest headroom unless otherwise indicated.
- .5 Provide copy of manufacturer's wiring diagram submittal. Install electrical wiring to manufacturer's submittals.
- .6 Install units with seismic isolation/bracing. Refer to section 23 05 49.
- .7 Provide heating season start-up, cooling season shut-down service, for first year of operation.
- .8 Shut-down system if initial start-up and testing takes place in summer and units are to remain inoperative. Repeat start-up and testing operation at beginning of first heating season.

**END OF SECTION**



## **PART 1 GENERAL**

### **1.1 GENERAL REQUIREMENTS**

- .1 Read and be governed by conditions of the Contract Documents, including sections of Division 01.

### **1.2 SUMMARY**

- .1 Section Includes
  - .1 Electric-Resistance Air Coils

### **1.3 SUBMITTALS**

- .1 Product Data: Provide coil and frame configurations, dimensions, materials, rows, connections, and rough-in dimensions.
- .2 Shop Drawings: Indicate coil and frame configurations, dimensions, materials, rows, connections, and rough-in dimensions.

### **1.4 SUBMITTALS FOR INFORMATION**

- .1 Installation Data: Submit manufacturer's installation requirements.

### **1.5 CLOSEOUT SUBMITTALS**

- .1 Operation and Maintenance Data: Include start-up instructions, maintenance instructions, parts lists, controls, and accessories.

### **1.6 QUALITY ASSURANCE**

- .1 Products of This Section: Manufactured to ISO 9000 certification requirements.
- .2 Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three (3) years documented experience.
- .3 Installer Qualifications: Company specializing in performing the work of this section with minimum three (3) years documented experience and approved by the manufacturer.

### **1.7 REGULATORY REQUIREMENTS**

- .1 Products Requiring Electrical Connection: Listed and classified by CSA testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

### **1.8 DELIVERY, STORAGE, AND PROTECTION**

- .1 Protect coil fins from crushing and bending by leaving in shipping cases until installation, and by storing indoors.
- .2 Protect coils from entry of dirt and debris with pipe caps or plugs.

## **PART 2 PRODUCTS**

### **2.1 ELECTRIC POST HEATERS**

- .1 General
  - .1 Duct heaters shall be open coil heaters.
    - .1 Voltage, size, wattage, control type and control voltage shall be as scheduled on the drawings.
    - .2 Manufacturer shall be capable of furnishing single-phase or three-phase heaters as indicated on mechanical schedules.

- .3 Heaters shall be UL listed for zero clearance and meet all applicable requirements of the NEC.
- .4 Electric duct heaters shall be independently powered.
- .2 Type: Heaters shall be of the flanged mount type for duct mounting.
- .3 Duct heaters shall be for indoor use only.
- .4 Heating Elements: Open coil of nickel-chrome resistance wire, supported and insulated by floating ceramic bushings. Heating element support structure shall consist of galvanized steel wire formed and constructed to support ceramic bushings through which the heating element passes.
- .5 All heating elements shall be made of nickel/chromium resistance wire with ends terminated by means of staking and heliarc welding to machine screws.
- .6 Coil Layout: Vertical (air flow horizontal). EH series is only approved for vertical up airflow.
- .7 Casing Assembly: Flanged type, galvanized-steel frame
- .8 Coil terminals shall be stainless steel plated, terminal insulators and bracket bushings shall be of ceramic and securely positioned.
- .9 Control Box: Control cabinet shall have a solid cover also of heavy gauge galvanized steel and held in place with hinges and interlocking disconnect switch.
- .10 Orientation: Heaters shall be interchangeable for mounting in a horizontal or vertical duct.
- .11 Heaters up to 60 kW shall be capable of being rotated 180°.
- .12 Built-in components shall include disconnecting break magnetic contactors, transformer with primary fusing, pressure-type airflow switch set at 0.05" + 0.02" WC all as required by UL, branch circuit fuses per NEC, interlocking disconnect switch and a single terminal block to accept the number, type and size of conductors as required.
- .13 Over-Temperature Protection:
  - .1 Serviceable through electric duct heater without removing heater from duct or unit.
  - .2 Disk-type, automatic reset, thermal-cutout safety devices for primary over-temperature protection.
  - .3 Secondary over-temperature protection by built in disc type manually resettable thermal cutouts. These devices must function independently of one another and are not acceptable if series connected in the control circuit wiring.
  - .4 All duct heaters will require either a fan interlock circuit or an airflow switch. The airflow switch shall be diaphragm operated differential pressure switch to prevent duct heater from operating when there is no air flow.
- .14 A disconnecting magnetic control circuit is required.
- .15 Over-current protection by means of factory-installed fusing within the control cabinet shall be provided. Heating elements shall be subdivided and fused accordingly.
- .16 All wiring, component sizing, component spacing and protective devices within the control cabinet shall be factory installed and comply with CSA and ULC standards.
- .17 Control Panel: Mounted on unit, with means of a safety disconnect and overcurrent protection. Include the following controls:
  - .1 Magnetic contactor.
  - .2 Silicon Controlled Rectifier (SCR) that shall be capable of accepting 0-10Vdc or 4-20mA as control signal and modulating as required to meet discharge air set point temperature.

- .3 Recessed Control Box that shall extend 1" beyond internally insulated duct. Only applicable for installing in internally insulated ducts with an insulation thickness of 1".
- .4 Dust tight control box via compression type gasket installed on control box flanges to seal door opening. Control box seams are filled to prevent dust intrusion.
- .5 Pilot light to indicate the heater is energized
- .6 24VAC control voltage
- .18 A wiring diagram depicting layout and connections of electrical components within the control cabinet shall be affixed to the inside of the control cabinet cover.
- .19 A rating plate label shall be affixed to the exterior of the control cabinet cover which states model number, serial number, volts, amps, phase, frequency, control volts, volt-amps and minimum airflow requirements.
- .20 Ability to control setpoint through BAS.
- .2 Manufacturers
  - .1 Renewaire;
  - .2 Thermolec;
  - .3 Nailor;
  - .4 Chromalox;
  - .5 Substitutions: Refer to Section 01 60 00.

## **PART 3 EXECUTION**

### **3.1 ELECTRIC POST HEATER INSTALLATION**

- .1 Locate, orient, and connect ductwork per AMCA, ASHRAE, and SMACNA guidelines. Provide service clearances as indicated on the plans. Locate units distant from sound critical occupancies.
- .2 Provide a structurally suitable support as necessary for all units. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.
- .3 Perform all work required to provide and install the following electric duct heaters indicated by the contract documents with supplementary items necessary for proper installation.
- .4 All installation shall be in accordance with manufacturer's published recommendations.
- .5 Inspect areas and conditions under which heater units are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to installer.
- .6 Do not operate electric heaters for any purpose until ductwork is clean of any possible debris.
- .7 Maintain minimum working clearances around the heater electrical panel in accordance with NEC Article 110.
- .8 Install duct heaters in metal ducts and casings constructed according to SMACNA "HVAC Duct Construction Standards".
- .9 If applicable, anchor duct heaters in position using suitable supports.
- .10 Connect duct heaters and components to wiring systems and to ground as indicated and instructed by manufacturer. Tighten connectors and terminals, including screws and bolts, according to equipment manufacturer's published torque-tightening values for equipment connectors. Where manufacturer's torque requirements are not indicated, tighten connectors and terminals according to tightening torques specified in UL 486A.
- .11 After construction is completed, including painting, clean unit's exposed surfaces and vacuum clean electric duct heaters and inside of cabinets.

- .12 Touch up scratches and marks from handling and placement of equipment with masking enamel to match manufacturer's color. Refer to Division 09 for site-applied finishes

### **3.2 ELECTRIC UNIT HEATER INSTALLATION**

- .1 Install to manufacturer's written instructions.
- .2 Provide for connection to electrical service.
- .3 Install units on vibration isolation. Refer to Section 23 05 48.
- .4 Provide heating season start-up, cooling season shut-down service, for first year of operation.
- .5 Shut-down system if initial start-up and testing takes place in summer and units are to remain inoperative. Repeat start-up and testing operation at beginning of first heating season.

**END OF SECTION**

## **PART 1 GENERAL**

### **1.1 GENERAL REQUIREMENTS**

- .1 Read and be governed by conditions of the *Contract Documents*, including sections of Division 01.

### **1.2 SECTION INCLUDES**

- .1 Electrode Steam Humidifiers

### **1.3 RELATED SECTIONS**

- .1 Section 22 10 00 - Plumbing Piping.
- .2 Section 23 22 00 - Steam and Steam Condensate Piping.
- .3 Section 25 30 00 - Instruments and Control Elements: Humidistats.
- .4 Section 26 05 80 - Equipment Wiring: Electrical characteristics and wiring connections.

### **1.4 SUBMITTALS FOR REVIEW**

- .1 Product Data: Provide catalogue data indicating rated capacity, dimensions, duct and service connections, electric nameplate data and wiring diagrams.
- .2 Shop Drawings: Indicate layout of system and components.

### **1.5 CLOSEOUT SUBMITTALS**

- .1 Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listing.
- .2 Warranty Documentation: Submit manufacturer warranty and ensure forms have been completed in Owners name and registered with manufacturer.

### **1.6 MAINTENANCE MATERIAL SUBMITTALS**

- .1 Extra Stock Materials: Provide two (2) replacement humidifier cylinders.

## **PART 2 PRODUCTS**

### **2.1 ELECTRODE STEAM HUMIDIFIERS**

- .1 Base design manufacturer and model is the Condair Nortec EL.
- .2 Humidifier: AHRI 640, self contained, disposable cylinder, microprocessor controlled electrode steam generating unit.
- .3 Cylinders: Disposable plastic with electrodes. Water conductivity is measured to control drainage of mineral-laden water to minimize water and energy consumption. Staged electrode use to minimize performance drop over time. Cylinder must have welded seam to ensure watertight and have high water sensor to prevent overfilling. 98% thermal efficiency from startup until end of cylinder life.
- .4 Integral fill cup with minimum 1-inch [25 mm] air gap to prevent back siphoning.
- .5 Full cylinder indication and pre-notification of automatic shutdown at end of cylinder life.

- .6 Automatic pulse feature to clean any obstruction from the drain solenoid valve if required.
- .7 Automatic off-season shut-down (e.g. after 3 days of "no call") will completely drain the cylinders and automatically restart on call for humidity. Adjustable on/off and time sequence. Provides extended cylinder life, while ensuring stagnant water does not remain in the system.
- .8 Accommodates water inlet pressure from 207 to 552 kPa (30 to 80 psig).
- .9 Cabinet: Durable powder coated steel cabinet with zero side clearance requirement for minimal footprint.
- .10 Modulating output between 20% and 100% of rated capacity.
- .11 Incorporate electrical terminals for installation of humidistat, duct high-limit humidistat, air flow switch.
- .12 Steam Distributor: Stainless steel steam dispersion tube suitable for insertion in duct with condensate separator and return leg to remove condensate from distributor return to humidifier fill.
- .13 Drain Water Cooling: Provide optional Extreme drain water cooling to temper water to 49°C (120°F) during normal and manual operation.
- .14 Provide external dedicated fused disconnect switch close to unit.
- .15 Touchscreen controller with standard building automation:
  - .1 Intuitive touchscreen control.
  - .2 Standard building automation communication protocols BACnet IP, BACnet MSTP. Additional hardware required for building automation communication not acceptable.
  - .3 Embedded web interface for easy configuration and remote monitoring from any computer with a web browser over a local area network (LAN) connection.
  - .4 USB interface for new software/feature upload and download of operational information.
  - .5 Single or dual channel analog signal acceptance, supporting both demand and transducer control. Ability to control setpoint from humidifier control when using transducer controls.
- .16 Manufacturers:
  - .1 Condair Ltd.
  - .2 Dristeem
  - .3 Or approved equal.

## **PART 3 EXECUTION**

### **3.1 INSTALLATION**

- .1 Install humidifiers per manufacturers' instructions.
- .2 Install with required clearance for service and maintenance.
- .3 Install accessories in accordance with manufacturer's recommendations.
- .4 Insulate steam piping with 1.5" thick insulation and provide jacketing for energy conservation and personnel protection.

**END OF SECTION**

## **2.1 GENERAL**

### **3.1. APPLICABLE STANDARDS**

- .1 Applicable Standards are listed below:
  - .1 2015 ASHRAE Handbook – HVAC Applications Chapter 43 HVAC Commissioning
  - .2 ASHRAE Guideline 1.1 – 2007 – The HVAC&R Technical Requirements for the Commissioning Process
  - .3 ASHRAE Guideline 0 – 2013 – The Commissioning Process
  - .4 ASHRAE 202 – 2013 – Commissioning Process for Buildings and Systems
  - .5 ASHRAE Guideline 4-2008 – Preparation of O&M Documentation
  - .6 ATSM E2813 – Standard Practice for Building Enclosure Commissioning
  - .7 ATSM E2947 – Standard Guide for Building Enclosure Commissioning
  - .8 CSA Z320-11 Building Commissioning Standard & Check Sheets
  - .9 CSA C282-15 – Emergency Power Supply for Buildings
  - .10 NIBS Guideline 3-2012 – Building Enclosure Commissioning Process

### **3.2. GENERAL**

- .2 The purpose of this section is to specify Division 25 responsibilities in the commissioning process.
- .3 Commissioning requires the participation of Division 25 to ensure that all systems are operating in a manner consistent with the Contract Documents. The general commissioning requirements and coordination are detailed in Section 01 91 00. Division 25 shall be familiar with all parts of Section 01 91 00 and the commissioning plan issued by the CxA and shall execute all commissioning responsibilities assigned to them in the Contract Documents.

### **3.3. SYSTEMS TO BE COMMISSIONED**

- .4 Systems to be commissioned as part of this contract include, but may not be limited to the following:
  - .1 Building Automation System

### **3.4. COMMISSIONING TEAM**

- .5 The Commissioning Team shall consist of representatives of the following as appropriate:
  - .1 Owner and the Owner's FM Staff
  - .2 Consultant
  - .3 Commissioning Authority (CxA)
  - .4 General Contractor (GC)
  - .5 Subcontractors (Mechanical, Electrical, Controls, TAB)
  - .6 Specialized third-party for verification

## **2.2 PRODUCTS**

Not Used.

## **2.3 EXECUTION**

### **3.5. COMMISSIONING AUTHORITY RESPONSIBILITIES**

- .6 The Commissioning Authority shall:
  - .1 Plan, organize and implement the commissioning process as specified herein;
  - .2 Prepare the commissioning plan, ensure its distribution for review and comment;
  - .3 Revise the commissioning plan as required during construction;
  - .4 Chair commissioning meetings, and prepare and distribute minutes to all commissioning team members, whether or not they attended the meeting;
  - .5 In conjunction with the GC, coordinate commissioning activities;
  - .6 Monitor system verification checks, and ensure the results are documented as the checks are done;
  - .7 Observe select start-ups and initial system operations tests and checks;
  - .8 Direct the GC to operate equipment and systems as required to ensure that all required functional performance tests are carried out for verification purposes;
  - .9 Witness functional performance tests and document the results;
  - .10 Prepare and submit a commissioning report which documents all checks and tests done throughout the commissioning process, and the results obtained from each;
  - .11 Ensure all required O&M manuals, instructions and demonstrations are provided to the Owner's designated facility operating staff.

### **3.6. CONSULTANT RESPONSIBILITIES**

- .7 The Consultant commissioning responsibilities are outlined below:
  - .1 Review the commissioning plan, proposed test procedures, and participate (as appropriate) in on-site commissioning meetings.
  - .2 At their discretion during the acceptance phase of the commissioning process, be on site to review commissioning documentation, to witness functional performance tests, and to analyze the installation and its performance

### **3.7. OWNER RESPONSIBILITIES**

- .8 The Owner shall have the following commissioning responsibilities
  - .1 Ensure the availability of facility operations staff for all scheduled instructions and demonstration sessions (training).
  - .2 At their discretion, witness commissioning performance tests.

### **3.8. SUBCONTRACTOR RESPONSIBILITIES**

- .9 The responsibilities of the Subcontractor, during construction and acceptance phases in addition to those listed above are as follows:
  - .1 Sequences of Operation Submittals. The Controls Subcontractor's submittals of control drawings shall include complete detailed sequences of operation for each piece of equipment, regardless of the completeness and clarity of the sequences in the specifications. They shall include:



- .1 An overview narrative of the system (1 or 2 paragraphs) generally describing its purpose, components and function.
  - .2 All interactions and interlocks with other systems.
  - .3 Detailed delineation of control between any packaged controls and the BAS, listing what points the BAS monitors only and what BAS points are control points and are adjustable.
  - .4 Written sequences of control for packaged controlled equipment. (Equipment manufacturers' stock sequences may be included, but will generally require additional narrative).
  - .5 Start-up sequences.
  - .6 Warm-up mode sequences.
  - .7 Normal operating mode sequences.
  - .8 Unoccupied mode sequences.
  - .9 Shutdown sequences.
  - .10 Capacity control sequences and equipment staging.
  - .11 Temperature and pressure control: setbacks, setups, resets, etc.
  - .12 Detailed sequences for all control strategies, e.g., economizer control, optimum start/stop, staging, optimization, demand limiting, etc.
  - .13 Effects of power or equipment failure with all standby component functions.
  - .14 Sequences for all alarms and emergency shut downs.
  - .15 Seasonal operational differences and recommendations.
  - .16 Initial setpoints and recommended values for all adjustable settings, setpoints and parameters that are typically set or adjusted by operating staff; and any other control settings or fixed values, delays, etc. that will be useful during testing and operating the equipment.
  - .17 Schedules, if known.
  - .18 To facilitate referencing in testing procedures, all sequences shall be written in concise statements
- .2 Control Drawings Submittal
  - .1 The control drawings shall have a key to all abbreviations.
  - .2 The control drawings shall contain graphic schematic depictions of the systems and each component (i.e. sensors, dampers, coils, valves, etc.)
  - .3 The schematics will include the system and component layout of any equipment that the control system monitors, enables or controls, even if the equipment is primarily controlled by packaged or integral controls.
- .3 Provide a full points list with at least the following included for each point:
  - .1 Controlled system
  - .2 Point abbreviation
  - .3 Point description
  - .4 Display unit
  - .5 Control point or setpoint (Yes / No)

- .6 Monitoring point (Yes / No)
- .7 Intermediate point (Yes / No)
- .8 Calculated point (Yes / No)
- .9 Key:
- .10 Point Description: DB temp, airflow, etc.
- .11 Control or Setpoint: Point that controls equipment and can have its setpoint changed (OSA, SAT, etc.)
- .12 Intermediate Point: Point whose value is used to make a calculation which then controls equipment (space temperatures that are averaged to a virtual point to control reset).
- .13 Monitoring Point: Point that does not control or contribute to the control of equipment, but is used for operation, maintenance, or performance verification.
- .14 Calculated Point: "Virtual" point generated from calculations of other point values.
- .4 The Controls Subcontractor shall keep the CxA informed of all changes to this list during programming and setup.
- .5 As-Built Controls Package - An updated as-built version of the Controls Drawings and Sequence of Operation, which is to include all items identified above, shall be provided to the CxA and included in the final controls O&M manual submittal.
- .6 Assist in TAB Work- The Controls Subcontractor shall assist in the TAB work through the following:
  - .1 Meet with the TAB subcontractor prior to beginning TAB and review the TAB plan to determine the capabilities of the control system toward completing TAB. Provide the TAB Subcontractor any needed unique instruments for setting terminal unit boxes and instruct the TAB Subcontractor in their use (handheld control system interface for use around the building during TAB, etc.).
  - .2 For a given area, have all required prefunctional checklists, calibrations, startup and selected functional tests of the system completed and approved by the CxA prior to TAB.
  - .3 Provide a qualified technician to operate the controls to assist the TAB subcontractor in performing TAB, or provide sufficient training for TAB to operate the system without assistance.
- .7 Required assistance to the CxA - Assist and cooperate with the CxA in the following manner:
  - .1 Using a skilled technician who is familiar with the building, execute the functional testing of the all equipment specified in Section 01 91 00 under direction of the CxA. Provide two-way radios during the testing.
  - .2 Execute all control system trend logs specified in Section 01 91 00.
  - .3 Written Plan - The Controls Subcontractor shall prepare a written plan indicating in a step-by-step manner, the procedures that will be followed to test, checkout and adjust the control system prior to functional performance testing, according to the process in Section 01 91 00. At minimum, the plan shall include the following for each type of equipment controlled by the automatic controls:
    - .1 System name.
    - .2 List of devices.
    - .3 Step-by-step procedures for testing each controller after installation, including:

- .4 Process of verifying proper hardware and wiring installation.
- .5 Process of downloading programs to local controllers and verifying that they are addressed correctly.
- .6 Process of performing operational checks of each controlled component.
- .7 Plan and process for calibrating valve and damper actuators and all sensors.
- .8 A description of the expected field adjustments for transmitters, controllers and control actuators should control responses fall outside of expected values.
- .4 A copy of the log and field checkout sheets that will document the process. This log must include a place for initial and final read values during calibration of each point and clearly indicate when a sensor or controller has "passed" and is operating within the contract parameters.
- .5 A description of the instrumentation required for testing.
- .6 Indicate what tests on what systems should be completed prior to TAB using the control system for TAB work. Coordinate with the CxA and TAB subcontractor for this determination.
- .7 Checkout Certification - Provide a signed and dated certification report to the CxA and GC upon completion of the checkout of each controlled device, equipment and system prior to functional testing. This report shall serve as confirmation that all system programming is complete in accordance to the Contract Documents, with the exception functional testing requirements. The checkout report shall also include complete point-to-point verification and sequence of operations verification checklists.
- .8 List and clearly identify on the as-built duct and piping drawings the locations of all static and differential pressure sensors (air, water and building pressure).

### **3.9. SUBMITTALS**

- .10 Section 25 Contractors shall provide submittal documentation relative to commissioning to the CxA as requested by the CxA. Refer to Section 01 91 00 for additional Division 25 requirements.

### **3.10. START-UP OF EQUIPMENT**

- .11 The Controls Subcontractor shall follow the start-up and initial checkout procedures listed in the Responsibilities list in this section and in Section 01 91 00, Part 3.10. Division 25 has start-up responsibility and is required to complete systems and sub-systems so they are fully functional, meeting the design objectives of the Contract Documents. The commissioning procedures and functional testing do not relieve or lessen this responsibility or shift that responsibility partially to the CxA or Owner.
- .12 Functional testing is intended to begin upon completion of a system. Functional testing may proceed prior to the completion of systems or sub-systems at the discretion of the CxA and GC. Beginning system testing before full completion does not relieve the Subcontractor from fully completing the system, including all pre functional checklists as soon as possible.
- .13 Prior to the start up of equipment the Division 25 Subcontractor shall arrange to have the Manufacturer of all major equipment inspect the installation to ensure their equipment has been installed in accordance with their recommendations.
- .14 The Supplier shall submit a written report of their findings.
- .15 Upon confirmation that the equipment has been installed in accordance with the Manufacturers Recommendations the equipment may be started.
- .16 All equipment shall be started by the Manufacturer's representative.

### **3.11. PRE-FUNCTIONAL TEST SHEETS**

- .17 Pre-functional test sheets contain items for Section 25 Contractors to perform. On each checklist, a column is provided that is to be completed by the contractor assigning responsibility for that line item to a trade. Those executing the test sheets are only responsible to perform items that apply to the specific application at hand. These test sheets do not take the place of the manufacturer's recommended checkout and start-up procedures or report. Some checklist procedures may be redundant in relation to checkout procedures that will be documented on typical factory field checkout sheets. Double documenting may be required in those cases.
- .18 Refer to Section 01 91 00 for additional requirements regarding pre-functional test sheets, startup and initial checkout. Items that do not apply should be noted along with the reasons on the form. If this form is not used for documenting, one of similar rigor and clarity shall be used pending approval from the CxA.

### **3.12. FUNCTIONAL TESTING, DOCUMENTATION, NON-CONFORMANCE AND ACCEPTANCE**

- .19 Refer to Specification 01 91 00 for more information in addition to this 25 08 00.

### **3.13. OPERATION AND MAINTENANCE MANUALS**

- .20 Section 25 Contractors shall compile and prepare documentation for all equipment and systems covered in Section 25 and deliver to the GC for inclusion in the O&M manuals.
- .21 ASHRAE Guideline 4-2008 is the recommended format.
- .22 The CxA shall receive a copy of the O&M manuals for review.

### **3.14. TRAINING OF OWNER PERSONNEL**

- .23 The GC shall be responsible for training coordination and scheduling and ultimately to ensure that training is completed. Refer to Section 01 91 00 for additional details.
- .24 The CxA shall be responsible for overseeing and approving the content and adequacy of the training of Owner personnel for commissioned equipment. Refer to Section 01 91 00 for additional details.
- .25 The Controls Subcontractor shall have the following training responsibilities:
  - .1 Provide the CxA with a training plan two weeks before the planned training according to the outline described in Section 01 91 00, Part 3.14.
  - .2 Provide designated Owner personnel with comprehensive training in the understanding of the systems and the operation and maintenance of the BAS system.
  - .3 Training shall start with classroom sessions, if necessary, followed by hands on training on the BAS, which shall illustrate the various modes of operation, including startup, shutdown, fire/smoke alarm, power failure, etc.
  - .4 During any demonstration, should the system fail to perform in accordance with the requirements of the O&M manual or sequence of operations, the system will be repaired or adjusted as necessary and the demonstration repeated.
  - .5 The training sessions shall follow the outline in the Table of Contents of the operation and maintenance manual and illustrate whenever possible the use of the O&M manuals for reference.
  - .6 Training shall include:
    - .1 Use the printed installation, operation and maintenance instruction material included in the O&M manuals.

- .2 Include a review of the written O&M instructions emphasizing safe and proper operating requirements, preventative maintenance, special tools needed and spare parts inventory suggestions. The training shall include start-up, operation in all modes possible, shut-down, seasonal changeover and any emergency procedures.
- .3 Discuss relevant health and safety issues and concerns.
- .4 Discuss warranties and guarantees.
- .5 Cover common troubleshooting problems and solutions.
- .6 Explain information included in the O&M manuals and the location of all plans and manuals in the facility.
- .7 Discuss any peculiarities of equipment installation or operation.
- .8 Classroom sessions shall include the use of overhead projections, slides, video and audio taped material as might be appropriate.
- .26 Hands-on training shall include start-up, operation in all modes possible, including manual, shut-down and any emergency procedures and maintenance of all pieces of equipment.
- .27 The Controls Subcontractor shall fully explain and demonstrate the operation, function and overrides of any local packaged controls, not controlled by the central control system.
- .28 Training shall occur after functional testing is complete, unless approved otherwise by the Project Manager.

### **3.15. DEFERRED TESTING**

- .29 Refer to Section 01 91 00, Part 3.15 for requirements of deferred testing.

### **3.16. WRITTEN WORK PRODUCTS**

- .30 Written work products of Section 25 Contractors will consist of the startup and initial checkout plan as described in Section 01 91 00, as well as completed startup, initial checkout and pre-functional test sheets. Refer to Section 01 91 00 Part 3.16.

**END OF SECTION**

## **PART 1 GENERAL**

### **1.1 SUMMARY**

- .1 Read and be governed by conditions of the Contract Documents, including sections of Division 01.
- .2 This document outlines the minimum equipment and performance standards for a completely interoperable Building Automation System (BAS).
- .3 The work shall include design, supply, installation, and commissioning a complete microprocessor based automatic control system to achieve the performance specified in the following Sections.
- .4 The BAS shall be capable of total integration of facility infrastructure systems with user access to all system data, locally over a secure Intranet within the building and by remote access by a standard Web Browser over the Internet.
- .5 The entire BAS shall be peer-to-peer networked, stand-alone, distributed control in accordance with American National Standards Institute/American Society of Heating, Refrigerating and Air Conditioning Engineers (ANSI/ASHRAE) Minimum Standard 135-2015, BACnet – A Data Communication Protocol for Building Automation and Control Networks.
- .6 All labour, material, equipment and software not specifically referred to herein or on the plans, but is required to meet the functional intent, shall be provided without additional cost to the Owner.
- .7 Contractors shall be manufacturers or licensed factory representatives and installers of the manufacturers, specified for the local area in which the Site is located.
- .8 The automation vendor must have least 2 dealers in Ontario that can provide parts and services to upon request.
- .9 The BAS contractor shall provide the necessary engineering, installation, supervision, commissioning and programming for a complete and fully operational system. The contractor will provide as many trips to the job site for installation, supervision, and commissioning as are necessary to complete the project to the satisfaction of the consultant and/or project supervisor.
- .10 The controls contractor will specifically read all mechanical and electrical drawings, specifications, and addenda and determine the controls work provided by the mechanical contractor, his subcontractors, and the electrical contractor. The controls contractor is expected to have the expertise to coordinate the work of other contractors and to make a completely coordinated Building Automation Control System (BAS) for the mechanical systems.
- .11 The BAS shall be compatible with future control Products for 10 years or more.
- .12 When the BAS is installed all devices must be the latest publicly released version of hardware, firm ware and software.
- .13 Ensure compliance with all applicable codes and authorities having jurisdiction.
- .14 The system shall be installed by trade certified electricians regularly employed by the controls contractor. The system shall be tested and calibrated by factory certified technicians qualified for this type of work and in the regular employment of the BAS manufacturer or its exclusive factory authorized installing contracting field office representative. The installing office shall have a minimum of five years of installation

experience with the manufacturer. Supervision, calibration and commissioning of the system shall be by the employees of the factory authorized BAS branch or representative.

## **1.2 BUILDING MANAGEMENT SYSTEM SUB-CONTRACTOR**

- .1 All work of this Section shall be coordinated and provided by a single BMS Subcontractor.
- .2 The work of this Section shall be scheduled, coordinated, and interfaced with the associated work of other trades. Reference the Mechanical Division Sections for details.
- .3 The work of this Section 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, warranties, services, and items which are required for the complete, fully functional and commissioned BMS, even if these are not specifically mentioned or fully described under this Section.
- .4 If the BMS subcontractor believes there are conflicts or missing information in the project documents, the subcontractor shall promptly request clarification and instruction from the design team.

## **1.3 ACCEPTABLE BMS CONTRACTORS**

- .1 The Building Automation System shall be one of the following systems:
  - .1 Automated Logic
  - .2 Delta Controls
  - .3 Reliable Controls.

## **1.4 SCOPE**

- .1 This project scope shall include, but not be limited to, the following work:
  - .1 Preparation of control shop drawings for review and approval. See Submittals.
  - .2 Supply and install a network of Building Automation Control System (BAS) panels and field devices. See Hardware, Software and Field Devices.
  - .3 Supply and install customized graphics software as specified. See Software.
  - .4 Install, wire and label all BAS control system components. See Installation.
  - .5 Calibrate and commission the installed control system. See Commissioning.
  - .6 Provide maintenance manuals and as-built drawings. See As-Built Documentation.
  - .7 Provide customized training for operations, maintenance and technical staff. See Training.

## **1.5 DRAWINGS AND SUBMISSIONS**

- .1 Submit the following information to the consultant and/or the project manager for review and approval:
  - .1 Control Schematics.

- .2 Detailed sequence of operation for each control schematic or controlled system.
- .3 System Architecture indicating the proposed interconnection and location of all BAS panels, network connections and key peripheral devices (workstations, modems, printers, repeaters, etc.)
- .4 BAS Points List indicating the panel ID, panel location, hardware address, point acronym, point description, field device type, point type (i.e, AO/DO/AI/DI), end device fail position, end device manufacture and model number, and wire tag ID). Terminal identification for all control wiring shall be shown on the shop drawings.
- .5 Wiring diagrams including complete power system, interlocks, control and data communications.
- .6 Hard copy graphical depiction of the application control programs.
- .7 Manufacturers' data / specification sheets for all material supplied.

## 1.6 MATERIALS

- .1 All points shall be available to BACnet.
- .2 Points shall be field reconfigurable. No set points shall be hard coded in the programs.
- .3 All controllers shall be loaded to a maximum of 80%. 20% of each of the inputs, outputs and variables shall remain unused to allow for future growth and expandability.
- .4 The system shall consist of all operator interfaces, microprocessor-based controllers, sensors, wells, automatic control valves, control dampers, transducers, and relays, automatic control valves, and damper actuators.
- .5 All equipment, points, etc. shall have common labelling.
- .6 Software shall be completely programmable and capable of all control and mathematical functions.
- .7 BAS shall come with copies of all software and licenses required to operate and configure the system. Software shall be the latest version as of substantial completion. Software updates, new versions and patches shall be provided to the Region as they are released free of charge for 2 years from substantial completion.
- .8 All temperature units for BAS and controlled equipment shall be in °C (degrees Celsius).
- .9 Operator Activity Tracking - An audit trail report to track system changes, accounting for operator initiated actions, changes made by a particular person or changes made to a specific piece of equipment designated time frame, shall be printable and archived for future use. The operator activity tracking shall be in a tamper-proof buffer file.
- .10 Operator workstation interface software shall optimize operator understanding through the use of English language prompting, English language point identification and industry standard PC application software. The software shall provide, as a minimum, the following functionality:
  - .1 Real-time graphical viewing and control of environment
  - .2 Scheduling and override of building operations
  - .3 Collection and analysis of historical data and dynamic data (trend plot)
  - .4 Definition and construction of dynamic color graphic displays
  - .5 Editing, programming, storage and downloading of global controller databases



- .6 Alarm reporting, routing, messaging, and acknowledgment
- .11 Provide a graphical user interface, which shall minimize the use of the keyboard through the use of a mouse or a similar pointing device and a “point and click” approach to menu selection.
- .12 Battery backup: Automatic restart after power failure: Upon restoration of power after an outage, the BAS shall automatically, and without human intervention, update all monitored functions, resume operation based on current synchronized time and status and implement special start-up strategies as required.
- .13 Refresh rate – The maximum permissible refresh rate is ONE (1) second. The refresh rate is defined as the time it takes the controller central processing unit (CPU) to sample all inputs, calculate all variables, update all timers and proportional integral derivative (PID) controllers, check all schedules, update all trend logs and runtime logs, execute all programs and assign values to all outputs.
- .14 The HVAC equipment shall be supplied as “Thermostat-Ready”. The building automation system shall have direct control of dampers, heating and cooling stages without the requirement of BACnet, Lonworks or any other type of communication interface. Factory installed interlocks, safeties and anti-cycle timers shall be provided as required.
- .15 Reports shall be generated on demand or via a pre-defined schedule and directed to video displays, printers or hard drive. As a minimum, the system shall allow the user to easily obtain the following types of reports:
  - .1 A general listing of all or selected points in the network
  - .2 List of all points currently in alarm
  - .3 List of all points currently in override status
  - .4 List of all disabled points
  - .5 List of all points currently locked out
  - .6 List of user accounts and access levels
  - .7 List all weekly schedules
  - .8 List of limits and dead-bands
  - .9 Excel reports
  - .10 System diagnostic reports including a list of BAS panels on line and communicating, and the status of all BAS terminal unit device points
  - .11 List of programs
- .16 Provide a means for the operator to view the communication status of all controllers connected to the system. The status should show whether the controller is communicating or not.
- .17 Provide a means for the operator to reset the error count for all controllers to zero.
- .18 Provide a means for the operator to display and change the system configuration. This shall include, but not be limited to, system time, day of the week, date of day light savings set forward/ set back, printer type and port addresses, modem port and speed, etc. Items shall be modified utilizing easy to understand terminology using simple mouse/cursor key movements.
- .19 Provide a security system that prevents unauthorized use unless the operator is logged on. Access shall be limited to the operator's terminal functions unless the user is logged on.

- .20 Where possible, utilize Optimized Start features on equipment to reduce hydro demand charges.
- .21 During the initial design The Region shall supply the controls contractor a range of BACnet addresses the BAS will run on. The BAS network will run either BACnet over IP or BACnet over MSTP. All BAS points will be network visible so that other BACnet systems can auto discover them. Contractor shall consult with York Region Project Manager during the development of addresses.

## 1.7 WAN ACCESS

- .1 Provide necessary interface and cabling to connect the BAS to the YR WAN. Obtain the particular WAN system details from the Engineer or Project Supervisor.
- .2 The Region shall supply the WAN IP address, Gateway and Subnet mask for the BBMD router in the network. The controls contractor will facilitate integration into the Region's existing BAS BACNET network.
- .3 On the network a BACnet IP device that is capable of BBMD will route information from other sites and the operator work station. In addition there shall be a CAT6A wire that is run to the Region's IT switch with a 4' pigtail and connector.

## 1.8 TREND DATA

- .1 Provide trend logs for every hardware input and output.
- .2 All trends should be accessible via the graphical interface.
- .3 Trends should contain all related variables of a control loop (i.e. setpoint, measured variable and control output) and have the ability to be plotted simultaneously on the same graph. Field Devices Individual trends should provide an appropriate "snapshot" of the variable. Trends should contain a minimum of 5 days worth of trend data.
- .4 Provide trending capabilities at 5 minute intervals that allow the user to easily monitor and preserve records of system activity over a one year period. Any system point may be trended automatically at time-based intervals or change of value, both of which shall be user-definable. Trend data may be stored on hard drive for future diagnostics and reporting. Additionally, trend data may be archived to network drives or removable disk media for future retrieval.
- .5 Trending shall be accessible from the graphics screens for each point. Each point shall have its associated trend capability accessible from the graphic via an icon located beside the point name on the graphic page.
- .6 Trend data reports shall be provided to allow the user to view all trended point data. Reports may be customized to include individual point or predefined groups of at least six points. Provide sufficient capacity to allow for trending a minimum of 100 points at 2000 samples each. Reports should be easily transferable on-line to Microsoft Excel. The Contractor shall provide custom designed spreadsheet reports for use by the Owner to track energy usage and cost, equipment run-times, equipment efficiency, and/or building environmental conditions.
- .7 The operator shall be able to change trend log setup information. This includes information to be trend logged as well as the interval at which the information is to be logged. All points in the system may be logged. All operations shall be password protected. Setup and viewing may be accessed directly from any and all graphics where the point is displayed.
- .8 Trending shall include the ability to track energy management aspects including, but not limited to, the following:

- .1 Daily use
- .2 Monthly use
- .3 Daily Hi and Low
- .4 Monthly Hi and Low
- .5 Demand Limiting and Load Shedding Program
- .6 Run time accumulation for any specified equipment
- .7 After hour use log
- .9 The primary input sensor for all control loops must connect to the same panel containing the control loop output.
- .10 Trend data storage must be in the same panel as the hardware or logical points being trended.

## 1.9 ALARMS

- .1 The BAS shall be configured to 3 categories: notifications, urgent alarms and critical alarms with different priorities.
- .2 Notification alarms will reside on BAS interface only. Urgent and critical alarms will email out to addresses specified by Owner. Please consult with Owner to develop alarm strategy.

- .1 Example email message

Medium : 380 Bayview BAS YR\_BYV\_GEN\_ST (602211.BI1) Normal -> Alarm change-of-state ----- 380 Bayview Ave., generator is running, possibly loss of power. Time@ 2021-02-10 07:21:44



System Name:	CHS_9060 Jane
Source:	9060Jane Main Router (601100)
Message:	Urgent_alarm : 9060 Jane Street HPL Cooler Fan failed
State:	Alarm
Alarm Time:	10-03-2021 01:02:37 PM



- .3 The BAS will be configured to provide for remote alarm capabilities.
- .4 Alarms shall be capable of being routed to The Region's IT server so that they can be sent to Operator's email addresses.

- .5 The operator workstation shall provided with audible, visual and printed means of alarm indication. The Alarm Dialog box shall always become the Top Dialog box regardless of the application(s) being run at the time (such as a word processor). A printout of all alarms shall be sent to the assigned terminal and port.
- .6 Provide a log of alarm messages. The alarm log shall be archived to the hard drive of the operator workstation. Each entry shall include a point descriptor and address, time and date of alarm occurrence, point value at the time of alarm, time and date of point return to normal condition and time and date of alarm acknowledge.
- .7 The Controls Contractor shall work with the Region to determine the alarms unless specified otherwise.
- .8 Alarm messages shall be in plain English and shall be user definable on site or via remote communication.

#### **1.10 FIELD DEVICES**

- .1 Automatic Control Valves
  - .1 Valves used for throttling applications shall have a linear percentage-to-flow characteristic.
  - .2 Ball valves are the preferred valve type for zone and HVAC control valves. Globe and butterfly valves shall be used where required to provide the desired pressure drop and CV.
  - .3 Automatic Control valves shall be manufactured by Belimo.
- .2 Control Valve Actuators
  - .1 Size control valve actuators to provide a tight close off against system head pressures and pressure differentials.
  - .2 Valve actuators shall accept a 0-10VDC control voltage for all proportional applications.
  - .3 Floating point control of valves is not acceptable under any circumstances.
  - .4 Heating valves shall spring-return fail open and cooling valves shall spring-return fail closed. Non-spring-return control valves may be used for terminal reheat coils and large HVAC control valves requiring a higher close off pressure.
- .3 Damper Actuators
  - .1 Actuators shall be direct coupled for either modulating or two position control. Actuators shall be powered by an overload-proof synchronous motor. Provide 0-10 VDC control voltage for all proportional applications and either line or low voltage actuators for all two position applications.
  - .2 Damper actuators are to be manufactured by Belimo or approved equal.
- .4 Automatic Control Dampers
  - .1 Motorized control dampers, unless otherwise specified elsewhere, shall be as follows:
    - .1 Control dampers shall be parallel or opposed blade type as below or as scheduled on drawings

- .1 Outdoor and/or return air mixing dampers and face and bypass (F&BP) dampers shall be parallel blade, arranged to direct airstreams toward each other.
  - .2 Other modulating dampers shall be the opposed blade type.
  - .3 Two-position shutoff dampers may be parallel or opposed blade type with blade and side seals.
  - .2 Extruded aluminum damper frame and airfoil blades, EPDM blade gaskets, TPR thermoplastic frame seals, celcon/polycarbonate bearings. Blades are to be suitable for medium velocity performance (10 m/s [2000 fpm]).
  - .3 Two-position dampers for shutoff service to must be "flanged-to-duct" type, such that there is no reduction in duct cross section through the damper. Dampers may only be "installed-in-duct" type where indicated as such on drawings.
  - .4 Individual damper sections shall not be larger than 125 cm × 150 cm (48 in. × 60 in.).
  - .5 Exterior Dampers (intake and exhaust applications) to be Tamco Series 9000 or approved equal insulated dampers and thermally broken frame and leakage Class 1A type at 0.25 kPa (1 in w.g.) static pressure differential with silicon blade and frame seals. Blades are internally insulated with foam and thermally broken with an insulating factor of R-2.29.
  - .2 All automatic control dampers not furnished with packaged equipment shall be supplied by the controls subcontractor and installed by the sheet metal subcontractor (except for VAV Boxes or line voltage dampers which shall be supplied by the Mechanical Contractor).
- .5 Room Sensors/Thermostats
  - .1 Office: Temp Display, Set point Display, Set point Adjust, Schedule Override, High and Low Limit on set points.
  - .2 All areas except offices: Set point Adjust, Schedule Override, High and Low Limit on set points.
  - .3 Mount sensors at a height of 1200 mm above finish floor unless otherwise indicated. Confirm exact location and mounting height with architect or Owner prior to final installation.
  - .4 Mount thermostats and space sensors as noted on the drawing. Do not mount on outside walls without permission of consultant.
  - .5 Thermostats (or with programming through the BAS) shall allow for deadbands of at least 3°C.
- .6 Current Sensor
  - .1 Provide BAS status for fan and pump motors using a current sensor. Acceptable manufactures are ACI, Enercorp, Greystone, Veris and Elkor.
  - .2 All CTs should have a range close to 2 times of rated reading.
- .7 Pressure Transmitters

- .1 Technical Performance - Solid State design, operating on capacitance principle, with non-interactive fine resolution, zero and span adjustments. End-to-end accuracy +/- 2% of full scale pressure range, including temperature compensation. 4-20mA, 0-5 VDC output, or 0-10 VDC output.
- .2 Standard of Acceptance – ACI, Enercorp, Greystone, Modus.
- .8 Duct Temperature Sensor
  - .1 Probe - Technical Performance – 10 k ohm thermistor sensor encapsulated in a 200mm long, 6mm OD copper or stainless steel probe. Operating range 0-60 degrees C. End-to-end accuracy +/- 0.3 degC. Assembly complete with wiring housing and mounting flange.
  - .2 Averaging - Technical Performance - 10 k ohm thermistor constructed of FT6 plenum rated cable or soft copper tubing, incorporating numerous temperature sensors encapsulated at equal distances along the length of the element. The assembly acts as a single sensor reporting the average temperature from all individual sensors. End-to-end accuracy +/- 0.3°C. Assembly complete with wiring housing and mounting flange. Mount in a zig-zag manner to provide continuous coverage of the entire duct cross-sectional area.
- .9 Outdoor Air Temperature Sensor
  - .1 Two outdoor air temperature sensors shall be installed and shall be programmed to check each other for accuracy. In the event of sensor failure the sensor deemed to be accurate shall be used to control the systems. The outdoor air sensors shall be located on a north wall if possible and a minimum of three (3) feet from any opening in the building envelope which could affect the sensor readings. The back face of the sensor enclosure shall be insulated to prevent temperature pick up from the building wall.
  - .2 Technical Performance, 10 k ohm thermistor -50oC to 50oC in a weatherproof enclosure mounted on north exposure. End accuracy of +/- 0.3 °C over the entire operating range.
- .10 Pipe Temperature Sensor
  - .1 Well - Technical Performance - 10k ohm thermistor sensor encapsulated in a 6mm OD, 50mm long probe, with screw fitting for insertion into a standard thermowell. Operating range -10 - +100°C. End-to-end accuracy +/- 0.3°C over the entire operating range. Complete with brass thermowell. Use heat transfer paste when mounting the sensor in thermowell. No surface mount strap on temperature sensors shall be used to monitor fluid temperature unless approved by the engineer.
- .11 CO2 Detector
  - .1 Technical Performance – Infrared CO2 monitor c/w 4-20mA or 0-5 VDC output, accuracy of +/- 40 ppm +3% reading.
  - .2 Standard of Acceptance – ACI-CO2-D or Telaire duct mount.

#### **1.11 SECURITY SYSTEM MONITORING TO BAS**

- .1 Provide digital input from security system.
- .2 All outside lighting control shuts off 20 minutes after building alarm system is armed.
- .3 When building security armed, all HVAC system shall be changed to unoccupied mode immediately when armed regardless of scheduled times.

- .4 All critical alarms as determined by York Region.

#### **1.12 ENCLOSURE**

- .1 The BAS control and power supply cabinets shall conform with the following:
  - .1 Panel enclosures shall be a locking type, metal cabinet, with common keying.
  - .2 CSA certified 150359 and UL listed E109310.
  - .3 16 or 14 gauge steel.
  - .4 Slip hinges enabling door removal for easier access and mounting. Door shall be lockable.
  - .5 1/4 turn keyed latch standardized to G549 keyset.
  - .6 14 or 12 gauge galvanized steel panel on collar studs natural finish.
  - .7 Grounding stud on inner cover surface.
  - .8 Grounding hole on mounting panel with grounding screw.
  - .9 ANSI/ASA61 grey polyester - epoxy textured powder coating inside out.
  - .10 3" deep wire duct shall be installed to neatly conceal controller wiring.
  - .11 Power supply cabinets shall be provided with a ESA Field Evaluation approval.
  - .12 2-100VA 120/24 Transformers Class II UL5085-3.
  - .13 Over Current Protection by Circuit Breaker.
  - .14 Outlet Receptacle for Service Laptop Power.

#### **1.13 BAS DATABASE NAMING CONVENTIONS & PROGRAMS**

- .1 All BAS programs shall follow the equipment manufacturer's sequence recommendations.
- .2 All BAS programs should include comments embedded in the program to describe the function and steps of the coding.
- .3 All BAS programs shall be created in each panel in logical order as determined by the equipment being controlled by each panel on the network.
- .4 All programs and program code is to follow proper coding practices including internal comments to describe the function of the statements and also ensure the source code is formatted in a consistent and logical manner. Programming coding should be kept as simple as possible.
- .5 System Schedules shall be submitted for approval and will include global and local scheduling.
- .6 The Outdoor Air Temperature Program shall be in its own program named OAT PG.
- .7 Network Status Panel Naming Conventions should indicate the building, panel location and panel number. The building name can be abbreviated as necessary to fit in the space.

#### **1.14 GRAPHIC DISPLAY SCREENS**

- .1 All Graphic Display Screens shall have the following common elements and functions regardless of system manufacturer. Every site shall have a graphic display screen for Site Graphic, System Architecture, each air handler, boilers, emergency generator, lighting, exhaust fans, heat reclaim, and for each room controlled by the BAS system.

- .2 All operator accessible points shall be yellow text and all information points shall be blue.
- .3 Trending shall be accessible from the graphics screens for each point. Each point shall have its associated trend capability accessible from the graphic via an icon located beside the point name on the graphic page.
- .4 Appendix A at the end of this document shows examples of typical graphic screens. These are examples only. Graphics shall comply with the following specific screen content. Not all equipment and systems are listed below but the format will be the same for other equipment:
- .5 Graphic Screens General All Screens
  - .1 Navigation buttons to each major system in the building which indicate current screen display by a change in button colour
  - .2 Background colour shall be black
  - .3 Outdoor air temperature shall be displayed on every graphic screen
- .6 Site Graphic
  - .1 The York Region Logo on the site or opening graphic screen
  - .2 Artist concept or scanned in picture of the front of the building
  - .3 Access links to all global schedules or specific screens affecting entire building operation
  - .4 Access buttons links to Set Time, Holiday Schedule, Schedule, Alarms, Points on Manual
- .7 System Architecture
  - .1 Control panel layout and network architecture
  - .2 Indicating BAS panels and panel type(model)
  - .3 Panel locations room number text on screen
  - .4 Systems controlled by each panel
  - .5 Links to points list accessible from each panel
- .8 Architecture Panel Layout (Locations on Floor Plans)
  - .1 Locations of each panel on each floor plan level
  - .2 Panel types indicated by different icon
  - .3 Controls transformers locations
  - .4 Main network wiring and sub-network wiring layout
- .9 Floor Plans graphics
  - .1 Room numbers accurate as per room signage
  - .2 Mechanical rooms locations & signage tags
  - .3 Space temperatures for every temperature on each floor in appropriate room
  - .4 Space focus pick area for individual room control where applicable shall be yellow text
  - .5 Air Handler symbols indicating areas of the floor plan serviced by each air handler by a corresponding colour



- .6 Status of Air Handler by colour change Red for off status, or text indication
- .7 Supply air temperature for each air handler
- .10 AHU / Fan Coil graphic
  - .1 Accurate representation of the AHU / Fan Coil design
  - .2 All associated control points to be displayed
  - .3 All points to be monitored for automatic mode and shall be displayed when in Manual mode
  - .4 A calculated percentage of fresh air shall be indicated on the AHU / Fan Coil graphic
  - .5 Operator offset adjustment of the supply air setpoint, adjustable directly form the graphic
  - .6 AHU / Fan Coil physical location shall be indicated on the graphic
  - .7 Weekly occupied time of day schedule for the associated AHU / Fan Coil shall be accessible directly from the graphic by selecting an icon
  - .8 Trend logs shall be accessible directly form the graphic by selecting an icon
- .11 Water Heater graphic
  - .1 Water heater graphic piping layout shall be accurate as per piping layout
  - .2 All associated control points for the water heating system to be displayed
  - .3 Operator offset adjustment of the scheduled water setpoint, adjustable directly form the graphic
  - .4 Status shall be indicated graphically
  - .5 Operator offset editable directly from the graphic screen
  - .6 Weekly time of day schedule for the building occupied schedule shall be accessible directly from the graphic by selecting an icon
  - .7 Trend logs shall be accessible directly from the graphic by selecting an icon
- .12 Exhaust fans graphic
  - .1 Exhaust fans control shall be editable directly from the graphic
  - .2 Exhaust fan status shall be indicated in text and a change in the exhaust fan icon
  - .3 Exhaust fan physical location shall be indicated on the graphic
  - .4 Area of the building being exhausted shall be indicated on the graphic
- .13 ERV graphic
  - .1 ERV control shall be editable directly from the graphic
  - .2 ERV status (normal/boost/off) shall be indicated in text and a change in the icon.

## 1.15 INSTALLATION

- .1 All wiring line and low voltage shall be installed in EMT conduit unless specifically specified otherwise.

- .2 All wiring shall be in accordance with the Ontario Electrical Code and any applicable local codes. All BAS wiring shall be installed in conduit unless otherwise allowed by the Ontario Electrical Code or applicable local codes. Where BAS plenum-rated cable wiring is allowed, it shall be run parallel to, or at right angles to, the structure, properly supported and installed in a neat and workmanlike manner. BAS wiring that runs in exposed ceiling spaces (eg garages, mechanical rooms) shall be installed in conduit.
- .3 In accessible ceilings, wiring from BAS controllers to sensors and actuators, control system network and low voltage wiring only may be installed with plenum-rated yellow jacket cable.
- .4 BX or flex conduit may only be used for the final (approximately one meter) run to controls devices, where the controls equipment is mounted on vibrating machinery.
- .5 Install EMT and cable at right angles to building lines, securely fastened, and in accordance with the standards set out in Division 16.
- .6 No wire smaller than 18 gauge is to be used on the project except for: wiring between terminal computer devices, wire in standard communication cables, such as printers and short haul modems, wire used in communication networks, i.e. any cable transferring digital data, using twisted shielded pairs.
- .7 All field wiring including sensor wiring and wiring from panels to devices shall be continuous. The use of wire connectors, wire nuts or splicing is not allowed.
- .8 Provide wells for all specified temperature sensors in hydronic piping system. Strap-on sensors may be only be used where a well installation is not possible. Obtain approval of Engineer for the use of any strap-on sensors.
- .9 Power for control system shall not be obtained by tapping into miscellaneous circuits that could be inadvertently be switched off.
- .10 Mount transformers and other peripheral equipment in panels located in serviceable areas. Provide line side breakers/fuses for all transformers.
- .11 All 120 VAC power for any controls equipment shall be from dedicated circuits. Provide a breaker lock for each breaker used to supply the control system. Update the panel circuit directory.
- .12 The controller may be powered from the equipment that it is directly controlling (i.e. heat pump, roof-top unit) only if the controller controls no other equipment and the power supply to the controller remains energized independently of unit operation or status. If power for the control system is taken from the equipment it serves, it should be clearly marked "Powered from Equipment".
- .13 All BAS control wiring shall be yellow jacket for identification purposes. BAS control inputs wiring shall be one colour, output should be another, and communication wires another.
- .14 The breaker or power isolation location shall be clearly marked on the inside door of each BAS panel enclosure.
- .15 Wiring in ceiling spaces to be installed clear of ceiling tiles and lights to allow access and removal of tiles and lights.
- .16 Contractor shall prepare a wiring mock-up of a typical system/device/main panel to demonstrate quality and workmanship for approval by the Region. This approved mock-up quality shall be maintained throughout the entire installation. System requiring mock-up to be discussed with the Region's Project Manager.
- .17 All wiring shall be routed orthogonally and drops shall have additional wiring coiled in ceilings to facilitate future sensor relocation.
- .18 Wiring in ceiling spaces to be secured/tied every 48" minimum.

- .19 Surge suppression shall comply, as a minimum, with the manufacturer's requirements.
- .20 All equipment including controllers shall be grounded.
- .21 All end-of-wire connectors shall be certified.
- .22 All components shall be labelled and detailed in manuals.
- .23 All wiring systems shall be colour coded to simplify maintenance.
- .24 All equipment shall be located for ease of service access.
- .25 Contractor shall maintain a list of deficiencies when close to completion, and shall update this list on a regular basis for review by the Owner's representative.
- .26 If the project is a retrofit of an existing system:
  - .1 Contractor shall remove all old redundant wiring following system verification
  - .2 Re-use of existing wiring is not allowed. Run continuous new wiring
  - .3 Re-use of components (eg enclosures, transformers) is not allowed unless approved by the Region's Project Manager

#### **1.16 EQUIPMENT LOCATION**

- .1 All distributed equipment such as VAV boxes, Roof top units, unit ventilators, fan coil units, etc. that utilize dedicated BAS controllers, shall have locally mounted controllers, in accessible locations within the building envelope. All locally mounted controllers shall be installed in enclosures suitable for that location. BAS controllers for mechanical equipment other than those listed above shall be mounted in mechanical rooms as noted below, unless specifically approved by the Engineer for this project.
- .2 All other BAS controllers, and interface devices that require regular inspection or that serve multiple HVAC systems shall be located in mechanical rooms, or in pre-approved storage rooms, or janitor closets.
- .3 No BAS panel shall be located inside the rooftop fan enclosure under any circumstances. All BAS panels shall be located within the building envelope, and shall be enclosed in a metal locking enclosure, as specified in 16.4.
- .4 All equipment located in mechanical rooms, storage rooms or janitor closets shall be installed in metal cabinets with hinged, lockable covers.
- .5 Transformers or power supplies shall not be located in ceiling spaces unless approved by the engineer for terminal control valves, actuators or zone controllers. When transformers are installed above ceilings, transformers shall be installed in metal enclosures, and the location shall be clearly labeled on the t-bar ceiling to indicate power transformer location.
- .6 A 120 VAC duplex receptacle for laptop power shall be provided if the cabinet is located further than 5' laterally from the nearest outlet.

#### **1.17 IDENTIFICATION AND LABELLING EQUIPMENT**

- .1 All panels must have a lamacoid tag (min. 3"x1") affixed to the front face indicating panel designation and function (i.e. "BAS Panel 1" or "Relay Panel 3").
- .2 All field sensors or devices must have a lamacoid tag (min. 3"x1") attached with tie-wrap or adhesive indicating the point software name and hardware address (i.e. F-1\_MAT, 2.IP4).

- .3 Room sensors and other sensors in finished areas will require a device tag.
- .4 All devices within a field enclosure will be identified via a label or tag.
- .5 All BAS panel power sources must be identified by an adhesive label indicating the source power panel designation and circuit number on the outside of the enclosure door (i.e. "120vac fed from LP-2A cct #1).
- .6 All field equipment panels fed from more than one power source must have a warning label on the front cover.
- .7 All wires will be identified with self-adhesive wire labels or clip-on plastic wire markers at both ends.
- .8 All rotating equipment controlled by the BAS will have a tag or label affixed indicating that the equipment may start without warning.
- .9 All BAS panels will have a points list sheet (within a plastic sleeve) attached to the inside door. The points list will identify the following for each point: Panel number, panel location, hardware address, software name, point description, field device type, point type (i.e. AI or DO), device fail position, device manufacturer and model number or reference and wire tag reference.
- .10 Where required, field panels will have wiring diagrams attached to the inside door.
- .11 Provide new or modify existing equipment wiring diagrams (i.e. boilers, chillers, etc.) wherever the BAS interfaces to other equipment.

#### **1.18 COMMISSIONING**

- .1 Perform all necessary calibration, testing and de-bugging and perform all required operational checks to ensure that the system is functioning.
- .2 Upon completion of the performance tests, repeat these tests, point-by-point in the presence of the Owner's representative, as required. Properly schedule these tests so that testing is completed by the time directed by the Owner's representative.
- .3 Confirm and demonstrate to the Engineer and the Owner's agent that all systems are programmed and operating correctly. When project is complete the contract shall allow sufficient programming time in order to customize the sequences to meet operational needs, fine tuning of the system and other duties as required. The Owner shall determine the schedule.
- .4 Submit a copy of the system commissioning report to the Engineer for review and approval.
- .5 Each analogue input (i.e. temperatures, pressure, etc.) shall be verified with an approved calibration device. All actual temperature readings should be with +/- 1°C of the readings observed at the workstation.
- .6 Each analogue output shall be verified by manually commanding the output channel from the operator workstation to two or more positions within the 0-100% range and verifying the actual position of the actuator or device. All devices shall operate over their entire 0-100% range from a minimum control range of 10-90%.
- .7 Digital outputs shall be verified by witnessing the actual start/stop operation of the equipment under control.
- .8 Digital inputs shall be verified by observing the status of the input point as the equipment is manually cycled on and off.
- .9 Record all out-of-season or unverified points in the commissioning report as "uncommissioned".

- .10 The BAS field panel power source shall be toggled on and off to ensure reboot functionality and power down memory retention of all parameters. During the power down test, all connected system components should go to their fail-safe state.
- .11 All trends should be reviewed to ensure that setpoints are being maintained and excessive cycling of equipment is not occurring.
- .12 Control loop tuning parameters can be verified by applying a change to the current setpoint and observing the resulting trend log. Setpoint should be reached in a "reasonable" period of time without excessive cycling or hunting of the controlled device.

#### **1.19 TRAINING**

- .1 Once 5 consecutive Days of alarm-free operation are complete and documented, operator training may begin.
- .2 Provide 1 day of instruction to the Owner's designated personnel on the operation of the BAS and describe its intended use with respect to the programmed functions. Operator orientation of the BAS shall include, but not be limited to, the overall operation program, equipment functions (both individually and as part of the total integrated system), commands, systems generation, advisories, and appropriate operator intervention required in responding to the system's operation.

#### **1.20 WARRANTY**

- .1 Warranty all components supplied under this contract for a period of two years from substantial completion. Replace all controls equipment that fails during this period without cost to the owner.
- .2 All Controllers shall have a 5 year manufacturer's warranty.

#### **1.21 AS-BUILT DOCUMENTATION**

- .1 Within two weeks following substantial completion of the project, update the original submittal documents to reflect the "As Built" conditions of the project and submit four copies as required by the consultant and/or the Project Manager.
- .2 Provide a separate laminated copy of the control drawings for mounting in the mechanical room or in the controls panels.
- .3 Provide final point lists, shop drawings and all installed equipment data and operations sheets.
- .4 Submit USB drive containing up to date copies of the programs in each controller. Provide original program disks and documentation proving registration for all software programs provided as a part of this contract including: the BAS operator interface software, and the BAS graphics (bitmap files). Provide one set of original disks for every computer supplied under this contract or that the software has been loaded onto.
- .5 Submit (4) printed copies of the final programs that include all point definitions, weekly and annual schedule setting, controller setpoints and tuning parameters, and documented programmed sequences of operation.

#### **1.22 CONTROL POINTS AND POINT LIST**

- .1 A typical points list for system control and monitoring shall be used as a guide for system design.

- .2 This points list is not intended to be complete. It is intended to be a typical list to capture all foreseeable equipment types. Project specific points list must be created on a project-by-project basis by the BAS contractor and shall be reviewed by York Region.
- .3 York Region staff shall be consulted to develop the sequence of operations. York Region will provide the BACnet address range for each building.
- .4 All control points shall have built in time delays to prevent short cycling.
- .5 Point Naming conventions shall be submitted for review by York Region Project team. Names may be changed to comply with the Regions naming conventions.

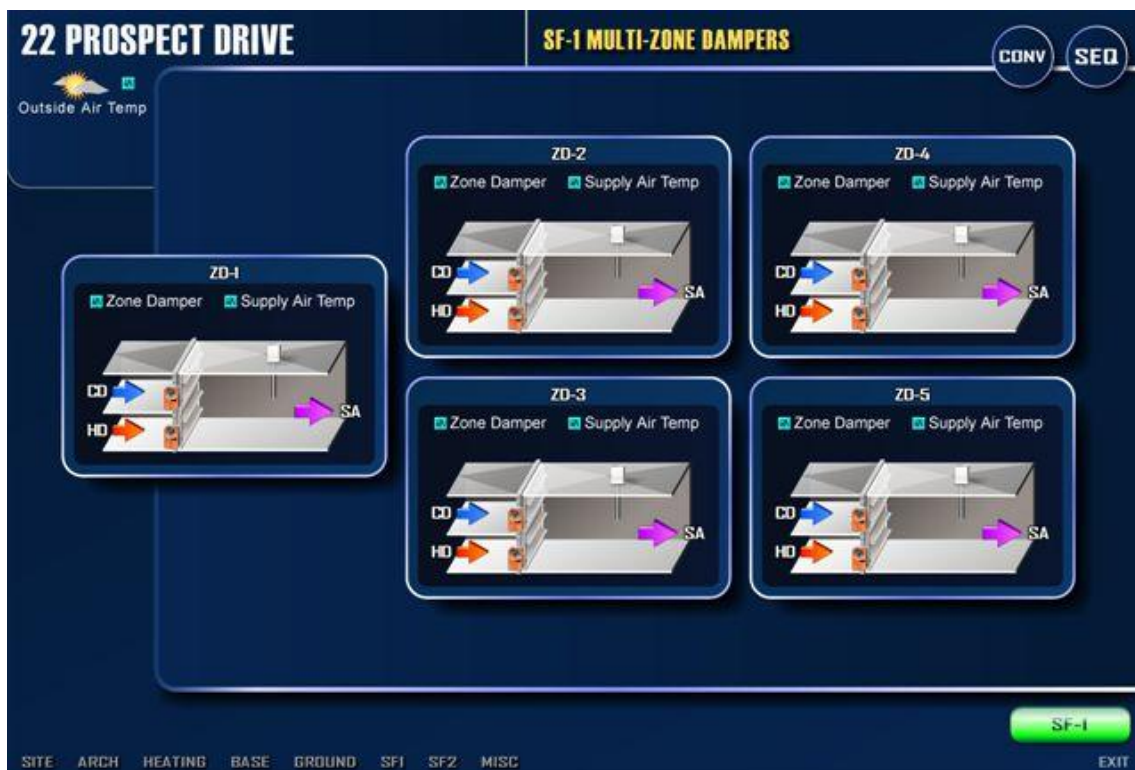
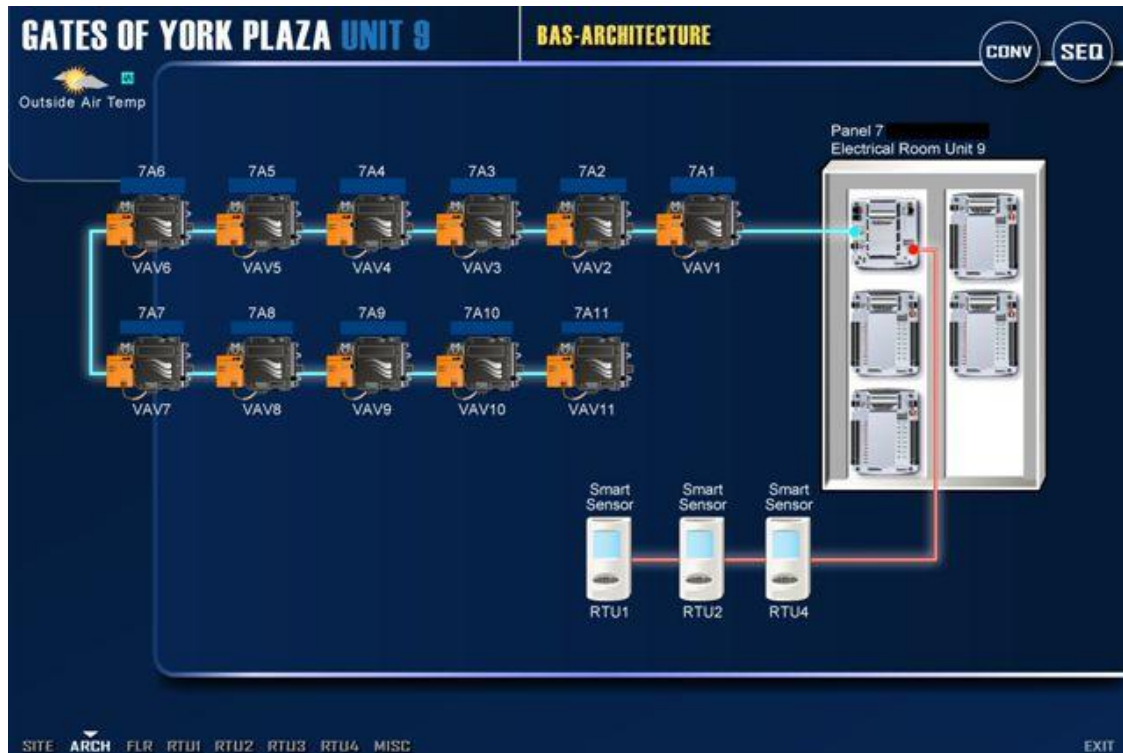
## **PART 2 PRODUCTS**

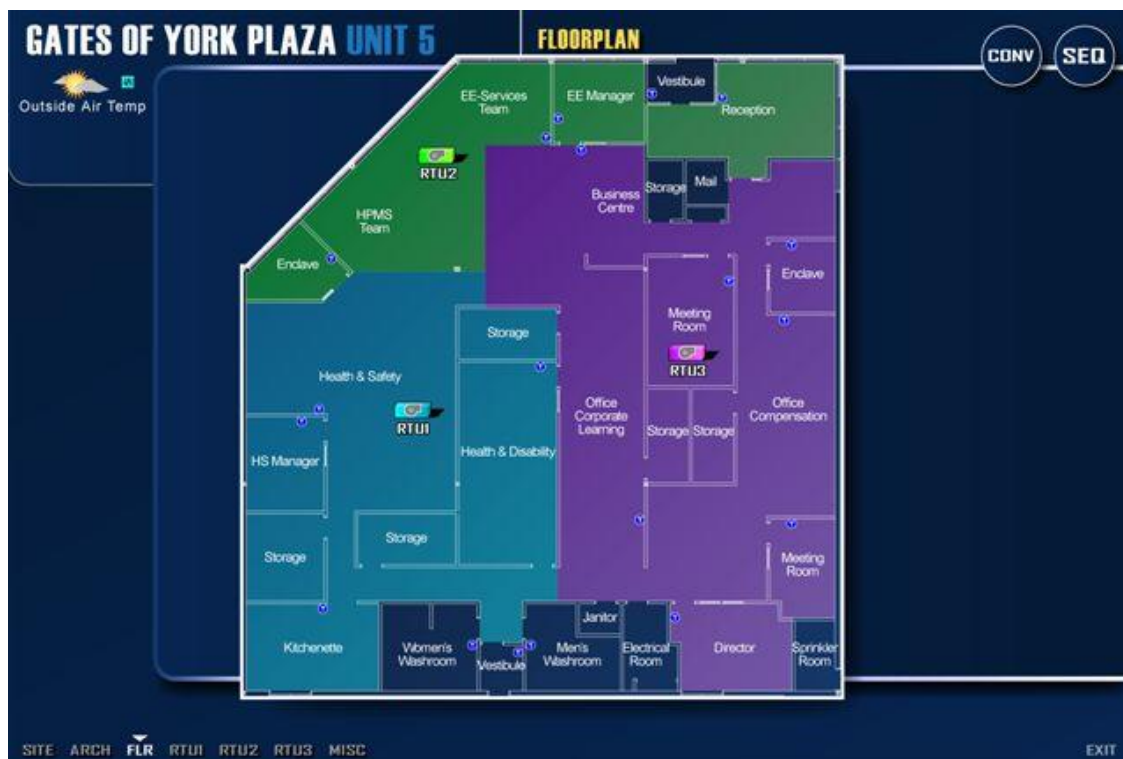
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## **PART 3 EXECUTION**

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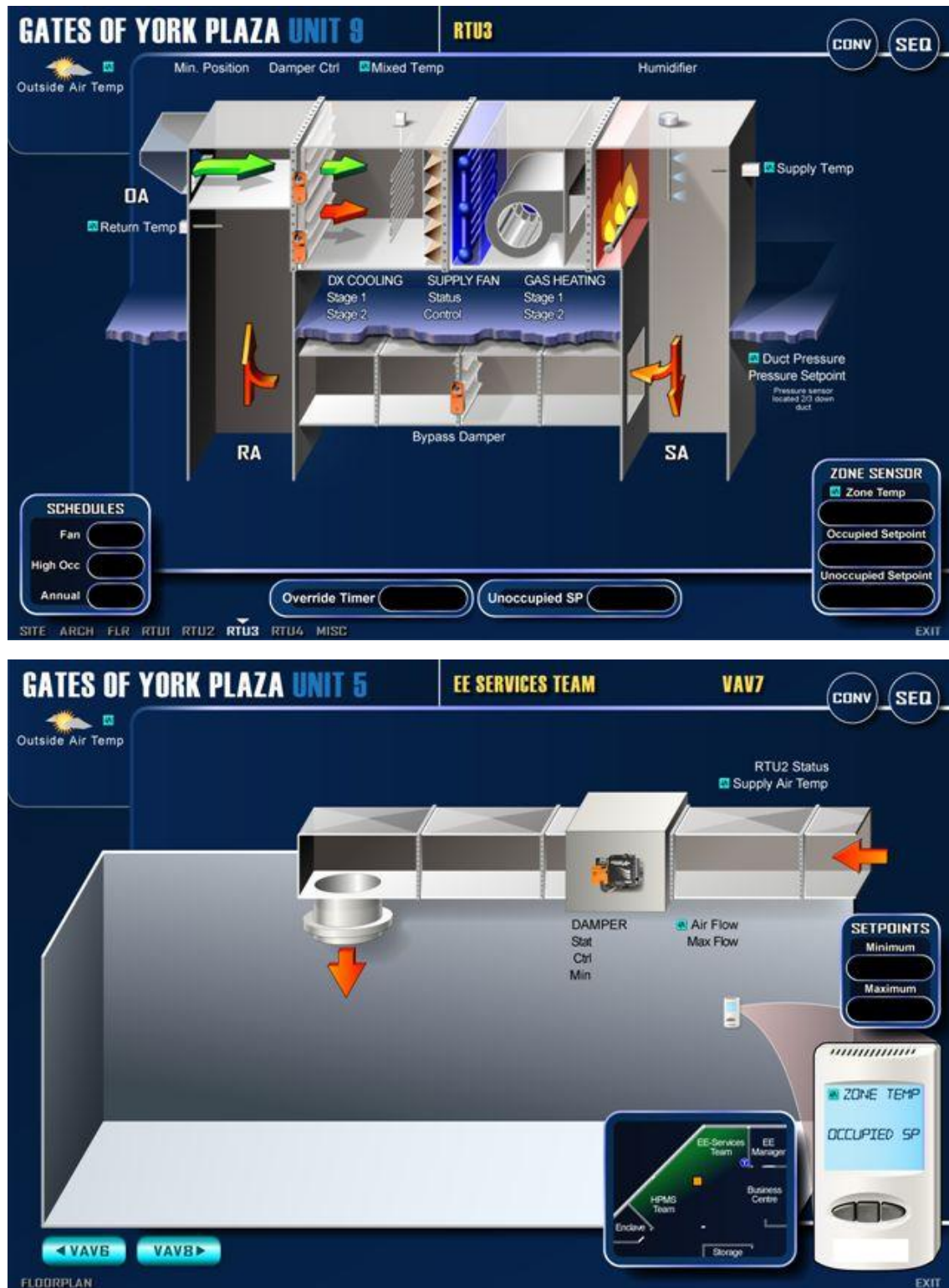
## Appendix A – Typical Graphic Screens











END OF SECTION

## **PART 1 – GENERAL**

### **1.1 GENERAL REQUIREMENTS**

- .1 Read and be governed by conditions of the *Contract Documents*, including sections of Division 01.
- .2 Section includes
  - .1 Sequence of operation:
    - .1 Furnace & DX Condensing unit
    - .2 ERV
    - .3 Fresh Air Heater
    - .4 Humidification
    - .5 IT Room Air Conditioning
    - .6 Medical Storage Room
    - .7 Vehicle Bay Radiant Tube Heaters and Unit Heater
    - .8 Vehicle Bay Ceiling Fan
    - .9 Vehicle Bay Overhead Doors
    - .10 Vehicle Bay Exhaust Fan EF-2
    - .11 CO/NOX Ventilation System for Vehicle Bay
    - .12 Vestibule Heater
    - .13 Mechanical Room Heater
    - .14 Generator Delay
    - .15 Domestic Hot Water System
    - .16 Trending

## **PART 2 – EQUIPMENT**

- .1 Furnace & DX Condensing unit
  - .1 The furnace will be controlled by the BAS as well as its own pre-programmed logic to maintain room temperature at set point. During the summer season the DX condensing unit will be energized to provide cooling to meet the room temperature set point. Heating and cooling staging shall be controlled by furnace controller with setpoints adjustable by operator through BAS. Furnace will be connected to BAS through direct connection to terminal strip to control (heat, cool, fan and off). Outside air temperature is monitored and used by the furnace for its energy efficiency algorithms.
  - .2 Provide feedback to BAS for furnace fan and air-conditioner statuses using current sensors and display motor current reading on BAS graphic.

- .3 BAS to control temperature setpoint within range with local area control. Temperature of Crew Lounge is available to BAS, viewable and adjustable by both occupant and operator.
- .4 Provide temperature/humidity sensors that communicate directly with BAS.
- .5 BAS will generate an alarm if the heating/cooling/fan system fails to operate when commanded on.
- .6 Status fan on/off, heating on/off and cooling on/off is available in BAS, viewable by occupant and operator.
- .7 There will be two modes of operation. 1) Auto mode: heating/cooling mode will be determined by the outdoor air temperature. In summer mode, all heating (including stand alone heaters) will be disabled. 2) Building mode: heating/cooling will be manually determined by operators based on the season.
- .8 Provide overflow/high-level switch for condensate drain pan to alert building operator that there is a problem with the drainage.

## .2 ERV

- .1 Control ERV's on/off, low and high speed directly through BAS. Provide feedback to BAS for ERV status (supply and exhaust fans) using current sensors and display motor current reading on BAS graphic.
- .2 Provide ERV discharge air (to building) temperature sensor and display temperature reading on BAS graphic.
- .3 ERV fans can be operated through the BAS based on time of day schedule (adjustable), although it is expected at this point the ERV will run at all times. When ERV is running, BAS will open motorized intake and exhaust dampers and command fans to start. When ERV is set to run at all times (default), ERV shall turn off and dampers closed every five days for 5 minutes to exercise the actuators. Fans will run at airflows indicated on drawings so that supply is greater than exhaust airflow rate (exhaust is always 85% of supply for slight positive pressurization of living areas).
- .4 Provide occupancy sensors in washrooms to initiate high speed on ERV. High speed mode ends 20 minutes after person leaves the washroom.
- .5 Provide CO2 sensor in crew lounge that will also initiate high speed mode if CO2 reading exceeds 1330 ppm CO2.

## .3 Fresh Air Heater

- .1 The on/off status of the ERV post heater will be monitored by the BAS, hourly trending recorded.
- .2 The discharge air setpoint is provided by the BAS, set at 16°C (operator adjustable). The temperature reading is displayed on the BAS graphic.
- .3 In cooling season (during/after the air-conditioner has been running) the ERV post heater is disabled and setpoint is set to 14°C (operator adjustable) for free cooling at night.

## .4 Humidification

- .1 Humidifier is only enabled during heating season.

- .2 Upon call for humidification through humidity sensor located in Crew Lounge, humidifier runs until furnace turns off or set point of 30% RH (adjustable through BAS; maximum of 35%RH is recommended to minimize ERV core frosting) is reached. Status on/off is available in BAS, viewable by operator.
- .3 If humidity being monitored in Write-Up Room exceeds 50%RH (adjustable), turn off the humidifier.

.5 IT Room Air Conditioning

- .1 In winter there are two stages of cooling. The BAS monitors temperature in the space. The first stage of cooling (shoulder or heating season only) is enabled when the temperature reaches 23°C (adjustable through BAS) and uses a transfer fan to blow warm air to the plenum space. When the temperature reaches 25°C (adjustable through BAS), the second stage of cooling is enabled. The transfer fan turns off and the split air-conditioning unit turns on until the unit has run for at least 10 minutes (adjustable through BAS) and the setpoint to turn cooling off (22°C, adjustable through BAS) is reached. During cooling season, the transfer fan is not used for cooling, only the split air-conditioning unit is used.
- .2 If temperature reaches 27°C (adjustable through BAS) the BAS will generate an alarm to alert building operator. Temperature of room is available at BAS, viewable by operator. Status of transfer fan and split AC unit (on/off) is viewable by operator.

.6 Medical Storage Room

- .1 The medical storage room has a dedicated modulating damper that will open/close in increments to maintain a relatively stable temperature between 20 to 25°C. The damper shall have the ability to open and close all the way. If the temperature drops below 18°C, turn on furnace heating even if main thermostat (located in Crew Lounge) is satisfied. If the temperature rises above 27°C, turn on furnace cooling even if main thermostat is satisfied. Track through BAS each time the furnace or air-conditioning is turned on to solely serve the medical storage room, the temperature of the medical storage room, and the outdoor air temperature.
- .2 If the temperature reaches below 15°C or above 30°C, the BAS shall generate alarm to alert building operator. Temperature of room is available at BAS, viewable by operator.

.7 Vehicle Bay Radiant Tube Heaters and Unit Heater

- .1 The Premium User Interface controller is used to connect the radiant tube heaters to the BAS. The BAS uses the temperature reading from the black bulb radiant temperature sensor and monitors/trends with the air temperature sensor (1 pair of sensors for each radiant tube heater). The BAS modulates the radiant gas tube heater output based on the outdoor air temperature and how far from setpoint the calculated indoor temperature is. When the outdoor air temperature is above 18°C (adjustable), the radiant tube heaters do not operate. The radiant tube heaters turn off once setpoint is reached.
- .2 The unit heater will turn on when local temperature setpoint is unmet due to ventilation system being in use. It will also be used as a second stage of heating to the radiant heaters.

.8 Vehicle Bay Ceiling Fan

- .1 The operation of the fans shall be disabled when outdoor air temperature is below 12°C (operator adjustable through BAS; limit may be disabled through BAS).

- .2 Timer enabled on-function provided so building occupant turns on fan, which automatically shuts off after specified time (default 3 h, operator adjustable). Building occupant may also turn off fan locally. Fan speed locally adjustable by building occupant.
- .3 BACnet compatible communication to fan controller shall be used to provide above functionality.
- .4 BAS shall turn on fan 5 minutes after CO/NO2 ventilation system starts (intake louver opens and exhaust fan starts).

.9 Vehicle Bay Overhead doors

- .1 The vehicle bay's large doors for vehicle entry (overhead and folding) shall be monitored as open or closed by BAS, in a way that the local operation of the doors is not affected by a temporarily disabled BAS system.

.10 Vehicle Bay Exhaust Fan EF-2

- .1 EF-2 shall run continuously to slightly negatively pressurize the space and status shall be monitored by BAS, viewable by operator. If the fan ceases to operate, alert the operator, unless the stoppage is due to generator delay.

.11 CO/NOX Ventilation System for Vehicle Bay

- .1 CO and NO2 monitoring system shall be controlled by Honeywell model E3 Point. Upon first alarm the exhaust fan will locally open the intake louver damper (with spring type return actuator) and then turn on the exhaust fan. If gas concentration continues to rise, upon second alarm audible buzzer will sound. Program a 3 minute relay delay-off. Gas alarm concentrations and placement heights:
- .2 CO and NO2 monitoring system shall be controlled by Honeywell model E3 Point. Upon first alarm the monitoring system shall signal the intake air louver damper and exhaust louver dampers to open. Once open, the exhaust fan (EF-1) will be allowed to run. If gas concentration continues to rise, upon second alarm audible buzzer will sound. Program a 3-minute relay delay-off. Gas alarm concentrations and placement heights below:

	First Alarm	Second Alarm	Sensor Height
Carbon monoxide (CO)	25 ppm	35 ppm	1200 mm AFF
Nitrogen dioxide (NO2)	0.25 ppm	2 ppm	1500 mm AFF

- .3 The CO gas concentration upon alarm will be sent to the BAS via 4-20 mA signal for monitoring time and duration of alarm events for record. If the gas detector alarms due to NO2, use output relay to signal and record BAS that alarm was due to NO2 event at that time.
- .4 A 10-20-30 minute timer push-button is provided for the occupant to turn on the ventilation system (exhaust fan EF-1 and intake louver damper) when desired.

.12 Vestibule Heater

- .1 Vestibule temperature and outdoor air temperature shall be monitored by BAS, with alarm sent to operator if temperature drops below 6°C (default, adjustable). The heater will operate to maintain vestibule at heating set point (15°C default, adjustable). If outdoor air is above 7°C (default, adjustable) the heater will not turn on.
- .2 BAS will monitor the status to generate an alarm if the heater fails to operate when commanded on. Temperature of room is available at BAS, viewable by operator.

.13 Mechanical Room Heaters

- .1 Mechanical room temperature shall be monitored by BAS.
- .2 If the heat drops below 14°C (adjustable), the electric heaters will operate.
- .3 The temperature of the room from one temperature sensor is available at BAS, viewable by operator. An alarm is generated to alert operator when temperature goes below 12°C (adjustable).

.14 Generator Delay

- .1 Upon power outage, BAS receives transfer switch signal and immediately disables the following mechanical equipment: humidifier HUM, mechanical room electric heaters EUH-1.1 and EUH-1.2. After 5 seconds of receiving the transfer switch signal, the abovementioned equipment can be enabled again.
- .2 BAS shall monitor generator run status and trouble/fault signals.

.15 Domestic Hot Water System

- .1 Provide direct connection from water heater to BAS. BAS monitors faults/alarms to alert operator and provides adjustable setpoints.
- .2 BAS monitors temperature at domestic hot water tank via thermowell temperature sensor. If the water temperature goes below 40°C (105°F) (operator adjustable), then the BAS alerts the operator there is a problem.
- .3 The BAS monitors the outlet temperature after the master thermostatic mixing valve. If that temperature goes over 5°C out of range (above or below the thermostatic set point temperature, adjustable by operator), the operator is alerted that there is a problem with the thermostatic mixing valve.
- .4 The BAS monitors the recirculation hot water temperature. If the temperature goes below 32°C (90°F), operator adjustable, the recirculation pump P-DHWR starts and runs until the return temperature reaches at least 38°C (100°F), operator adjustable. The BAS alerts the operator if there is a problem with the recirculation pump.

.16 Trending

- .1 Provide hourly trending of measured temperatures at each thermostat (Crew Lounge, Medical Storage room, Write-Up Room, IT Room, Vehicle Bay, Mechanical room (and relative humidity at Crew Lounge and Write-Up Room)).
- .2 Provide hourly trending of outdoor air temperature.
- .3 Provide trending of all BAS connected equipment.

**PART 3- RECOMMENDED BASELINE SETPOINTS**

Occupied				
	Heating		Cooling	
	Temperature Setpoint	Relative Humidity	Temperature Setpoint	Relative Humidity
Crew Lounge / Living Area	22°C	30	24°C	50
Vehicle Bay	18°C	-	-	-
IT Room Air Conditioning	-	-	22°C	-
Medical Storage Room	20°C	-	25°C	-
Vestibule Heater	15°C	-	-	-
Mechanical Room	15°C	-	33°C	-

**END OF SECTION**



[illegible]

[illegible]

## **PART 1 – GENERAL**

### **1.1 Related Requirements**

- .1 Conform to General Requirements, Division 1 and Instructions to Bidders.

### **1.2 Reference Standards**

- .1 CSA Group
  - .1 CSA C22.1-24, Ontario Electrical Safety Code, Part 1 (29th Edition), Safety Standard for Electrical Installations.
  - .2 CSA C22.2 No..
  - .3 CAN/CSA-C22.3 No.1-10, Overhead Systems.
  - .4 CAN3-C235-83(R2010), Preferred Voltage Levels for AC Systems, 0 to 50,000 V.
- .2 Institute of Electrical and Electronics (IEEE)/National Electrical Safety Code Product Line (NESC)
  - .1 IEEE SP1122-2000, The Authoritative Dictionary of IEEE Standards Terms, 7th Edition.

### **1.3 Definitions**

- .1 Electrical and electronic terms: unless otherwise specified or indicated, terms used in these specifications, and on drawings, are those defined by IEEE SP1122.

### **1.4 Action And Informational Submittals**

- .1 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for distribution equipment, lighting, fire alarm, emergency lighting, exit signs, lighting control, security and access control, and include product characteristics, performance criteria, physical size, finish and limitations.
  - .2 Submit for review single line electrical diagrams under plexiglass and locate as indicated.
    - .1 Electrical distribution system in main electrical room.
  - .3 Submit for review fire alarm riser diagram, plan and zoning of building under plexiglass at fire alarm control panel and annunciator.
  - .4 Shop drawings:
    - .1 Submit for review manufacturer's drawings for all products being furnished except cable (up to 1000V) and wire and conduit.
    - .2 Submit wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to ensure coordinated installation.
    - .3 Identify on wiring diagrams circuit terminals and indicate internal wiring for each item of equipment and interconnection between each item of equipment.
    - .4 Indicate on drawings clearances for operation, maintenance, and replacement of operating equipment devices.
    - .5 Submit 2 copies of 600 x 600 mm minimum size drawings and product data to inspection authorities.

- .6 If changes are required, notify Consultant of these changes before they are made.
- .5 Certificates:
  - .1 Provide CSA certified equipment and material.
  - .2 Where CSA certified equipment and material is not available, submit such equipment and material to inspection authorities 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 as described in PART 3 - LOAD BALANCE.
  - .6 Submit certificate of acceptance from authority having jurisdiction upon completion of Work to Consultant.
- .6 Manufacturer's Field Reports: submit to Consultant manufacturer's written report, within 3 days of review, verifying compliance of Work and electrical system and instrumentation testing, as described in PART 3 - FIELD QUALITY CONTROL.
- .7 Sustainable Design Submittals:
  - .1 Construction Waste Management:
    - .1 Submit project Waste Management Plan highlighting recycling and salvage requirements.

### **1.5 Closeout Submittals**

- .1 Refer to and comply with Division 1.
- .2 Operation and Maintenance Data: submit operation and maintenance data for distribution equipment, lighting, fire alarm, emergency lighting, exit signs, lighting control, security and access control, for incorporation into manual.
  - .1 Provide for each system and principal item of equipment as specified in technical sections for use by operation and maintenance personnel.
  - .2 Operating instructions to include following:
    - .1 Wiring diagrams, control diagrams, and control sequence for each principal system and item of equipment.
    - .2 Start up, proper adjustment, operating, lubrication, and shutdown procedures.
    - .3 Safety precautions.
    - .4 Procedures to be followed in event of equipment failure.
    - .5 Other items of instruction as recommended by manufacturer of each system or item of equipment.
  - .3 Print or engrave operating instructions and frame under glass or in approved laminated plastic.
  - .4 Post instructions where directed.
  - .5 For operating instructions exposed to weather, provide weather-resistant materials or weatherproof enclosures.
  - .6 Ensure operating instructions will not fade when exposed to sunlight and are secured to prevent easy removal or peeling.
- .3 Provide As-Built drawings to Consultant upon completion of Contract Work, prior to Substantial Performance inspection and after final review by Consultants. The submission shall include:
  - .1 Updated ACAD R2012 drawings

- .2 One (1) set of neatly red lined legible prints. The consultant will review the submission and the contractor shall be responsible to address the comments and re-submit the as-built drawings.

### **1.6 Delivery, Storage And Handling**

- .1 Refer to, and comply with Division 1. Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirement: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
  - .1 Store materials off ground, indoors, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Store and protect electrical equipment from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan.
- .5 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding, and packaging materials as specified in Construction Waste Management Plan.

### **1.7 Seismic Restraints**

- .1 Include all costs related to provision of seismic restraints and equipment as required for the electrical equipment and systems. Include the cost of a professional structural engineer licensed in the Province of Ontario to design the seismic restraints for all electrical equipment included in the contract.

## **PART 2 – PRODUCTS**

### **2.1 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.
  - .1 Equipment to operate in extreme operating conditions established in above standard without damage to equipment.
- .3 Language operating requirements: provide identification nameplates and labels for control items in English.

### **2.2 Materials And Equipment**

- .1 Provide material and equipment in accordance with Division 1.
- .2 Material and equipment to be CSA certified. Where CSA certified material and equipment is are not available, obtain special approval from inspection authorities before delivery to

site and submit such approval as described in PART 1 - ACTION AND INFORMATIONAL SUBMITTALS.

- .3 Factory assemble control panels and component assemblies.

### 2.3 Electric Motors, Equipment And Controls

- .1 Verify installation and co-ordination responsibilities related to motors, equipment and controls, as indicated.
- .2 Provide conduit and wiring except for conduit, wiring and connections below 50 V which are related to control systems specified in mechanical sections and as shown on mechanical drawings.

### 2.4 Warning Signs

- .1 Warning Signs: in accordance with requirements of authority having jurisdiction and inspection authorities.
- .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 either copper or aluminum conductors.

### 2.6 Equipment Identification

- .1 Identify electrical equipment with nameplates and labels as follows:
  - .1 Nameplates: plastic laminate lamicaid 3 mm thick plastic engraving sheet melamine, black matt white finish face, black white core, lettering accurately aligned and engraved into core mechanically attached with self tapping screws.
  - .2 Sizes as follows:

#### NAMEPLATE SIZES

Size 1	10 x 50 mm	1 line	3 mm high letters
Size 2	12 x 70 mm	1 line	5 mm high letters
Size 3	12 x 70 mm	2 lines	3 mm high letters
Size 4	20 x 90 mm	1 line	8 mm high letters
Size 5	20 x 90 mm	2 lines	5 mm high letters
Size 6	25 x 100 mm	1 line	12 mm high letters
Size 7	25 x 100 mm	2 lines	6 mm high letters

- .2 Labels: embossed plastic labels with 6 mm high letters unless specified otherwise.

- .3 Wording on nameplates and labels to be approved by Consultant prior to manufacture.
- .4 Allow for minimum of twenty-five (25) letters per nameplate and label.
- .5 Nameplates for terminal cabinets and junction boxes to indicate system and/or voltage characteristics.
- .6 Disconnects, starters and contactors: indicate equipment being controlled and voltage.
- .7 Terminal cabinets and pull boxes: indicate system and voltage.
- .8 Transformers: indicate capacity, primary and secondary voltages.

## 2.7 Wiring Identification

- .1 Identify wiring with permanent indelible identifying markings, numbered coloured plastic tapes, on both ends of phase conductors of feeders and branch circuit wiring.
- .2 Maintain phase sequence and colour coding throughout.
- .3 Colour coding: to CSA C22.1.
- .4 Use colour coded wires in communication cables, matched throughout system.

## 2.8 Conduit And Cable Identification

- .1 Colour code conduits, boxes and metallic sheathed cables.
- .2 Code with plastic tape or paint at points where conduit or cable enters wall, ceiling, or floor, and at 15 m intervals.
- .3 Colours: 25 mm wide prime colour and 20 mm wide auxiliary colour.

Type	Prime	Auxiliary
up to 250 V	Yellow	
up to 600 V	Yellow	Green
up to 5 kV	Yellow	Blue
up to 15 kV	Yellow	Red
Telephone	Green	
Other	Green	Blue
Communication Systems		
Fire Alarm	Red	
Emergency Voice	Red	Blue
Other	Red	Yellow
Security Systems		

## 2.9 Finishes

- .1 Shop finish metal enclosure surfaces by application of rust resistant primer inside and outside, and at least two coats of finish enamel.

## **PART 3 – EXECUTION**

### **3.1 Examination**

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for electrical installation in accordance with manufacturer's written instructions.
  - .1 Visually inspect substrate in presence of York Region Representative.
  - .2 Inform York Region Representative of unacceptable conditions immediately upon discovery.
  - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from York Region Representative.

### **3.2 Installation**

- .1 Do complete installation in accordance with CSA C22.1 except where specified otherwise.
- .2 Do overhead and underground systems in accordance with CAN/CSA-C22.3 No.1 except where specified otherwise.

### **3.3 Nameplates And Labels**

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

### **3.4 Conduit And Cable Installation**

- .1 Install conduit and sleeves prior to pouring of concrete.
  - .1 Sleeves through concrete: schedule 40 steel pipe plastic sheet metal, sized for free passage of conduit, and protruding 50 mm.
- .2 If plastic sleeves are used in fire rated walls or floors, remove before conduit installation.
- .3 Install cables, conduits and fittings embedded or plastered over, close to building structure so furring can be kept to minimum.

### **3.5 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 150 mm horizontal clearance between boxes.
- .3 Change location of outlets at no extra cost or credit, providing distance does not exceed 3000 mm, and information is given before installation.
- .4 Locate light switches on latch side of doors.
  - .1 Locate disconnect devices in mechanical and elevator machine rooms on latch side of floor.



### **3.6 Mounting Heights**

- .1 Mounting height of equipment is from finished floor to centre line of equipment unless specified or indicated otherwise.
- .2 If mounting height of equipment is not specified or indicated, verify before proceeding with installation.
- .3 Install electrical equipment at following heights unless indicated otherwise.
  - .1 Local switches: 1000 mm.
  - .2 Wall receptacles:
    - .1 General: 400 mm.
    - .2 Above top of continuous baseboard heater: 300 mm.
    - .3 Above top of counters or counter splash backs: 175 mm.
    - .4 In mechanical rooms: 1400 mm.
  - .3 Panelboards: as required by Code or as indicated.
  - .4 Telephone and interphone outlets: 400 mm.
  - .5 Wall mounted telephone and interphone outlets: 1500 mm.
  - .6 Fire alarm stations: 1200 mm.
  - .7 Fire alarm horns: in accordance with CAN/ULC S524-14.
  - .8 Television outlets: 300 mm.
  - .9 Wall mounted speakers: 2100 mm.
  - .10 Clocks: 2100 mm.
  - .11 Door bell pushbuttons: 1000 mm.

### **3.7 Co-Ordination Of Protective Devices**

- .1 Ensure circuit protective devices such as overcurrent trips, relays and fuses are installed to required values and settings.

### **3.8 Co-Ordination Study**

- .1 Employ the services of a qualified engineering company to perform a co-ordination and short circuit study of all electrical distribution equipment which is part of the project. Study to start at main disconnect switch and include down to each breaker feeding panelboards.
- .2 The company shall have experience in providing co-ordination studies.
- .3 Ensure circuit protective devices such as overcurrent trips, relays and fuses are installed to required values and settings.
- .4 Co-ordination and short circuit study shall be sealed and signed by a professional engineer licensed in the Province of Ontario.
- .5 Approval of the Co-ordination and short circuit Study must be obtained before any shop drawings for service entrance board, switchboards, distribution panels, panel boards, moulded case circuit breakers or disconnects (fused and non-fused) will be reviewed.

### **3.9 Arc Flash Hazard Assessment**

- .1 Employ the services of a qualified engineering company to perform a short circuit and an arc flash hazard assessment of all electrical distribution equipment which is part of the

project.

- .2 The company shall have experience in providing arc flash assessments.
- .3 Ensure that equipment identified in the assessment are provided with approved labelling.
- .4 Arc Flash Hazard Assessment shall be sealed and signed by a professional engineer licensed in the Province of Ontario.
- .5 The selection of electrical equipment including circuit breakers type and setting shall be selected to reduce the FR Clothing Category to 12 cal/cm2 where possible at equipment down stream from each circuit breaker.
- .6 Based on the Arc Flash Study, provide labels for equipment in accordance with ANSI Z535.4-2011(R2017).
- .7 Provide a protection plan in accordance with CSA Z462-18 Workplace Electrical Safety.

### 3.8 Field Quality Control

- .1 Load Balance:
  - .1 Measure phase current to panelboards with normal loads (lighting) operating at time of acceptance; adjust branch circuit connections as required to obtain best balance of current between phases and record changes.
  - .2 Measure phase voltages at loads and adjust transformer taps to within 2% of rated voltage of equipment.
  - .3 Provide upon completion of work, load balance report as directed in PART 1 - ACTION AND INFORMATIONAL SUBMITTALS, phase and neutral currents on panelboards, dry-core transformers and motor control centres, operating under normal load, as well as hour and date on which each load was measured, and voltage at time of test.
- .2 Conduct following tests in accordance with Section 01 45 00 - Quality Control.
  - .1 Power generation and distribution system including phasing, voltage, grounding and load balancing.
  - .2 Circuits originating from branch distribution panels.
  - .3 Lighting and its control.
  - .4 Motors, heaters and associated control equipment including sequenced operation of systems where applicable.
  - .5 Systems: fire alarm, communications, security.
  - .6 Insulation resistance testing:
    - .1 Megger circuits, feeders and equipment up to 350 V with a 500 V instrument.
    - .2 Megger 350-600 V circuits, feeders and equipment with a 1000 V instrument.
    - .3 Check resistance to ground before energizing.
- .3 Carry out tests in presence of York Region Representative.
- .4 Provide instruments, meters, equipment and personnel required to conduct tests during and at conclusion of project.
- .5 Manufacturer's Field Services:
  - .1 Obtain written report from manufacturer verifying compliance of Work, in

handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports as described in PART 1 - ACTION AND INFORMATIONAL SUBMITTALS.

- .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.

### **3.9 System Startup**

- .1 Instruct York Region Representative and operating personnel in operation, care and maintenance of systems, system equipment and components.
- .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.

### **3.10 Cleaning**

- .1 Progress Cleaning:
  - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment
- .3 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 19 - Waste Management and Disposal.
  - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

**END OF SECTION**

## **PART 1 – GENERAL**

### **1.1 Product Data**

- .1 Provide product data in accordance with Section 01 33 00 - Submittal Procedures.

### **1.2 Delivery, Storage And Handling**

- .1 Packaging Waste Management: remove for reuse and return by manufacturer of pallets crates padding and packaging materials in accordance with Section 01 74 19 - Waste Management and Disposal.

## **PART 2 – PRODUCTS**

### **2.1 Building Wires**

- .1 Conductors: stranded for 10 AWG and larger. Minimum size: 12 AWG.
- .2 Copper conductors: size as indicated, with 600 V insulation of cross-linked thermosetting polyethylene material rated RW90 XLPE or RWU90 XLPE, Non Jacketted.
- .3 Copper conductors: size as indicated, with thermoplastic insulation type T90 Nylon rated at 600 V.

### **2.2 Teck 90 Cable**

- .1 Cable: in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Conductors:
  - .1 Grounding conductor: copper as indicated.
  - .2 Circuit conductors: copper as indicated, size as indicated.
- .3 Insulation:
  - .1 Ethylene propylene rubber EP.
  - .2 Cross-linked polyethylene XLPE.
  - .3 Rating:, 600 V.
- .4 Inner jacket: polyvinyl chloride material.
- .5 Armour: flat interlocking galvanized steel .
- .6 Overall covering: thermoplastic polyvinyl chloride, compliant to applicable Building Code classification for this project.
- .7 Fastenings:
  - .1 One hole steel 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 at 1000mm centers.
  - .3 Threaded rods: 6 mm diameter to support suspended channels.

- .8 Connectors:
  - .1 Watertight, explosion-proof approved for TECK cable.

### **2.3 Armoured Cables**

- .1 Conductors: insulated, copper, size as indicated.
- .2 Type: AC90.
- .3 Armour: interlocking type fabricated from aluminum strip.
- .4 Type: ACWU90 PVC flame retardant jacket over thermoplastic armour and compliant to applicable Building Code classification for this project wet locations.
- .5 Connectors: anti short connectors.

## **3 EXECUTION**

### **3.1 Field Quality Control**

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Perform tests using method appropriate to site conditions and to approval of York Region Representative and local authority having jurisdiction over installation.
- .3 Perform tests before energizing electrical system.

### **3.2 General Cable Installation**

- .1 Cable Colour Coding: to Section 26 05 00 - Common Work Results for Electrical.
- .2 Conductor length for parallel feeders to be identical.
- .3 Lace or clip groups of feeder cables at distribution centres, pull boxes, and termination points.
- .4 Wiring in walls: typically drop or loop vertically from above to better facilitate future renovations. Generally wiring from below and horizontal wiring in walls to be avoided unless indicated.
- .5 Branch circuit wiring for surge suppression receptacles and permanently wired computer and electronic equipment to be 2-wire circuits only, i.e. common neutrals not permitted.
- .6 Provide numbered wire collars for control wiring. Numbers to correspond to control shop drawing legend. Obtain wiring diagram for control wiring.

### **3.3 Installation Of Building Wires**

- .1 Install wiring as follows:
  - .1 In conduit systems in accordance with Section 26 05 34 - Conduits, Conduit Fastenings and Conduit Fittings.
  - .2 In underground ducts in accordance with Section 26 05 43.01.

#### **3.4 Installation Of Teck90 Cable (0 -1000 V)**

- .1 Group cables wherever possible on channels.
- .2 Install cable exposed , securely supported by straps or hangers.

#### **3.5 Installation Of Armoured Cables**

- .1 Group cables wherever possible on channels.

**END OF SECTION**

## **PART 1 – GENERAL**

### **1.1 Action And Informational Submittals**

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for hangers and supports and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Sustainable Design Submittals:
  - .1 Construction Waste Management:
    - .1 Submit project Waste Management Plan highlighting recycling and salvage requirements.

### **1.2 Delivery, Storage And Handling**

- .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
  - .1 Store materials off ground indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Store and protect hangers and supports from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan related to Work of this Section.
- .5 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding, and packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 19 - Waste Management and Disposal.

## **PART 2 - PRODUCTS**

### **2.1 Support Channels**

- .1 U shape, size 41 x 41 mm, 2.5 mm thick, surface mounted suspended set in poured concrete walls and ceilings.

## **PART 3 – EXECUTION**

### **3.1 Examination**

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for hangers and supports installation in accordance with manufacturer's written instructions.

- .1 Visually inspect substrate in presence of York Region Representative.
- .2 Inform York Region Representative of unacceptable conditions immediately upon discovery.
- .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from York Region Representative.

### **3.2 Installation**

- .1 Secure equipment to hollow solid masonry, tile and plaster surfaces with lead anchors or nylon shields.
- .2 Secure equipment to poured concrete with expandable inserts.
- .3 Secure equipment to hollow masonry walls or suspended ceilings with toggle bolts.
- .4 Secure surface mounted equipment with twist clip fasteners to inverted T bar ceilings. Ensure that T bars are adequately supported to carry weight of equipment specified before installation.
- .5 Support equipment, conduit or cables using clips, spring loaded bolts, cable clamps designed as accessories to basic channel members.
- .6 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.
- .7 Suspended support systems.
  - .1 Support individual cable or conduit runs with 6 mm diameter threaded rods and spring clips.
  - .2 Support 2 or more cables or conduits on channels supported by 6 mm diameter threaded rod hangers where direct fastening to building construction is impractical.
- .8 For surface mounting of two or more conduits use channels at 1000mm on centre spacing.
- .9 Provide metal brackets, frames, hangers, clamps and related types of support structures where indicated or as required to support conduit and cable runs.
- .10 Ensure adequate support for raceways and cables dropped vertically to equipment where there is no wall support.
- .11 Do not use wire lashing or perforated strap to support or secure raceways or cables.
- .12 Do not use supports or equipment installed for other trades for conduit or cable support except with permission of other trade and approval of York Region Representative.
- .13 Install fastenings and supports as required for each type of equipment cables and conduits, and in accordance with manufacturer's installation recommendations.

### **3.3 Cleaning**



- .1 Progress Cleaning:
  - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment
- .3 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 19 - Waste Management and Disposal.
  - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

**END OF SECTION**

## **PART 1 – GENERAL**

### **1.1 Reference Standards**

- .1 CSA Group (CSA)
  - .1 CSA C22.1-24, Canadian Electrical Code, Part 1, 26th Edition.
  - .2 Ontario Electrical Safety Code, 29th Edition and all Bulletins

### **1.2 Action And Informational Submittals**

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Provide manufacturer's printed product literature, specifications and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Provide shop drawings: in accordance with Section 01 33 00 - Submittal Procedures.
  - .1 Submit shop drawings.

### **1.3 Delivery, Storage And Handling**

- .1 Waste Management and Disposal:
  - .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 19 - Waste Management and Disposal.

## **PART 2 – PRODUCTS**

### **2.1 Splitters**

- .1 Construction: sheet metal enclosure, welded corners and formed hinged cover suitable for locking in closed position.
- .2 Terminations: main and branch lugs connection blocks to match required size and number of incoming and outgoing conductors as indicated.
- .3 Spare Terminals: minimum three spare terminals or lugs on each connection or lug block sized less than 400 A.

### **2.2 Junction And Pull Boxes**

- .1 Construction: welded steel enclosure.
- .2 Covers Flush Mounted: 25 mm minimum extension all around.
- .3 Covers Surface Mounted: screw-on flat turned edge covers.

### **2.3 Cabinets**

- .1 Construction: welded sheet steel hinged door, handle, latch lock 2 keys and catch

- .2 Type E Empty: flush overlapping sides mounting as indicated.
- .3 Type T Terminal: flush overlapping sides mounting as indicated containing 19 mm G1S fir plywood backboard.

## **PART 3 – EXECUTION**

### **3.1 Splitter Installation**

- .1 Mount plumb, true and square to building lines.
- .2 Extend splitters full length of equipment arrangement except where indicated otherwise.

### **3.2 Junction, Pull Boxes And Cabinets Installation**

- .1 Install pull boxes in inconspicuous but accessible locations.
- .2 Mount cabinets with top not higher than 2 m above finished floor except where indicated otherwise.
- .3 Install terminal block as indicated in Type T cabinets.
- .4 Only main junction and pull boxes are indicated. Install additional pull boxes as required by CSA C22.1.

### **3.3 Identification**

- .1 Equipment Identification: to Section 26 05 00- Common Work Results for Electrical.
- .2 Identification Labels: size 2 indicating system name voltage and phase or as indicated.

**END OF SECTION**

## **PART 1 - GENERAL**

### **1.1 Reference Standards**

- .1 CSA Group (CSA)
  - .1 CSA C22.1-24, Canadian Electrical Code, Part 1, 26th Edition.
  - .2 Ontario Electrical Safety Code, 29th Edition and all Bulletins.

### **1.2 Action And Informational Submittals**

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit samples for floor box in accordance with Section 01 33 00 - Submittal Procedures

### **1.3 Delivery, Storage And Handling**

- .1 Waste Management and Disposal:
  - .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 19 - Waste Management and Disposal.

## **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.
- .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.

### **2.2 Galvanized Steel Outlet Boxes**

- .1 One-piece electro-galvanized construction.
- .2 Single and multi gang flush device boxes for flush installation, minimum size 76 x 50 x 38 mm or as indicated. 102 mm square outlet boxes when more than one conduit enters one side with extension and plaster rings as required.
- .3 Utility boxes for outlets connected to surface-mounted EMT conduit, minimum size 102 x 54 x 48 mm.
- .4 102 mm square or octagonal outlet boxes for lighting fixture outlets.
- .5 Extension and plaster rings for flush mounting devices in finished plaster tile walls.

### **2.3 Masonry Boxes**

- .1 Electro-galvanized steel masonry single and multi gang boxes for devices flush mounted in exposed block walls.

### **2.4 Concrete Boxes**

- .1 Electro-galvanized sheet steel concrete type boxes for flush mount in concrete with matching extension and plaster rings as required.

### **2.5 Conduit Boxes**

- .1 Cast FS or FD aluminum boxes with factory-threaded hubs and mounting feet for surface wiring of devices.

### **2.6 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 35mm 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 For flush installations mount outlets flush with finished wall using plaster rings to permit wall finish to come within 6 mm of opening.
- .4 Provide correct size of openings in boxes for conduit and armoured cable connections. Do not install reducing washers.
- .5 Vacuum clean interior of outlet boxes before installation of wiring devices.
- .6 Identify systems for outlet boxes as required.

**END OF SECTION**

## **PART 1 – GENERAL**

### **1.1 Reference Standards**

- .1 CSA Group (CSA)
  - .1 CAN/CSA C22.2 No. 18-98(R2003), Outlet Boxes, Conduit Boxes, Fittings and Associated Hardware, A National Standard of Canada.
  - .2 CSA C22.2 No. 45-M1981(R2003), Rigid Metal Conduit.
  - .3 CSA C22.2 No. 56-04, Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit.
  - .4 CSA C22.2 No. 83-M1985(R2003), Electrical Metallic Tubing.
  - .5 CSA C22.2 No. 211.2-M1984(R2003), Rigid PVC (Unplasticized) Conduit.
  - .6 CAN/CSA C22.2 No. 227.3-05, Nonmetallic Mechanical Protection Tubing (NMPT), A National Standard of Canada (February 2006).

### **1.2 Action And Informational Submittals**

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product data: submit manufacturer's printed product literature, specifications and datasheets.
  - .1 Submit cable manufacturing data.
- .3 Quality assurance submittals:
  - .1 Test reports: submit certified test reports.
  - .2 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
  - .3 Instructions: submit manufacturer's installation instructions.

### **1.3 Waste Management And Disposal**

- .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 19 - Waste Management and Disposal.
- .2 Place materials defined as hazardous or toxic waste in designated containers.
- .3 Ensure emptied containers are sealed and stored safely for disposal away from children.

## **PART 2 – PRODUCTS**

### **2.1 Cables And Reels**

- .1 Provide cables on reels or coils.
  - .1 Mark or tag each cable and outside of each reel or coil, to indicate cable length, voltage rating, conductor size, and manufacturer's lot number and reel number.
- .2 Each coil or reel of cable to contain only one continuous cable without splices.
- .3 Identify cables for exclusively dc applications.
- .4 Reel and mark shielded cables rated 2,001 volts and above.

## **2.2 Conduits**

- .1 Rigid metal conduit: to CSA C22.2 No. 45, galvanized steel
- .2 Electrical metallic tubing (EMT): to CSA C22.2 No. 83, with couplings.
- .3 Rigid pvc conduit: to CSA C22.2 No. 211.2.
- .4 Flexible metal conduit: to CSA C22.2 No. 56, steel liquid-tight flexible metal.
- .5 Flexible pvc conduit: to CAN/CSA-C22.2 No. 227.3.

## **2.3 Conduit Fastenings**

- .1 One hole steel straps to secure surface conduits 50 mm and smaller.
  - .1 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 at spacing recommended by manufacturer.
- .4 Threaded rods, 6 mm diameter, to support suspended channels.

## **2.4 Conduit Fittings**

- .1 Fittings: to CAN/CSA C22.2 No. 18, manufactured for use with conduit specified. Coating: same as conduit.
- .2 Ensure factory "ells" where 90 degrees bends for 25 mm and larger conduits.
- .3 Watertight connectors and couplings for EMT.
  - .1 Set-screws are not acceptable.

## **2.5 Expansion Fittings For Rigid Conduit**

- .1 Weatherproof expansion fittings with internal bonding assembly suitable for 100 mm linear expansion.
- .2 Watertight expansion fittings with integral bonding jumper suitable for linear expansion and 19 mm deflection.
- .3 Weatherproof expansion fittings for linear expansion at entry to panel.

## **2.6 Fish Cord**

- .1 Polypropylene.

## **PART 3 - EXECUTION**

### 3.1 Manufacturer's Instructions

- .1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheets.

### 3.2 Installation

- .1 Install conduits to conserve headroom in exposed locations and cause minimum interference in spaces through which they pass.
- .2 Conceal conduits except in mechanical and electrical service rooms in unfinished areas.
- .3 Use rigid galvanized steel threaded conduit except where specified otherwise.
- .4 Use electrical metallic tubing (EMT) except in cast concrete, exposed in unfinished areas, above 3.0 m not subject to mechanical injury, and in block walls and stud partitions.
- .5 Use rigid PVC conduit underground.
- .6 Use flexible metal conduit for connection to motors in dry areas connection to recessed incandescent fixtures without prewired outlet box connection to surface or recessed fluorescent fixtures work in movable metal partitions.
- .7 Use liquid tight flexible metal conduit for connection to motors or vibrating equipment in damp, wet or corrosive locations.
- .8 Use explosion proof flexible connection for connection to explosion proof motors.
- .9 Install conduit sealing fittings in hazardous areas.
  - .1 Fill with compound.
- .10 Minimum conduit size for lighting and power circuits: 19 mm.
- .11 Bend conduit cold:
  - .1 Replace conduit if kinked or flattened more than 1/10th of its original diameter.
- .12 Mechanically bend steel conduit over 19 mm diameter.
- .13 Field threads on rigid conduit must be of sufficient length to draw conduits up tight.
- .14 Install fish cord in empty conduits.
- .15 Run 2-25 mm spare conduits up to ceiling space from each flush panel.
  - .1 Terminate these conduits in 152 x 152 x 102 mm junction boxes in ceiling space or in case of an exposed concrete slab, terminate each conduit in flush concrete surface type box.
- .16 Remove and replace blocked conduit sections.
  - .1 Do not use liquids to clean out conduits.
- .17 Dry conduits out before installing wire.



### **3.3 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 on suspended or surface channels.
- .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.

### **3.4 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.

### **3.5 Conduits In Cast-In-Place Concrete**

- .1 Locate to suit reinforcing steel.
  - .1 Install in centre one third of slab.
- .2 Protect conduits from damage where they stub out of concrete.
- .3 Install sleeves where conduits pass through slab or wall.
- .4 Provide oversized sleeve for conduits passing through waterproof membrane, before membrane is installed.
  - .1 Use cold mastic between sleeve and conduit.
- .5 Conduits in slabs: minimum slab thickness 4 times conduit diameter.
- .6 Encase conduits completely in concrete with minimum 25 mm concrete cover.
- .7 Organize conduits in slab to minimize cross-overs.

### **3.6 Conduits In Cast-In-Place Slabs On Grade**

- .1 Run conduits 25 mm and larger below slab and encase in 75 mm concrete envelope.
  - .1 Provide 50 mm of sand over concrete envelope below floor slab.

### **3.7 Conduits Underground**

- .1 Slope conduits to provide drainage.
- .2 Waterproof joints (PVC excepted) with heavy coat of bituminous paint.

### **3.8 Cleaning**

- .1 On completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

**END OF SECTION**

## **PART 1 - GENERAL**

### **1.1 Reference Standards**

- .1 CSA International
  - .1 CAN/CSA-Z809-08, Sustainable Forest Management.
- .2 Forest Stewardship Council (FSC)
  - .1 FSC-STD-01-001-2004, FSC Principle and Criteria for Forest Stewardship.
- .3 Insulated Cable Engineers Association, Inc. (ICEA)
- .4 Sustainable Forestry Initiative (SFI)
  - .1 SFI-2010-2014 Standard.

### **1.2 Action And Informational Submittals**

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for cables and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Sustainable Design Submittals:
  - .1 Construction Waste Management:
    - .1 Submit project Waste Management Plan highlighting recycling and salvage requirements.

### **1.3 Delivery, Storage And Handling**

- .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
  - .1 Store materials off ground indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Store and protect cables from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan related to Work of this Section.
- .5 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding, and packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 19 - Waste Management and Disposal.

## **PART 2 - PRODUCTS**

### **2.1 Markers**

- .1 Concrete type cable markers: 600 x 600 x 100 mm with words: cable, joint or conduit

impressed in top surface, with arrows to indicate change in direction of cable and duct runs.

## **PART 3 - EXECUTION**

### **3.1 Examination**

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for cable installation in accordance with manufacturer's written instructions.
  - .1 Visually inspect substrate in presence of York Region Representative.
  - .2 Inform York Region Representative of unacceptable conditions immediately upon discovery.
  - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from York Region Representative.

### **3.2 Direct Burial Of Cables**

- .1 After sand bed is in place, lay cables maintaining 75 mm clearance from each side of trench to nearest cable.
  - .1 Do not pull cable into trench.
- .2 Include offsets for thermal action and minor earth movements.
  - .1 Offset cables 150 mm minimum for each 60 m run, maintaining minimum cable separation and bending radius requirements.
- .3 Underground cable splices not acceptable.
- .4 Minimum permitted radius at cable bends for rubber, plastic or lead covered cables, 8 times diameter of cable or in accordance with manufacturer's written recommendations; for metallic armoured cables, 12 times diameter of cables or in accordance with manufacturer's instructions.
- .5 Cable separation:
  - .1 Maintain 75 mm minimum separation between cables of different circuits.
  - .2 Maintain 300 mm minimum horizontal separation between low and high voltage cables.
  - .3 When low voltage cables cross high voltage cables maintain 300 mm vertical separation with low voltage cables in upper position.
  - .4 At crossover, maintain 75 mm minimum vertical separation between low voltage cables and 150 mm between high voltage cables.
  - .5 Maintain 300 mm minimum lateral and vertical separation for fire alarm and control cables when crossing other cables, with fire alarm and control cables in upper position.
  - .6 Install treated planks on lower cables 0.6 m minimum in each direction at crossings.

### **3.3 Cable Installation In Ducts**

- .1 Install cables as indicated in ducts.
- .2 Do not pull spliced cables inside ducts.

- .3 Install multiple cables in duct simultaneously.
- .4 Use CSA approved lubricants of type compatible with cable jacket to reduce pulling tension.
- .5 To facilitate matching of colour coded multiconductor control cables reel off in same direction during installation.
- .6 Before pulling cable into ducts and until cables are properly terminated, seal ends of lead covered cables with wiping solder; seal ends of non-leaded cables with moisture seal tape.
- .7 After installation of cables, seal duct ends with duct sealing compound.

### **3.4 Markers**

- .1 Mark cable every 150 m along cable duct runs and changes in direction.
- .2 Where markers are removed to permit installation of additional cables, reinstall existing markers.
- .3 Lay concrete markers flat and centred over cable with top flush with finish grade.

### **3.5 Field Quality Control**

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Perform tests using qualified personnel.
  - .1 Include necessary instruments and equipment.
- .3 Check phase rotation and identify each phase conductor of each feeder.
- .4 Check each feeder for continuity, short circuits and grounds.
  - .1 Ensure resistance to ground of circuits is not less than 50 megohms.
- .5 Pre-acceptance tests:
  - .1 After installing cable but before splicing and terminating, perform insulation resistance test with 600 V megger on each phase conductor.
  - .2 Check insulation resistance after each splice and/or termination to ensure that cable system is ready for acceptance testing.
- .6 Acceptance Tests:
  - .1 Ensure that terminations and accessory equipment are disconnected.
  - .2 Ground shields, ground wires, metallic armour and conductors not under test.
  - .3 Leakage Current Testing:
    - .1 Raise voltage in steps from zero to maximum values as specified by ICEA manufacturer for type of cable being tested.
    - .2 Hold maximum voltage for specified time period by ICEA manufacturer.
    - .3 Record leakage current at each step.
- .7 Provide Consultant with list of test results showing location at which each test was made, circuit tested and result of each test.
- .8 Remove and replace entire length of cable if cable fails to meet any of test criteria.

### **3.6 Cleaning**

- .1 Progress Cleaning:
  - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment.
- .3 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 19 - Waste Management and Disposal.
  - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

### **3.7 Protection**

- .1 Repair damage to adjacent materials caused by cables installation.

**END OF SECTION**

## **PART 1 - GENERAL**

### **1.1 Scope / Summary**

- 1.1.1 Provide labelling of electrical power outlets and receptacles throughout the entire building to provide identification of electrical circuit.

## **PART 2 - DESIGN REQUIREMENTS / PRODUCTS**

### **1.2 Receptacle Labelling**

- 1.2.1 Provide labelling as per photograph below and as follows:
  - 1.2.1.1 Labels for circuits on normal power shall be in black lettering.
  - 1.2.1.2 Labels for circuits on emergency power shall be red lettering.
  - 1.2.1.3 Each label shall contain the distribution panel identification number and circuit number.
  - 1.2.1.4 As-built drawings shall show the distribution panel identification number and circuit number at each receptacle location.
- 1.2.2 Photograph of typical receptacle labelling:



**END OF SECTION**

## **2.1 GENERAL**

### **3.1. APPLICABLE STANDARDS**

- .1 Applicable Standards are listed below:
  - .1 2015 ASHRAE Handbook – HVAC Applications Chapter 43 HVAC Commissioning
  - .2 ASHRAE Guideline 1.1 – 2007 – The HVAC&R Technical Requirements for the Commissioning Process
  - .3 ASHRAE Guideline 0 – 2013 – The Commissioning Process
  - .4 ASHRAE 202 – 2013 – Commissioning Process for Buildings and Systems
  - .5 ASHRAE Guideline 4-2008 – Preparation of O&M Documentation
  - .6 ATSM E2813 – Standard Practice for Building Enclosure Commissioning
  - .7 ATSM E2947 – Standard Guide for Building Enclosure Commissioning
  - .8 CSA Z320-11 Building Commissioning Standard & Check Sheets
  - .9 CSA C282-15 – Emergency Power Supply for Buildings
  - .10 NIBS Guideline 3-2012 – Building Enclosure Commissioning Process

### **3.2. GENERAL**

- .2 The purpose of this section is to specify Division 26 responsibilities in the commissioning process.
- .3 Commissioning requires the participation of Division 26 to ensure that all systems are operating in a manner consistent with the Contract Documents. The general commissioning requirements and coordination are detailed in Section 01 91 00. Division 26 shall be familiar with all parts of Section 01 91 00 and the commissioning plan issued by the CxA and shall execute all commissioning responsibilities assigned to them in the Contract Documents.

### **3.3. SYSTEMS TO BE COMMISSIONED**

- .4 Systems to be commissioned as part of this contract include, but may not be limited to the following:
  - .1 Electrical, including service, distribution, lighting and controls including daylighting controls

### **3.4. COMMISSIONING TEAM**

- .5 The Commissioning Team shall consist of representatives of the following as appropriate:
  - .1 Owner and the Owner's FM Staff
  - .2 Consultant
  - .3 Commissioning Authority (CxA)
  - .4 General Contractor (GC)
  - .5 Subcontractors (Mechanical, Electrical, Controls, TAB)
  - .6 Specialized third-party for verification

## **2.2 PRODUCTS**

Not Used.



## **2.3 EXECUTION**

### **3.5. COMMISSIONING AUTHORITY RESPONSIBILITIES**

- .6 The Commissioning Authority shall:
  - .1 Plan, organize and implement the commissioning process as specified herein;
  - .2 Prepare the commissioning plan, ensure its distribution for review and comment;
  - .3 Revise the commissioning plan as required during construction;
  - .4 Chair commissioning meetings, and prepare and distribute minutes to all commissioning team members, whether or not they attended the meeting;
  - .5 In conjunction with the GC, coordinate commissioning activities;
  - .6 Monitor system verification checks, and ensure the results are documented as the checks are done;
  - .7 Observe select start-ups and initial system operations tests and checks;
  - .8 Direct the GC to operate equipment and systems as required to ensure that all required functional performance tests are carried out for verification purposes;
  - .9 Witness functional performance tests and document the results;
  - .10 Prepare and submit a commissioning report which documents all checks and tests done throughout the commissioning process, and the results obtained from each;
  - .11 Ensure all required O&M manuals, instructions and demonstrations are provided to the Owner's designated facility operating staff.

### **3.6. CONSULTANT RESPONSIBILITIES**

- .7 The Consultant commissioning responsibilities are outlined below:
  - .1 Review the commissioning plan, proposed test procedures, and participate (as appropriate) in on-site commissioning meetings.
  - .2 At their discretion during the acceptance phase of the commissioning process, be on site to review commissioning documentation, to witness functional performance tests, and to analyze the installation and its performance

### **3.7. OWNER RESPONSIBILITIES**

- .8 The Owner shall have the following commissioning responsibilities
  - .1 Ensure the availability of facility operations staff for all scheduled instructions and demonstration sessions (training).
  - .2 At their discretion, witness commissioning performance tests.

### **3.8. SUBCONTRACTOR RESPONSIBILITIES**

- .9 The commissioning responsibilities applicable to the Electrical Subcontractor are as follows (all references apply to commissioned equipment only):
  - .1 Documentation of all procedures performed shall be provided and forwarded to the engineer. Written documentation must contain recorded test values of all electrical tests performed per the individual product specification.

- .2 The start-up service company shall be present during energization of the electrical equipment. Jobsite and equipment access must be provided by the Electrical Subcontractor.
- .3 The subcontractor shall supply a power source, specified by the start-up service company, for on-site test equipment.
- .4 The subcontractor is to attend all factory witness testing required within the respective specification sections. The subcontractor is responsible to cover all their costs and include them in their bid.
- .5 Perform tests using qualified personnel. Provide necessary instruments and equipment.
- .6 Include the cost of commissioning in the contract price, if not yet let.
- .7 In each purchase order or subcontract written, include requirements for submittal data, O&M data and training.
- .8 Attend a commissioning scoping meeting and other necessary meetings scheduled by the CxA to facilitate the Cx process.
- .9 Contractors shall provide normal cut sheets and shop drawing submittals to the CxA of commissioned equipment. Provide additional requested documentation, prior to normal O&M manual submittals, to the CxA for development of pre-functional and functional testing procedures.
  - .1 Typically, this will include detailed manufacturer installation and start-up, operating, troubleshooting and maintenance procedures, full details of any owner-contracted tests, full factory testing reports (if any), and full warranty information including all responsibilities of the Owner to keep the warranty in force clearly identified. In addition, the installation and checkout materials that are shipped inside the equipment and the actual field checkout sheet forms to be used by the factory or field technicians shall be submitted to the Commissioning Authority.
  - .2 The Commissioning Authority may request further documentation necessary for the commissioning process. This data request may be made prior to normal submittals.
- .10 Provide a copy of the O&M manuals submittals of commissioned equipment, through normal channels, to the CxA for review.
- .11 Contractors shall assist (along with the design engineers) in clarifying the operation and control of commissioned equipment in areas where the specifications, control drawings or equipment documentation is not sufficient for writing detailed testing procedures.
- .12 Provide assistance to the CxA in preparation of the specific functional performance test procedures specified in Section 26. Subs shall review test procedures to ensure feasibility, safety and equipment protection and provide necessary written alarm limits to be used during the tests.
- .13 Develop a full start-up and checkout plan using manufacturer's start-up procedures and the pre-functional test sheets from the CxA. Submit manufacturer's detailed start-up procedures and the full start-up plan and procedures and other requested equipment documentation to CxA for review.
- .14 During the startup and checkout process, execute and document the electrical-related portions of the pre-functional test sheets provided by the CxA for all commissioned equipment.
- .15 Perform and clearly document all completed startup and system operational checkout procedures, providing a copy to the CxA.
- .16 Provide skilled technicians to execute starting of equipment and to execute the functional performance tests. Ensure that they are available and present during the agreed upon

schedules and for sufficient duration to complete the necessary tests, adjustments and problem-solving.

- .17 Perform functional performance testing under the direction of the CxA for specified equipment in Table 1 of this section (Section 26 08 00). Assist the CxA in interpreting the monitoring data, as necessary.
- .18 Correct deficiencies (differences between specified and observed performance) as interpreted by the CxA, GC and Consultant and retest the equipment.
- .19 Prepare O&M manuals according to the Contract Documents, including clarifying and updating the original sequences of operation to as-built conditions.
- .20 During construction, maintain as-built red-line drawings for all drawings. Update after completion of commissioning (excluding deferred testing). Prepare red-line as-built drawings for all drawings.
- .21 Provide training of the Owner's operating personnel as specified.
- .22 Coordinate with equipment manufacturers to determine specific requirements to maintain the validity of the warranty.
- .23 Execute seasonal or deferred functional performance testing, witnessed by the CxA, according to the specifications.
- .24 Correct deficiencies and make necessary adjustments to O&M manuals and as-built drawings for applicable issues identified in any seasonal testing.

### **3.9. SUBMITTALS**

- .10 Section 26 Contractors shall provide submittal documentation relative to commissioning to the CxA as requested by the CxA. Refer to Section 01 91 00 for additional Division 26 requirements.

### **3.10. START-UP OF EQUIPMENT**

- .11 The Electrical Contractors shall follow the start-up and initial checkout procedures listed in the Responsibilities list in this section and in Section 01 91 00, Part 3.10. Section 26 has start-up responsibility and is required to complete systems and sub-systems so they are fully functional, meeting the design objectives of the Contract Documents. The commissioning procedures and functional testing do not relieve or lessen this responsibility or shift that responsibility partially to the CxA or Owner.
- .12 Functional testing is intended to begin upon completion of a system. Functional testing may proceed prior to the completion of systems, or sub-systems at the discretion of the CxA and PM. Beginning system testing before full completion, does not relieve the Subcontractor from fully completing the system, including all Pre Functional test sheets as soon as possible.
- .13 All equipment shall be started by the Manufacturer's representative.

### **3.11. PRE-FUNCTIONAL TEST SHEETS**

- .14 Pre-functional test sheets contain items for Section 26 Contractors to perform. On each checklist, a column is provided that is to be completed by the GC assigning responsibility for that line item to a trade. Those executing the test sheets are only responsible to perform items that apply to the specific application at hand. These test sheets do not take the place of the manufacturer's recommended checkout and start-up procedures or report. Some checklist procedures may be redundant in relation to checkout procedures that will be documented on typical factory field checkout sheets. Double documenting may be required in those cases.

- .15 Refer to Section 01 91 00 for additional requirements regarding pre-functional test sheets, startup and initial checkout. Items that do not apply should be noted along with the reasons on the form. If this form is not used for documenting, one of similar rigor and clarity shall be used pending approval from the CxA.

### **3.12. FUNCTIONAL TESTING, DOCUMENTATION, NON-CONFORMANCE AND ACCEPTANCE**

- .16 Refer to Specification 01 91 00 for more information in addition to this 26 08 00.

### **3.13. OPERATION AND MAINTENANCE MANUALS**

- .17 Section 26 Contractors shall compile and prepare documentation for all equipment and systems covered in Section 26 and deliver to the GC for inclusion in the O&M manuals.
- .18 ASHRAE Guideline 4-2008 is the recommended format.
- .19 The CxA shall receive a copy of the O&M manuals for review.

### **3.14. TRAINING OF OWNER PERSONNEL**

- .20 The GC shall be responsible for training coordination and scheduling and ultimately to ensure that training is completed. Refer to Section 01 91 00 for additional details.
- .21 The CxA shall be responsible for overseeing and approving the content and adequacy of the training of Owner personnel for commissioned equipment. Refer to Section 01 91 00 for additional details.
- .22 The Electrical Subcontractor shall have the following training responsibilities:
  - .1 Provide the CxA with a training plan two weeks before the planned training according to the outline described in Section 01 91 00, Part 3.14.
  - .2 Provide designated Owner personnel with comprehensive training in the understanding of the systems and the operation and maintenance of each major piece of commissioned electrical equipment or system.
  - .3 Training shall start with classroom sessions, if necessary, followed by hands on training on each piece of equipment, which shall illustrate the various modes of operation, including startup, shutdown, fire/smoke alarm, power failure, etc.
  - .4 During any demonstration, should the system fail to perform in accordance with the requirements of the O&M manual or sequence of operations, the system will be repaired or adjusted as necessary and the demonstration repeated.
  - .5 The appropriate trade or manufacturer's representative shall provide the instructions on each major piece of equipment. This person may be the start-up technician for the piece of equipment, the installing subcontractor or manufacturer's representative. Practical building operating expertise as well as in-depth knowledge of all modes of operation of the specific piece of equipment are required. More than one party may be required to execute the training.
  - .6 The training sessions shall follow the outline in the Table of Contents of the O&M manual and illustrate whenever possible the use of the O&M manuals for reference.
  - .7 Training shall include:
    - .1 Use of the printed installation, operation and maintenance instruction material included in the O&M manuals.
    - .2 Include a review of the written O&M instructions emphasizing safe and proper operating requirements, preventative maintenance, special tools needed and spare parts inventory suggestions. The training shall include start-up, operation in all modes possible, shut-down, seasonal changeover and any emergency procedures.

- .3 Discuss relevant health and safety issues and concerns.
- .4 Discuss warranties and guarantees.
- .5 Cover common troubleshooting problems and solutions.
- .6 Explain information included in the O&M manuals and the location of all plans and manuals in the facility.
- .7 Discuss any peculiarities of equipment installation or operation.
- .8 Classroom sessions shall include the use of overhead projections, slides, video and audio taped material as might be appropriate.
- .9 Hands-on training shall include start-up, operation in all modes possible, including manual, shut-down and any emergency procedures and maintenance of all pieces of equipment.
- .10 The Electrical Subcontractor shall fully explain and demonstrate the operation, function and overrides of any local packaged controls, not controlled by the central control system.
- .11 Training shall occur after functional testing is complete, unless accepted otherwise by the Project Manager.

**3.15. DEFERRED TESTING**

- .23 Refer to Section 01 91 00, Part 3.15 for requirements of deferred testing.

**3.16. WRITTEN WORK PRODUCTS**

- .24 Written work products of Section 26 Contractors will consist of the startup and initial checkout plan as described in Section 01 91 00, as well as completed startup, initial checkout and pre-functional test sheets. Refer to Section 01 91 00 Part 3.16.

**END OF SECTION**

## **PART 1 – GENERAL**

### **1.1 Reference Standards**

- .1 American National Standards Institute (ANSI)
  - .1 ANSI C39.1-1981, Requirements, Electrical Analog Indicating Instruments.
- .2 CSA International
  - .1 CAN3-C17-M84(R2008), Alternating - Current Electricity Metering.

### **1.2 Action And Informational Submittals**

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for metering and switchboard instruments and include product characteristics, performance criteria, physical size, finish and limitations.
  - .2 Include meter, instrument, outline dimensions, panel drilling dimensions and installation cutout template.
- .3 Sustainable Design Submittals:
  - .1 Construction Waste Management:
    - .1 Submit project Waste Management Plan highlighting recycling and salvage requirements.

### **1.3 Delivery, Storage And Handling**

- .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
  - .1 Store materials off ground indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Store and protect metering and switchboard instruments from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan related to Work of this Section.
- .5 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding, and packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 19 - Waste Management and Disposal.

## **PART 2 - PRODUCTS**

### **2.1 Metering Equipment**

- .1 Electricity Meters
  - .1 Internet Protocol (IP) based meter complete with:
    - .1 Built-in web server.
    - .2 Capable of operating with a dedicated IP address (to be provided by the Region).
    - .3 Communications Protocols:
      - .1 HTTP/Post capable of pushing data to 3<sup>rd</sup> party applications/databases.
      - .2 Modbus TCP
    - .4 Built-in real-time and historic graphics accessible with any HTML 5 internet browser (computer, tablet, phone) on the Region's network. Data to be displayed in local time, adjusted for daylight savings time.
    - .5 Real-time clock with battery backup and email alert for battery end of life.
    - .6 Time stamp:
      - .1 Represent date and time
      - .2 In UTC time or offset from a specified UTC time
      - .3 Resolution: Minimum 1 second
    - .7 Ability to export all stored trend data to comma separated value (.csv) or Microsoft Excel format for importing into spreadsheets. Time-stamps to be exported as a single field with a numeric (non-text) value in local time.
    - .8 Published application programming interface (API) allowing data to be retrieved from the meter via non-proprietary means, such as JavaScript Object Notation (JSON).
    - .9 Built-in trending and data storage:
      - .1 2 years of consumption data (kWh) at 1 minute intervals with time-stamp; and
      - .2 10 years of consumption data (kWh) at 1 hour intervals with time-stamp.
      - .3 Stored in non-volatile memory.
    - .10 No special software required to set up meter or access data.
    - .11 Security:
      - .1 Unrestricted access to data and graphics over the Region's network.
      - .2 Password protection for access to setup, changing settings/parameters and deleting data.
    - .12 Ability to measure, store and trend the following data complete with time-stamp:
      - .1 Accumulated energy per phase (kWh)
      - .2 Accumulated total energy (kWh)
      - .3 Active power per phase (kW)
      - .4 Active total power (kW)
      - .5 RMS voltage per phase
      - .6 RMS current per phase
      - .7 Power factor per phase
      - .8 Total power factor.
      - .9 Line frequency
  - .2 Acceptable product: z3 Controls Inc. NetMeter
- .2 Current Transformers
  - .1 Compatible with electricity meter input without the use of transformers or other devices.
  - .2 Linear accuracy +/-1% of reading
  - .3 Accuracy at 10% to 130% of rated current.
  - .4 Unburdened current transformers shall not be permitted.

- .5 Acceptable product: Magnelab, Inc. SCT series.
- .3 Data Cabling
  - .1 Cat 5e or Cat 6 unshielded twisted pair (UTP)
  - .2 Colour: Green

## 2.2 SHOP INSTALLATION

- .1 Install meters and instrument transformers in separate compartment of switchboard.
- .2 Install instruments on panel switchboard.
- .3 Ensure adequate spacing between current transformers installed on each phase.
- .4 Verify correctness of connections, polarities of meters, instruments, potential and current transformers, transducers, signal sources, electrical supplies.

## 3 EXECUTION

### 3.1 Installation Requirements

- .1 Optimize electrical distribution to allow reduction in number of meters by grouping similar/like end use loads.
- .2 Install meter in a painted, hinged NEMA 1 (or better) enclosure complete with modular terminal blocks, finger safe fuse holders, fuses and power supply. Label front of enclosure with meter name, IP address and load(s) measured.
- .3 Provide disconnect at panel board for voltage reference.
- .4 All communication cables to continuous. No splicing is allowed.
- .5 Affix York Region Property Services Branch Asset ID tag (to be provided by the Region) to meter prior to installation.
- .6 Sensor and network configuration to be done in consultation with the Region's Property Services Branch.
- .7 Connect meter to the Region's IT network.
- .8 Commission meter:
  - .1 Ensure latest available firmware version is installed in meter.
  - .2 Obtain Network information from York Region project manager and program into meter, including IP address, subnet mask, default gateway, primary and secondary DNS addresses.
  - .3 Set meter clock to current local time.
  - .4 Set up email alerts as specified and/or requested by the Region's project manager.
  - .5 Set up trend logging as specified and/or requested by the Region's project manager. At minimum, set up trend logging per 2.2.1.1.8 and 2.2.1.1.11 above.
  - .6 Set default homepage to display real-time demand graphs and consumption statistics.
  - .7 Verify CT rating is correctly entered in meter setup.



- .8 Confirm each voltage and current reading displayed on meter software using voltmeter and clamp-on ammeter.
- .9 Verify CT's are wired to corresponding voltage reference and that CT's are installed in correct orientation.
- .10 Verify meter information is viewable through a web browser on a device on the Region's network.
- .11 Complete and submit Energy Meter Installation/Startup Verification Form (26 09 13.01)
- .12 Provide training on meter software use to Region staff including Facilities Operations and Maintenance and Corporate Energy Services.
- .13 Provide meter manufacturer's calibration certificate(s), installation, operations and maintenance manuals and recommended meter recalibration interval(s).

### **3.2 Examination**

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for metering and switchboard instruments installation in accordance with manufacturer's written instructions.
  - .1 Visually inspect substrate in presence of York Region Representative.
  - .2 Inform York Region Representative of unacceptable conditions immediately upon discovery.
  - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from York Region Representative

### **3.3 Field Quality Control**

- .1 Conduct tests in accordance with Section 26 05 00 - Common Work Results for Electrical and in accordance with manufacturer's recommendations.
- .2 Perform simulated operation tests with metering, instruments disconnected from permanent signal and other electrical sources.
- .3 Verify correctness of connections, polarities of meters, instruments, potential and current transformers, transducers, signal sources and electrical supplies.
- .4 Perform tests to obtain correct calibration.
- .5 Do not dismantle meters and instruments.

### **3.4 Cleaning**

- .1 Progress Cleaning:
  - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment.
- .3 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 19 - Waste Management and Disposal.
  - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

### **3.5 Protection**

- .1 Protect installed products and components from damage during construction.

- .2 Repair damage to adjacent materials caused by metering and switchboard instrument installation.

**END OF SECTION**

## **PART 1 - GENERAL**

### **1.1 Summary**

- .1 Section Includes:
  - .1 Materials and installation for low voltage control system designed to provide remote switching of lighting loads by use of:
    - .1 Low voltage momentary contact switches.

### **1.2 Reference Standards**

- .1 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
  - .1 Material Safety Data Sheets (MSDS).

### **1.3 Action And Informational Submittals**

- .1 Product Data:
  - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.
    - .1 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 33 00 - Submittal Procedures. Indicate VOC content.
- .2 Shop Drawings:
  - .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
  - .2 Shop drawings: Submit drawings.
- .3 Closeout Submittals:
  - .1 Submit maintenance data in accordance with Section 01 77 00 – Project Closeout.
- .4 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.
  - .1 Test reports:
    - .1 Submit certified test reports indicating compliance with specifications for specified performance characteristics and physical properties.
  - .2 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
  - .3 Manufacturer's Instructions: submit manufacturer's installation instructions.
  - .4 Manufacturer's Field Reports: manufacturer's field reports specified.

### **1.4 Quality Assurance**

- .1 Health and Safety:
  - .1 Do construction occupational health and safety in accordance Health and Safety Requirements.

### **1.5 Delivery, Storage, And Handling**

- .1 Packing, shipping, handling and unloading:
  - .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.

- .2 Waste Management and Disposal:
  - .1 Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 74 19 - Waste Management and Disposal.

## **PART 2 - PRODUCTS**

### **2.1 Materials**

- .1 Control system: by one manufacturer and assembled from compatible components.

### **2.2 Remote Control Switches**

- .1 Single pole, double throw, momentary contact, standard heavy duty, rated A, 25 V, double push-button centre pivot rocker action with pilot lights.

### **2.3 Low Voltage Relays**

- .1 Electrically operated by momentary impulse, mechanically latched until activated.
- .2 Two coil solenoid type with one coil to close relay contacts and one coil to open relay contacts.
- .3 Operating voltage: 24 V, AC rectified AC.
- .4 Load contacts: 20 A, 120 V, AC.
- .5 Auxiliary contacts for pilot light.
- .6 Coloured pre-stripped leads.

### **2.4 Control Transformer**

- .1 Low voltage power Class 2, input 120 347 V, AC, 60 Hz, output 20 35 VA at 24 V.

### **2.5 Single/Dual Relay Wall Switch Occupancy Sensors**

- .1 Manual-on, Automatic-off, dual technology (passive infrared and ultrasonic) wall switch occupancy sensor. Provide model suitable for the room size, the wattage requirement and for LED lighting. Watt Stopper model DW-100, DW-200, DW-103, DW-203

### **2.6 Dual Technology Ceiling Mounted Occupancy Sensor**

- .1 Digital Occupancy Sensor shall provide graphic LCD display for digital calibration and electronic documentation. Features include the following:
- .2 Digital calibration and pushbutton configuration for the following variables:
  - .1 Sensitivity, 0-100 percent in 1 minute increments.
  - .2 Increments. Time delay, 0-30 minutes in 1 minute.
  - .3 Test Mode, five second time delay.

- .4 Detection technology, PIR, Ultrasonic or Dual Technology activation and/or re-activation
- .5 Walk-through mode.
- .3 Load parameters including Auto/Manual-On, blink warning, and daylight enable/disable when photosensors are included in the DLM local network.
- .4 Programmable control functionality including:
  - .1 Each sensor may be programmed to control specific loads within a local network.
  - .2 Sensor shall be capable of activating one of 16 user-definable lighting scenes.
  - .3 Adjustable retrigger time period for (turn on) manual-on loads. Load will retrigger automatically within a configurable period of time (default 10 seconds) after turning off.
  - .4 On dual technology sensors, independently configurable trigger modes are available for both Normal Hours (NH) and After Hours (AH) time periods. The retrigger mode can be programmed to use the following technologies:
    - .1 Ultrasonic and Passive Infrared
    - .2 Ultrasonic and Passive Infrared
    - .3 Ultrasonic only
    - .4 Passive Infrared only
- .5 One or two RJ-45 port(s) for connection to DLM local network.
- .6 Two-way infrared (IR) transceiver to allow remote programming through handheld commissioning tool and control by remote personal controls.
- .7 Device Status LEDs, which may be disabled for selected applications, including
  - .1 PIR detection
  - .2 Ultrasonic detection
  - .3 Configuration mode
  - .4 Load binding
- .8 Assignment of occupancy sensor to a specific load within the room without wiring or special tools.
- .9 Manual override of controlled loads.
- .10 All digital parameter data programmed into an individual occupancy sensor shall be retained in non-volatile FLASH memory within the sensor itself. Memory shall have an expected life of no less than 10 years.
- .11 BACnet object information shall be available for the following objects:
  - .1 Detection state
  - .2 Occupancy sensor time display
  - .3 Occupancy sensor sensitivity, PIR and ultrasonic
- .12 Units shall not have any dip switches or potentiometers for field settings.
- .13 Multiple occupancy sensors may be installed in a room by simply connecting them to the free topology DLM local network. No additional configuration will be required.

## 2.7 Digital Wall Switches

- .1 Low voltage momentary pushbutton switches in 1, 2, 3, 4, 5 and 8 button configurations.

Wall switches shall include the following features:

- .1 Two-way infrared (IR) transceiver for use with personal and configuration remote controls
  - .2 Removable buttons for field replacement with engraved buttons and/or alternate colour buttons. Button replacement may be completed without removing the switch from the wall.
  - .3 Configuration LED on each switch that blinks to indicate data transmission.
- .2 Load/Scene Status LED on each switch button with the following characteristics:
- .1 Bi-level LED
  - .2 Dim locator level indicates power to switch
  - .3 Bright status level indicates that load or scene is active
  - .4 Dimming switches shall include seven bi-level LEDs to indicate load levels using 14 steps.
- .3 Programmable control functionality including:
- .1 Button priority may be configured to any BACnet priority level, from 1-16 corresponding to networked operation allowing local actions to utilize life safety priority.
  - .2 Scene patterns may be saved to any button other than dimming rockers. Once set, buttons may be digitally locked to prevent overwriting of the preset levels.
- .4 All digital parameter data programmed into an individual wall switch shall be retained in non-volatile FLASH memory within the wall switch itself. Memory shall have an expected life of no less than 10 years.
- .5 BACnet object information shall be available for the following objects:
- .1 Button state
  - .2 Switch lock control
  - .3 Switch lock status
- .6 Two RJ-45 ports for connection to DLM local network.
- .7 Multiple digital wall switches may be installed in a room by simply connecting them to the free topology DLM local network. No additional configuration shall be required to achieve multi-way switching.
- .8 Load and Scene button function may be reconfigured for individual buttons from Load to Scene and vice versa.
- .1 Individual button function may be configured to Toggle, On only or Off only
  - .2 Individual scenes may be locked to prevent unauthorized change.
  - .3 Fade Up and Fade Down times for individual scenes may be adjusted from 0 seconds to 18 hours
  - .4 Ramp rate may be adjusted for each dimmer switch
  - .5 Switch buttons may be bound to any load on any load controller or relay panel and are not load type dependent; each button may be bound to multiple loads.

## **2.8 Hand Held Remote Controls**

- .1 Watt stopper part number LMRH-101, LMRH-102, LMRH-105.

## **2.9 Room Controllers**

- .1 Dual voltage (120/277 VAC, 60 Hz) capable or 347 VAC, 60 Hz. 120/277 volt models

- rated for 20A total load.
- .2 Built in real time current monitoring.
- .3 One, two or three relays configurations.
- .4 Smart 250 mA switching power supply.
- .5 Four RJ-45 DLM local network ports. Provide integral strain relief.
- .6 One dimming output per relay.
  - .1 0-10V dimming – where indicated, one 0-10 volt analog output per relay for control of compatible ballasts and LED drivers. The 0-10 volt output shall automatically open upon loss of power to the Room Controller to assure full light output from the controlled lighting.
- .7 Plug load controller where required.
- .8 Watt Stopper product numbers: LMRC-211, LMRC-212, LMRC-213, LMRC-201, LMRC-311, LMRC-312, LMRC-313.
- .9 Room Controllers shall be provided to match the room lighting load and control requirements.
- .10 Room controllers shall be plenum rated.
- .11 Optional Network Bridge for BACnet MS/TP communications (LMRC-3xx).

## **2.10 Digital Sensors**

- .1 Digital daylighting sensors shall work with load controllers and relay panels to provide automatic switching, bi-level, or tri-level or dimming daylight harvesting capabilities for any load type connected to the controller or panel. Daylighting sensors shall be interchangeable without the need for re-wiring.
  - .1 Closed loop sensors measure incoming daylight in the space, and are capable of controlling up to three lighting zones.
  - .2 Open loop sensors measure incoming daylight in the space, and are capable of controlling up to three lighting zones.
  - .3 Dual loop sensors measure both ambient and incoming daylight in the space to ensure that proper light levels are maintained as changes to reflective materials are made in a single zone.
- .2 Digital daylighting sensors shall include the following features:
  - .1 Sensor's internal photodiode shall only measure light waves within the visible spectrum. The photodiode's spectral response curve shall closely match the entire photopic curve. Photodiode shall not measure energy in either the ultraviolet or infrared spectrums. Photocell shall have a sensitivity of less than 5 percent for any wavelengths less than 400 nanometers or greater than 700 nanometers.
  - .2 Sensor light level range shall be from 1-6,553 foot candles (fc)
  - .3 Capability of on/off, bi-level or tri-level switching, or dimming, for each controlled zone, depending on the selection of load controller(s) and load binding to controller(s)

- .3 For switching daylight harvesting, the photosensor shall provide a field-selectable dead band, or a separation, between the 'On setpoint' and the 'Off setpoint' that will prevent the lights from cycling excessively after they turn off.
- .4 For dimming daylight harvesting, the photosensor shall provide the option, when the daylight contribution is sufficient, of turning lights off or dimming lights to a field-selectable minimum level.
- .5 Photosensors shall have a digital, independently configurable fade rate for both increasing and decreasing light level in units of percent per second.
- .6 Photosensors shall provide adjustable cut-off time. Cut-off time is defined by the number of selected minutes the load is at the minimum output before the load turns off. Selectable range between 0-240 minutes including option to never cut off.
- .7 Integral infrared (IR) transceiver for configuration and/or commissioning with a handheld configuration tool, to transmit detected light level to wireless configuration tool, and for communication with personal remote controls.
- .8 Configuration LED status light on device that blinks to indicate data transmission.
- .9 Status LED indicates test mode, override mode and load binding.
- .10 Recessed switch on device to turn controlled load(s) ON and OFF.
- .11 BACnet object information shall be available for the following daylighting sensor objects, based on the specific photocell's settings:
  - .1 Light level
  - .2 Day and night setpoints
  - .3 Off time delay
  - .4 On and Off setpoints
  - .5 Up to three zone setpoints
  - .6 Operating mode – on/off, bi-level, tri-level or dimming
- .12 One RJ-45 port for connection to DLM local network.
- .13 A choice of accessories to accommodate multiple mounting methods and building materials. Photosensors may be mounted on a ceiling tile, skylight light well, suspended lighting fixture or backbox. Standard tube photosensors accommodate mounting materials from 0-0.62 inches thick (LMLS-400, LMLS-500). Extended tube photosensors accommodate mounting materials from 0.62 to 1.25 inches thick. Mounting brackets are compatible with J boxes and wall mounting. Photosensor to be mounted on included bracket below skylight well.
- .14 Any load or group of loads in the room can be assigned to a daylighting zone.
- .15 Each load within a daylighting zone can be individually enabled or disabled for discrete control (load independence).
- .16 All digital parameter data programmed into a photosensor shall be retained in non-volatile FLASH memory withing the photosensor itself. Memory shall have an expected life of no less than 10 years.
- .17 Open loop digital photosensors shall include the following additional features:



- .1 An internal photodiode that measures light in a 60-degree angle (cutting off the unwanted light from the interior of the room).
- .2 Automatically establishes application-specific setpoints following manual calibration using a wireless configuration tool or a PC with appropriate software. For switching operation, an adequate dead band between the ON and OFF setpoints for each zone shall prevent the lights from cycling; for dimming operation, a proportional control algorithm shall maintain the design lighting level in each zone.
- .3 Each of the three discrete daylight zones can include any non-overlapping group of loads in the room.

## **2.12 Configuration Tools**

- .1 Each lighting control panel system shall be supplied with at least (1) handheld IR remote programming interface consisting of a keypad and associated OLED display screen. The user interface shall allow setup, configuration, and diagnostics of the panel without the need for software or connection of a computer. The user interface shall have the following functions as a minimum:
  - .1 Set network parameters including panel device ID, MS/TP MAC address, baud rate and max master range.
  - .2 Relay Group creation of up to 99 groups. Group creation shall result in programming of all seven key relay parameters for member relays. The seven parameters are as follows: After-hours Override Time Delay, Normal Hours Override Time Delay, Action on Transition to Normal Hours, Action on Transition to After Hours, Sensor Action During Normal Hours, Sensor Action During After Hours, Blink-Warn Time for After Hours.
  - .3 Program up to 254 separate scheduled events. Events shall occur on seven day intervals with each day selectable as active or inactive, and shall be configurable as to whether the event is active on holidays. Holidays are also defined through the User Interface.
  - .4 Program up to 32 separate Dark/Light events. Events shall have a selectable source as either calculated Astro with delay, or a digital IO module with an integral 0-5V or 0-10V analog photocell. Dark/Light events shall occur on seven day intervals with each day selectable as active or inactive, and shall be configurable as to whether the event is active on holidays.
  - .5 Button binding of digital switches to groups shall be accessible via the handheld IR remote and accomplished from the digital switch station.
  - .6 Programming of panel location information shall be accomplished by the handheld IR remote and include at a minimum LAT, LON, DST zone, and an approximate city/state location.
  - .7 An additional handheld IR remote may optionally be specified to be permanently mounted to the panel interior via a retractable anti-theft lanyard to allow for convenient programming of the panel while assuring that the handheld programmer is always present at that panel. An unlimited number of handheld IR remotes may also be purchased for facilities staff as seen fit by the end user's representative.

## **2.13 Lighting Control Panels**

- .1 Provide lighting control panels in the locations and capacities as indicated on the plans and schedules. Each panel shall be of modular construction and consist of the following components:

- .1 Enclosure/Tub shall be NEMA 1, sized to accept an interior with 1 – 8 relays, 1 – 24 relays and 6 four-pole contactors, or 1 – 48 relays and 6 four-pole contactors.
- .2 Cover shall be configured for surface or flush wall mounting of the panel as indicated on the plans. The panel cover shall have a hinged and lockable door with restricted access to line voltage section of the panel.
- .3 Interior assembly shall be supplied as a factory assembled component specifically designed and listed for field installation. The interior construction shall provide total isolation of high voltage (Class 1) wiring from low voltage (Class 2) wiring within the assembled panel. The interior assembly shall include intelligence boards, power supply, DIN rails for mounting optional Class 2 control devices, and individually replaceable latching type relays. The panel interiors shall include the following features:
  - .1 Removable, plug-in terminal blocks with screwless connections for all low voltage terminations.
  - .2 Individual terminal block, override pushbutton, and LED status light for each relay.
  - .3 Direct wired switch inputs associated with each relay and group channel shall support two-wire, momentary or maintained contact switches.
  - .4 Digital inputs (four RJ-45 jacks) shall support 1-, 2-, 3-, 4-, and 8-button digital switches, digital IO modules capable of receiving 0-5V or 0-10V analog photocell inputs, digital IO modules capable of receiving momentary or maintained contact closure inputs, digital photocell modules, and digital occupancy sensors.
  - .5 True relay state shall be indicated by the on-board LED and shall be available to external control devices and systems via BACnet.
  - .6 Automatically sequenced operation of relays to reduce impact on the electrical distribution system when large loads are controlled simultaneously.
  - .7 Group, channel, and pattern control of relays shall be provided through a simple keypad interface from a handheld IR programmer. Any group of relays can be associated with a channel for direct on/off control or pattern (scene) control via a simple programming sequence using the relay and channel override pushbuttons and LED displays for channels 1-9 or a handheld IR programmer for channels 1-99.
  - .8 Relay group status for each channel shall be provided through red LED indicators for groups 1-9 and via BACnet for groups 1-99. Solid red indicates that the last group action called for an ON state and relays in the group are on or in a mixed state.
  - .9 Single-pole latching relays with modular plug-in design. Relays shall provide the following ratings and features:
    - (1) Electrical:
      - (a) 30 amp ballast at 277V
      - (b) 20 amp ballast at 347V
      - (c) 20 amp tungsten at 120V
      - (d) 30 amp resistive at 347V
      - (e) 1.5 HP motor at 120V
      - (f) 14,000 amp short circuit current rating (SCCR) at 347V
      - (g) Relays shall be specifically UL listed for control of plug loads
    - (2) Mechanical:

- (a) Individually replaceable, ½" KO mounting with removable Class 2 wire harness.
    - (b) Actuator on relay housing provides manual override and visual status indication, accessible from Class 2 section of panel.
    - (c) Dual line and load terminals each support two #14 – #12 solid or stranded conductors.
    - (d) Tested to 300,000 mechanical on/off cycles.
  - (3) Isolated low voltage contacts provide for true relay status feedback and pilot light indication.
- .4 Power supply shall be a multi-voltage transformer assembly with rated power to supply all electronics, occupancy sensors, switches, pilot lights, and photocells as necessary to meet the project requirements. Power supply to have internal over-current protection with automatic reset and metal oxide varistor protection.
- .5 Lighting control panels shall be WattStopper model LMCP8, LMCP24 or LMCP48 as shown on the plans.
- .2 The lighting control panel shall support digital communications to facilitate the extension of control to include interoperation with building automation systems and other intelligent field devices. Digital communications shall be RS485 master/slave token passing-based using the BACnet® protocol.
  - .1 The panel shall have provision for an individual BACnet device ID. The device ID description property shall be writable via the network to allow unique identification of the lighting control panel on the network.
  - .2 The panel shall support MS/TP MAC addresses in the range of 0 – 127 and baud rates of 9600k, 38400k, 76800k, and 115.2k bits per second.
  - .3 Lighting control relays shall be controllable as binary output objects in the instance range of 1 – 64. The state of each relay shall be readable and writable by the BAS via the object present value property.
  - .4 Lighting control relays shall report their true on/off state as binary input objects in the instance range of 1 – 64.
  - .5 The 99 channel groups associated with the panel shall be represented by binary value objects in the instance range of 201 – 299. The occupancy state of each channel group shall be readable and writable by the BAS via the object present value property. Commanding 1 to a channel group will put all relays associated with the channel into the normal hours mode. Commanding 0 or NULL shall put the relays into the after hours mode.
  - .6 Setup and commissioning of the panel shall not require manufacturer-specific software or a computer. All configuration of the lighting control panel shall be performed using standard BACnet objects or via the handheld IR programming remote. Provide BACnet objects for panel setup and control as follows:
    - .1 Binary output objects in the instance range of 1 – 64 (one per relay) for on/off control of relays.
    - .2 Binary value objects in the instance range of 1 – 99 (one per channel) for normal hours/after hours schedule control.
    - .3 Binary input objects in the instance range of 1 – 64 (one per relay) for reading true on/off state of the relays.
    - .4 Analog value objects in the instance range of 1 – 64 (one per relay) shall assign relays to channel groups in the range of 1 – 99.

- .5 Analog value objects in the instance range of 101 – 199 (one per channel group) shall assign a blink warn time value to each channel. A value of 5 shall activate the blink warn feature for the channel and set a 5-minute grace time period. A value of 250 shall activate the sweep feature for the channel and enable the use of sweep type automatic wall switches.
- .6 Analog value objects in the instance range of 201 – 299 (one per channel) shall assign an after hours time delay value to the channel in the range of 1 – 240 minutes.
- .7 Multi-state value objects in the instance range of 1 – 99 (one per channel) shall provide the state of the relays assigned to the channel. Valid states shall be ALL ON, MIXED, BLINK, and ALL OFF.
- .7 The description property for all objects shall be writable via the network and shall be saved in non-volatile memory within the panel.
- .8 The BO and BV 1 – 99 objects shall support BACnet priority array with a relinquish default of off and after hours respectively. Prioritized writes to the channel BV objects shall propagate prioritized control to each member relay in a way analogous to the BACnet Channel object.
- .9 Panel-aggregate control of relay Force Off at priority 2 shall be available via a single BV5 object. Force On at priority 1 shall be available via a single BV4 object.
- .10 Lockout of all digital switch buttons connected to a given panel shall be command-able via a single BV2 object. The lock status of any connected switch station shall be represented as BV101-196.
- .11 Lighting control accessory devices connected to the panel shall be represented via BACnet objects including but not limited to the following:
  - .1 Digital occupancy sensor detection states shall be readable as BI objects ranging from BI1-96.
  - .2 Digital occupancy sensor configuration parameters shall each be accessible as BACnet objects when applicable to a given product.
    - .1 Occupancy sensor time delay in minutes shall be writeable via AV101-196.
    - .2 Occupancy sensor passive infrared (PIR) sensitivity percentage shall be writeable via AV201-296.
    - .3 Occupancy sensor ultrasonic (US) sensitivity percentage shall be writeable via AV301-396.
  - .3 Digital switch buttons shall be readable and writeable as BI objects ranging from BI101 – 9608.
  - .4 Digital daylight sensors foot-candle readings shall be readable as follows:
    - .1 Analog 0-5V/0-10V sensors connected to a digital input module shall be represented as AI1-96.
    - .2 Digital closed loop sensors shall be represented as AI4001-4096.
    - .3 Digital open loop sensors shall be represented as AI5001-5096.
  - .5 Digital dual loop sensors shall be represented as follows:
    - .1 The upward facing open loop sensor shall be represented as AI6001-6096.

- .2 The downward facing closed loop sensor shall be represented as AI6101-6196.
- 12 Digital daylight sensor configuration shall be exposed as BACnet objects as follows:
  - .1 Digital closed loop sensors shall be represented as follows:
    - .1 Daylight Sensor Day Setpoint (ftcd) AV4201-4296.
    - .2 Daylight Sensor Night Setpoint (ftcd) AV4301-4396.
    - .3 Daylight Sensor Off Setpoint Delay (minutes) AV4401-4496.
    - .4 Daylight Sensor On Setpoint (ftcd) AV4501-4596.
    - .5 Daylight Sensor Off Setpoint (ftcd) AV4601-4696.
- .3 Each panel shall include a digital clock capability able to issue system wide automation commands to up to (11) eleven other panels for a total of (12) twelve networked lighting control panels. The clock shall provide capability for up to 254 independent schedule events per panel for each of the ninety-nine system wide channel groups.
  - .1 The clock capability of each panel shall support all of the energy saving features required of ASHRAE 90.1 - 2001, IECC 2003, as well as all state and local energy codes.
  - .2 The clock module shall provide astronomic capabilities, time delays, blink warning, daylight savings, and holiday functions and will include a battery back-up for the clock function and EEPROM for program retention. Clocks that require multiple events to meet local code lighting shut off requirements shall not be allowed.
  - .3 The clock capability of each panel shall operate on a basis of ON/OFF or Normal Hours/After Hours messages to automation groups that implement pre-configured control scenarios. Scenarios shall include:
    - .1 Scheduled ON / OFF
    - .2 Manual ON / Scheduled OFF
    - .3 Astro ON / OFF (or Photo ON / OFF)
    - .4 Astro and Schedule ON / OFF (or Photo and Schedule ON / OFF)
  - .4 The user interface shall be a portable IR handheld remote control capable of programming any panel in the system.
  - .5 The clock capability of each panel shall employ non-volatile memory and shall retains user programming and time for a minimum of 10 years.
  - .6 Schedules programmed into the clock of any one panel shall be capable of executing panel local schedule or Dark/Light (photocell or Astro) events for that panel in the event that global network communication is lost. Lighting control panels that are not capable of executing events independently of the global network shall not be acceptable.
  - .7 The lighting control panel shall be WattStopper model LMCP8-115/347-8HD or approved equivalent.

## **PART 3 – EXECUTION**

### **3.1 Manufacturer's Instructions**

- .1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

### **3.2 Installation**

- .1 Locate and install equipment in accordance with manufacturer's recommendations and as indicated.

### **3.3 Field Quality Control**

- .1 Site Tests:
  - .1 Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Actuate control units in presence of York Region Representative to demonstrate lighting circuits are controlled as designated.
- .3 Manufacturer's Field Services:
  - .1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports as described in PART 1 - SUBMITTALS.
  - .2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.
  - .3 Schedule site visits, to review Work, as directed in PART 1 - QUALITY ASSURANCE
- .4 Third Party Testing:
  - .1 The contractor is responsible to provide third party testing of the lighting system in accordance with ASHRAE Standard 90.1-2010, Section 9.4.4 Functional Testing. The party responsible for the functional testing shall not be directly involved in either the design or construction of the project and shall provide documentation certifying that the installed lighting controls meet or exceed all documented performance criteria.
  - .2 Lighting control devices and control systems shall be tested to ensure that control hardware and software are calibrated, adjusted, programmed and in proper working condition in accordance with the construction documents and manufacturer's installation instructions.
  - .3 When sensors, time switches, programmable schedule controls or photosensors are installed, the following procedures shall be performed:
    - .1 Confirm that the placement, sensitivity and time-out adjustments for occupant sensors yield acceptable performance, lights turn off only after space is vacated. Where an auto-on mode has been selected, lights do not turn on unless the space is occupied.
    - .2 Confirm that the time switches and programmable schedule controls are programmed correctly to turn the lights off.
    - .3 Where daylight harvesting capability has been installed, confirm that photosensor controls reduce electric light levels based on the amount of usable daylight in the space as specified.

### **3.4 Cleaning**

- .1 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

**END OF SECTION**

## **PART 1 - GENERAL**

### **1.1 Reference Standards**

- .1 CSA International
  - .1 CSA C22.2 No.29-11, Panelboards and Enclosed Panelboards.

### **1.2 Action And Informational Submittals**

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for panelboards and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
  - .1 Submit drawings.
  - .2 Include on drawings:
    - .1 Electrical detail of panel, branch breaker type, quantity, ampacity and enclosure dimension.
- .4 Sustainable Design Submittals:
  - .1 Construction Waste Management:
    - .1 Submit project Waste Management Plan highlighting recycling and salvage requirements.

### **1.3 Closeout Submittals**

- .1 Submit in accordance with Section 01 77 00 – Project Closeout.
- .2 Operation and Maintenance Data: submit operation and maintenance data for panelboards for incorporation into manual.

### **1.4 Delivery, Storage And Handling**

- .1 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .2 Storage and Handling Requirements:
  - .1 Store materials off ground indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Store and protect panelboards from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.
- .3 Develop Construction Waste Management Plan related to Work of this Section.
- .4 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding, and packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 19 - Waste Management and Disposal.

## **PART 2 - PRODUCTS**

### **2.1 Panelboards**

- .1 Panelboards: to CSA C22.2 No.29 and product of one manufacturer.
  - .1 Install circuit breakers in panelboards before shipment.
  - .2 In addition to CSA requirements manufacturer's nameplate must show fault current that panel including breakers has been built to withstand.
- .2 250V panelboards: bus and breakers rated for 22,000 A (symmetrical) interrupting capacity or as indicated.
- .3 Sequence phase bussing with odd numbered breakers on left and even on right, with each breaker identified by permanent number identification as to circuit number and phase.
- .4 Panelboards: mains, number of circuits, and number and size of branch circuit breakers as indicated.
- .5 Minimum of 2 flush locks for each panel board.
- .6 Two keys for each panelboard and key panelboards alike.
- .7 Copper bus with neutral of same ampere rating of mains.
- .8 Mains: suitable for bolt-on breakers.
- .9 Trim with concealed front bolts and hinges.
- .10 Trim and door finish: baked enamel air dried enamel as per colour schedule.
- .11 Isolated ground bus.
- .12 Include grounding busbar with 3 of terminals for bonding conductor equal to breaker capacity of the panel board.
- .13 Surge Protective Devices as noted.

### **2.2 Breakers**

- .1 Breakers: to Section 26 28 16.02 - Moulded Case Circuit Breakers.
- .2 Breakers with thermal and magnetic tripping in panelboards except as indicated otherwise.
- .3 Lock-on devices for 10% of 15 to 30 A breakers installed as indicated. Turn over unused lock-on devices to York Region Representative.
- .4 Lock-on devices for receptacles, fire alarm clock outlet, emergency, door supervisory, intercom, exit and night light circuits.

### **2.3 Equipment Identification**



- .1 Provide equipment identification in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Nameplate for each panelboard size 4 engraved as indicated.
- .3 Nameplate for each circuit in distribution panelboards size 2 engraved as indicated.
- .4 Complete circuit directory with typewritten legend showing location and load of each circuit, mounted in plastic envelope at inside of panel door.

### **3 EXECUTION**

#### **3.1 Examination**

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for panelboards installation in accordance with manufacturer's written instructions.
  - .1 Visually inspect substrate in presence of York Region Representative.
  - .2 Inform York Region Representative of unacceptable conditions immediately upon discovery.
  - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from York Region Representative.

#### **3.2 Installation**

- .1 Locate panelboards as indicated and mount securely, plumb, true and square, to adjoining surfaces.
- .2 Install surface mounted panelboards on plywood backboards in accordance with Section 06 10 53 - Rough Carpentry. Where practical, group panelboards on common backboard.
- .3 Mount panelboards to height specified in Section 26 05 00 - Common Work Results for Electrical or as indicated.
- .4 Connect loads to circuits.
- .5 Connect neutral conductors to common neutral bus with respective neutral identified.

#### **3.3 Cleaning**

- .1 Progress Cleaning:
  - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment.
- .3 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 19 - Waste Management and Disposal.
  - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

#### **3.4 Protection**

- .1 Protect installed products and components from damage during construction.
- .2 Repair damage to adjacent materials caused by panelboards installation.

**END OF SECTION**

## **PART 1 - GENERAL**

### **1.1 Reference Standards**

- .1 CSA International
  - .1 CSA C22.2 No.42-10, General Use Receptacles, Attachment Plugs and Similar Devices.
  - .2 CAN/CSA C22.2 No.42.1-00(R2009), Cover Plates for Flush-Mounted Wiring Devices (Bi-national standard, with UL 514D).
  - .3 CSA C22.2 No.55-M1986(R2008), Special Use Switches.
  - .4 CSA C22.2 No.111-10, General-Use Snap Switches (Bi-national standard, with UL 20).

### **1.2 Action And Informational Submittals**

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for wiring devices and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
  - .1 Submit drawings.
- .4 Sustainable Design Submittals:
  - .1 Construction Waste Management:
    - .1 Submit project Waste Management Plan highlighting recycling and salvage requirements.

### **1.3 Closeout Submittals**

- .1 Submit in accordance with Section 01 77 00 – Project Closeout.
- .2 Operation and Maintenance Data: submit operation and maintenance data for wiring devices for incorporation into manual.

### **1.4 Delivery, Storage And Handling**

- .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
  - .1 Store materials off ground indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Store and protect wiring devices from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan related to Work of this Section.

- .5 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding, and packaging materials as specified in Construction Waste Management Plan Waste Reduction Workplan in accordance with Section 01 74 19 - Waste Management and Disposal.

## **PART 2 - PRODUCTS**

### **2.1 Switches**

- .1 15 or 20 A, 120 V , single pole, double pole, three-way, four-way switches to: CSA C22.2 No.55 and CSA C22.2 No.111.
- .2 Manually-operated general purpose AC switches with following features:
  - .1 Terminal holes approved for No. 10 AWG wire.
  - .2 Silver alloy contacts.
  - .3 Urea or melamine moulding for parts subject to carbon tracking.
  - .4 Suitable for back and side wiring.
  - .5 Ivory toggle.
- .3 Toggle operated locking fully rated for tungsten filament and fluorescent lamps, and up to 80% of rated capacity of motor loads and or heating loads.
- .4 Switches of one manufacturer throughout project.

### **2.2 Receptacles**

- .1 Duplex receptacles, CSA type 5-15 R, 125 V, 15 A, U ground, to: CSA C22.2 No.42 with following features:
  - .1 Ivory urea moulded housing.
  - .2 Suitable for No. 10 AWG for back and side wiring.
  - .3 Break-off links for use as split receptacles.
  - .4 Eight back wired entrances, four side wiring screws.
  - .5 Triple wipe contacts and rivetted grounding contacts.
- .2 Single receptacles CSA type 5-15 R, 125 V, 15 A, U ground with following features:
  - .1 Ivory urea moulded housing.
  - .2 Suitable for No. 10 AWG for back and side wiring.
  - .3 Four back wired entrances, 2 side wiring screws.
- .3 Other receptacles with ampacity and voltage as indicated.
- .4 Receptacles of one manufacturer throughout project.

### **2.3 Special Wiring Devices**

- .1 Special wiring devices:
  - .1 Pilot lights as indicated, with neon type 0.04 W, 125 V lamp and red plastic jewel lens flush type.

### **2.4 Cover Plates**

- .1 Cover plates for wiring devices to: CSA C22.2 No.42.1.
- .2 Sheet steel utility box cover for wiring devices installed in surface-mounted utility boxes.

- .3 Stainless steel, vertically brushed, 1 mm thick cover plates for wiring devices mounted in flush-mounted outlet box.
- .4 Cast cover plates for wiring devices mounted in surface-mounted FS or FD type conduit boxes.
- .5 Weatherproof double lift spring-loaded cast aluminum cover plates, complete with gaskets for duplex receptacles as indicated.
- .6 Weatherproof spring-loaded cast aluminum cover plates complete with gaskets for single receptacles or switches.

## **2.5 Source Quality Control**

- .1 Cover plates from one manufacturer throughout project.

## **PART 3 - EXECUTION**

### **3.1 Examination**

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for wiring devices installation in accordance with manufacturer's written instructions.
  - .1 Visually inspect substrate in presence of York Region Representative.
  - .2 Inform York Region Representative of unacceptable conditions immediately upon discovery.
  - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from York Region Representative.

### **3.2 Installation**

- .1 Switches:
  - .1 Install single throw switches with handle in "UP" position when switch closed.
  - .2 Install switches in gang type outlet box when more than one switch is required in one location.
  - .3 Mount toggle switches at height in accordance with Section 26 05 00 - Common Work Results for Electrical as indicated.
- .2 Receptacles:
  - .1 Install receptacles in gang type outlet box when more than one receptacle is required in one location.
  - .2 Mount receptacles at height in accordance with Section 26 05 00 - Common Work Results for Electrical as indicated.
  - .3 Where split receptacle has one portion switched, mount vertically and switch upper portion.
  - .4 Install GFI type receptacles as indicated.
- .3 Cover plates:
  - .1 Install suitable common cover plates where wiring devices are grouped.
  - .2 Do not use cover plates meant for flush outlet boxes on surface-mounted boxes.

### **3.3 Cleaning**

- .1 Progress Cleaning:
  - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment.
- .3 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 19 - Waste Management and Disposal.
  - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

#### **3.4 Protection**

- .1 Protect installed products and components from damage during construction.
- .2 Protect stainless steel cover plate finish with paper or plastic film until painting and other work is finished.
- .3 Repair damage to adjacent materials caused by wiring device installation.

**END OF SECTION**

## **PART 1 - GENERAL**

### **1.1 Reference Standards**

- .1 CSA International
  - .1 CSA C22.2 No. 5-09, Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures (Tri-national standard with UL 489, and NMJ-J-266-ANCE-2010).

### **1.2 Action And Informational Submittals**

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for circuit breakers and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Include time-current characteristic curves for breakers with ampacity of 100 A and over or with interrupting capacity of 22,000 A symmetrical (rms) and over at system voltage.
- .4 Sustainable Design Submittals:
  - .1 Construction Waste Management:
    - .1 Submit project Waste Management Plan highlighting recycling and salvage requirements.

### **1.3 Delivery, Storage And Handling**

- .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
  - .1 Store circuit breakers off ground indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Store and protect circuit breakers from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan related to Work of this Section .
- .5 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding, and packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 19 - Waste Management and Disposal.

## **PART 2 - PRODUCTS**

### **2.1 Breakers General**

- .1 Moulded-case circuit breakers, Circuit breakers, and ground-fault circuit-interrupters, fused circuit breakers, and accessory high-fault protectors: to CSA C22.2 No. 5

- .2 Bolt-on moulded case circuit breaker: quick- make, quick-break type, for manual and automatic operation with temperature compensation for 40 degrees C ambient.
- .3 Common-trip breakers: with single handle for multi-pole applications.
- .4 Magnetic instantaneous trip elements in circuit breakers to operate only when value of current reaches setting.
  - .1 Trip settings on breakers with adjustable trips to range from 3-8 times current rating.
- .5 Circuit breakers with interchangeable trips as indicated.
- .6 Circuit breakers to have minimum 22,00 symmetrical rms interrupting capacity rating.

## **2.2 Thermal Magnetic Breakers Design A**

- .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 Optional Features**

- .1 Include:
  - .1 On-off locking device.
  - .2 Handle mechanism.

# **PART 3 - EXECUTION**

## **3.1 Examination**

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for installation in accordance with manufacturer's written instructions.
  - .1 Visually inspect substrate in presence of York Region Representative.
  - .2 Inform York Region Representative of unacceptable conditions immediately upon discovery.
  - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from York Region Representative.

## **3.2 Installation**

- .1 Install circuit breakers as indicated.

## **3.3 Cleaning**

- .1 Progress Cleaning:
  - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment.
- .3 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 19 - Waste Management and Disposal.
  - .1 Remove recycling containers and bins from site and dispose of materials at



appropriate facility.

**END OF SECTION**

## **PART 1 - GENERAL**

### **1.1 Reference Standards**

- .1 CSA International
  - .1 CAN/CSA C22.2 No.144-M91(R2006), Ground Fault Circuit Interrupters.
- .2 National Electrical Manufacturers Association (NEMA)
  - .1 NEMA PG 2.2-1999(R2009), Application Guide for Ground Fault Protection Devices for Equipment.

### **1.2 Action And Informational Submittals\_**

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for ground fault circuit interrupters and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
  - .1 Submit drawings.
- .4 Test and Evaluation Reports: submit test report for field testing of ground fault equipment to York Region Representative and certificate that system as installed meets criteria specified.
- .5 Sustainable Design Submittals:
  - .1 Construction Waste Management:
    - .1 Submit project Waste Management Plan highlighting recycling and salvage requirements.

### **1.3 Closeout Submittals**

- .1 Submit in accordance with Section 01 77 00 – Project Closeout.
- .2 Operation and Maintenance Data: submit operation and maintenance data for ground fault circuit interrupters for incorporation into manual.

### **1.4 Delivery, Storage And Handling**

- .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
  - .1 Store materials off ground indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Store and protect ground fault circuit interrupters from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.

- .4 Develop Construction Waste Management Plan related to Work of this Section.
- .5 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding, and packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 19 - Waste Management and Disposal.

## **PART 2 - PRODUCTS**

### **2.1 Materials**

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

### **2.2 Breaker Type Ground Fault Interrupter**

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

### **2.3 Ground Fault Protector Unit**

- .1 Self-contained with 15 or 20 A, 120 V circuit interrupter and duplex receptacle complete with:
  - .1 Solid state ground sensing device.
  - .2 Facility for testing and reset.
  - .3 CSA Enclosure 1, surface or flush mounted as required with stainless steel face plate.

## **PART 3 - EXECUTION**

### **3.1 Examination**

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for ground fault circuit interrupters installation in accordance with manufacturer's written instructions.
  - .1 Visually inspect substrate in presence of York Region Representative.
  - .2 Inform York Region Representative of unacceptable conditions immediately upon discovery.
  - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from York Region Representative.

### **3.2 Installation**

- .1 Connect supply and load wiring to equipment in accordance with manufacturer's recommendations.

### **3.3 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.

### **3.4 Cleaning**

- .1 Progress Cleaning:
  - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment.
- .3 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 19 - Waste Management and Disposal.
  - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

**END OF SECTION**

## **PART 1 - GENERAL**

### **1.1 Reference Standards**

- .1 CSA Group
  - .1 CAN/CSA-C22.2 No.4-04(R2009 ), Enclosed and Dead-Front Switches (Tri-National Standard, with ANCE NMX-J-162-2004 and UL 98).
  - .2 CSA C22.2 No.39-13, Fuse holder Assemblies.

### **1.2 Action And Informational Submittals**

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for disconnect switches - fused and non-fused and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Sustainable Design Submittals:
  - .1 Construction Waste Management:
    - .1 Submit project Waste Management Plan highlighting recycling and salvage requirements.

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### **.3 Delivery, Storage And Handling**

- .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
  - .1 Store materials off ground, indoors, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Store and protect disconnect switches - fused and non-fused from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan related to Work of this Section.
- .5 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding, and packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 19 - Waste Management and Disposal.

## **PART 2 - PRODUCTS**

### **2.1 Disconnect Switches**

- .1 Fusible, Non-fusible, Horsepower rated where required, disconnect switch in CSA enclosure 3R, to CAN/CSA-C22.2 No.4 size as indicated.

- .2 Provision for padlocking in off switch position by 3 locks.
- .3 Mechanically interlocked door to prevent opening when handle in ON position.
- .4 Fuses: size as indicated.
- .5 Fuse holders: to CSA C22.2 No.39 relocatable and suitable without adaptors, for type and size of fuse indicated.
- .6 Quick-make, quick-break action.
- .7 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 Results for Electrical.
- .2 Indicate name of load controlled on size 4 nameplate.

## **PART 3 - EXECUTION**

### **3.1 Examination**

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for disconnect switches - fused and non-fused installation in accordance with manufacturer's written instructions.
  - .1 Visually inspect substrate in presence of York Region Representative.
  - .2 Inform York Region Representative of unacceptable conditions immediately upon discovery.
  - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from York Region Representative.

### **3.2 Installation**

- .1 Install disconnect switches complete with fuses if applicable.

### **3.3 Cleaning**

- .1 Progress Cleaning:
  - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment.
- .3 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 19 - Waste Management and Disposal.
  - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

**END OF SECTION**

## **PART 1 - GENERAL**

### **1.1 Reference Standards**

- .1 International Electrotechnical Commission (IEC)
  - .1 IEC 947-4-1-2002, Part 4: Electromechanical contactors and motor-starters.

### **1.2 Action And Informational Submittals**

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Provide manufacturer's printed product literature, specifications and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
  - .1 Provide shop drawings: in accordance with Section 01 33 00 - Submittal Procedures.
    - .1 Submit drawings.
    - .2 Provide shop drawings for each type of starter to indicate:
      - .1 Mounting method and dimensions.
      - .2 Starter size and type.
      - .3 Layout and components.
      - .4 Enclosure types.
      - .5 Wiring diagram.
      - .6 Interconnection diagrams.

### **1.3 Closeout Submittals**

- .1 Provide maintenance materials in accordance with Section 01 77 00 – Project Closeout.
- .2 Submit operation and maintenance data for each type and style of motor starter for incorporation into maintenance manual.
- .3 Extra Materials:
  - .1 Provide listed spare parts for each different size and type of starter.
    - .1 3 contacts, stationary.
    - .2 3 contacts, movable.
    - .3 1 contacts, auxiliary.
    - .4 1 control transformers.
    - .5 1 operating coil.
    - .6 2 fuses.
    - .7 10% indicating lamp bulbs used.

### **1.4 Delivery, Storage And Handling**

- .1 Deliver, store and handle in accordance with manufacturer's recommendations.
- .2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .3 Packaging Waste Management: remove for reuse and return by manufacturer of pallets

crates padding and packaging materials in accordance with Section 01 74 19 - Waste Management and Disposal.

## **PART 2 - PRODUCTS**

### **2.1 Materials**

- .1 Starters: to IEC 947-4 with AC4 utilization category.

### **2.2 Manual Motor Starters**

- .1 Single and Three phase manual motor starters of size, type, rating, and enclosure type as indicated, with components as follows:
  - .1 Switching mechanism, quick make and break.
  - .2 One or Three overload heaters, manual reset, trip indicating handle.
- .2 Accessories:
  - .1 Toggle switch: heavy duty labelled as indicated.
  - .2 Indicating light: heavy duty type and colour as indicated.
  - .3 Locking tab to permit padlocking in "ON" or "OFF" position.

### **2.3 Full Voltage Magnetic Starters**

- .1 Magnetic and combination magnetic starters of size, type, rating and enclosure type as indicated with components as follows:
  - .1 Contactor solenoid operated, rapid action type.
  - .2 Motor overload protective device in each phase, manually reset from outside enclosure.
  - .3 Wiring and schematic diagram inside starter enclosure in visible location.
  - .4 Identify each wire and terminal for external connections, within starter, with permanent number marking identical to diagram.
- .2 Combination type starters to include fused disconnect switch with operating lever on outside of enclosure to control disconnect, and provision for:
  - .1 Locking in "OFF" position with up to 3 padlocks.
  - .2 Independent locking of enclosure door.
  - .3 Provision for preventing switching to "ON" position while enclosure door open.
- .3 Accessories:
  - .1 Selector switches: heavy duty labelled as indicated.
  - .2 Indicating lights: heavy duty type and Colour as indicated.
  - .3 1-N/O and 1-N/C spare auxiliary contacts unless otherwise indicated.

### **2.4 Control Transformer**

- .1 Single phase, dry type, control transformer with primary voltage as indicated and 120 V secondary, complete with secondary fuse, installed in with starter as indicated.
- .2 Size control transformer for control circuit load plus 20% spare capacity.

### **2.5 Accessories**

- .1 Pushbutton: heavy duty, oil tight as required.



- .2 Selector switches: heavy duty, oil tight as required.
- .3 Indicating lights: heavy duty, oil tight, type and colour as indicated.

## **2.6 Finishes**

- .1 Apply finishes to enclosure in accordance with Section 26 05 00 - Common Work Results for Electrical.

## **2.7 Equipment Identification**

- .1 Provide equipment identification in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Manual starter designation label, white plate, black letters, size 1, engraved as indicated.
- .3 Magnetic starter designation label, white plate, black letters, size 3 engraved as indicated.

# **PART 3 - EXECUTION**

## **3.1 Installation**

- .1 Install starters and control devices in accordance with manufacturer's instructions.
- .2 Install and wire, starters and controls as indicated.
- .3 Ensure correct fuses installed.
- .4 Confirm motor nameplate and adjust overload device to suit.

## **3.2 Field Quality Control**

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrical and manufacturer's instructions.
- .2 Operate switches and contactors to verify correct functioning.
- .3 Perform starting and stopping sequences of contactors and relays.
- .4 Check that sequence controls, interlocking with other separate related starters, equipment, control devices, operate as indicated.

## **3.3 Cleaning**

- .1 Cleaning:
  - .1 Remove surplus materials, excess materials, rubbish, tools and equipment.
- .2 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 19 - Waste Management and Disposal.

**END OF SECTION**

## **PART 1 GENERAL**

### **1.1 General Requirements**

- .1 It is the intent of this specification to secure an engine-driven generator set that has been prototype tested, factory built, production-tested, and site-tested together with all accessories necessary for a complete installation as shown on the plans and drawings and specified herein.
- .2 Any exceptions to the published specifications shall be subject to the approval of the engineer.
- .3 It is the intent of this specification to secure a generator set system that has been tested during design verification, in production, and at the final job site. The generator set will be a commercial design and will be complete with all of the necessary accessories for complete installation as shown on the plans, drawings, and specifications herein. The equipment supplied shall meet the requirements of the Ontario Electrical Safety Code and applicable local codes and regulations.
- .4 All equipment shall be new and of current production by an international, power system manufacturer of generators and transfer switches. The manufacturer shall be a supplier of a complete and coordinated system. There will be single-source responsibility for warranty, parts, and service through a factory-authorized representative with factory-trained technicians.
- .5 The equipment shall be produced by a manufacturer that is ISO 9001 certified for the design, development, production and service of its complete product line.
- .6 The generator manufacturer shall maintain a service organization that is available 24 hours per day throughout the year and has produced this type of equipment for at least 10 years.

### **1.2 Action and Informational SUBMITTALS**

- .1 Action Submittals
  - .1 Product Data
    - .1 The submittal shall include prototype test certification and specification sheets showing all standard and optional accessories to be supplied; schematic wiring diagrams, dimension drawings, and interconnection diagrams identifying by terminal number each required interconnection between the generator set, the transfer switch, and the remote annunciator panel if it is included elsewhere in these specifications.

### **1.3 Reference Standards**

- .1 CSA C22.2, No. 14-M91 Industrial Control Equipment.
- .2 EN50082-2, Electromagnetic Compatibility-Generic Immunity Requirements, Part 2: Industrial.
- .3 EN55011, Limits and Methods of Measurement of Radio Interference Characteristics of Industrial, Scientific and Medical Equipment.

- .4 IEC8528 part 4, Control Systems for Generator Sets.
- .5 IEC Std 61000-2 and 61000-3 for susceptibility, 61000-6 radiated and conducted electromagnetic emissions.
- .6 IEEE446 Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications.
- .7 CSA-282-19 Emergency Electrical Power Supply for Buildings. The generator shall include emergency lighting, dampers, heaters and a distribution panel in accordance with this standard. All requirements of this standard shall be met by the generator including alarms, shutdowns, and indications shown on Table 2 of the standard.
- .8 CSA-149.1-10 National Gas and Propane Installation Code.
- .9 IBC and OSHPD seismic certification.

#### **1.4 Delivery, Storage and Handling**

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 – Common Product Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding and packaging materials in accordance with Section 01 74 19 – Waste Management and Disposal.

#### **1.5 Warranty and Maintenance**

- .1 The generator set shall include a standard one-year warranty to guarantee against defective material and workmanship in accordance with the manufacturer's published warranty from date of start-up. Optional warranties shall be available upon request.
- .2 The generator set manufacturer and its distributor shall maintain a 24-hour parts and service organization. This organization shall regularly engage in maintenance contract programs to perform preventive maintenance and service on equipment similar to that specified. A service agreement shall be available and shall include system operation under simulated operating conditions; adjustment to the generator set, transfer switch, and switchgear controls as required, and certification in the owner's maintenance log of repairs made and function tests performed on all systems.

### **PART 2 – PRODUCTS**

#### **2.1 Equipment**

The generator set shall be a Kohler model KG80 with a 4P8X alternator. It shall provide 100.00 kVA and 80.00 kW when operating at 120/208 volts, 60 Hz, 0.80 power factor. The generator set shall be capable of a 130°C Standby rating while operating in an ambient condition of less than or equal to 104 °F and a maximum elevation of 500 ft above sea level. The standby rating shall be available for the duration of the outage.

- .1 Motor starting performance and voltage dip determinations shall be based on the complete generator set. The generator set shall be capable of supplying 231.00 LRKVA for starting motor loads with a maximum instantaneous voltage dip of 35%, as measured by a digital RMS transient recorder in accordance with IEEE Standard 115. Motor starting performance and voltage dip determination that does not account for all components affecting total voltage dip, i.e., engine, alternator, voltage regulator, and governor will not be acceptable. As such, the generator set shall be prototype tested to optimize and determine performance as a generator set system.
- .2 Provide vibration isolators between the engine alternator and heavy duty steel base.

## 2.2 Engine

- .1 The minimum 6.2-liter displacement engine shall deliver a minimum of 103 HP at a governed engine speed of 1800 rpm, and shall be equipped with the following:
  - .1 Electronic isochronous governor capable of 1.0% steady-state frequency regulation
  - .2 12-volt positive-engagement solenoid shift-starting motor
  - .3 130-ampere automatic battery charging alternator with a solid-state voltage regulation and negative ground polarity
  - .4 Positive displacement, full-pressure lubrication oil pump, cartridge oil filters, dipstick, and oil drain
  - .5 Dry-type replaceable air cleaner elements for normal applications
  - .6 The engine shall be naturally aspirated and fueled by Natural Gas
  - .7 Operating fuel pressure for natural gas shall be between 7.0 and 11.0 inches of H2O
  - .8 Natural gas fuel consumption at 100% load shall not exceed 975 cubic feet per hour when operating in standby configuration
  - .9 The exhaust manifold shall be dry.
  - .10 Exhaust flow shall not exceed 478 cubic feet per minute at rated kW.
  - .11 Exhaust temp shall not exceed 1274F at rated kW.
  - .12 The engine shall have a minimum of 8 cylinders in a V configuration and be liquid-cooled
- .2 The engine shall be EPA certified from the factory
- .3 The generator must accept rated load in one-step.

## 2.3 Alternator

- .1 The alternator shall be salient-pole, brushless, 2/3-pitch, with 4 bus bar provision for external connections, self-ventilated, with drip-proof construction and amortisseur rotor windings, and skewed for smooth voltage waveform. The ratings shall meet the NEMA standard (MG1-32.40) temperature rise limits. The insulation shall be class H per UL1446 and the varnish shall be a vacuum pressure impregnated, fungus resistant epoxy. Temperature rise of the rotor and stator shall be limited to 130°C

Standby. The PMG based excitation system shall be of brushless construction controlled by a digital, three phase sensing, solid- state, voltage regulator. The AVR shall be capable of proper operation under severe nonlinear loads and provide individual adjustments for voltage range, stability and volts-per-hertz operations. The AVR shall be protected from the environment by conformal coating. The waveform harmonic distortion shall not exceed 5% total RMS measured line-to-line at full rated load. The TIF factor shall not exceed 50.

- .2 The alternator shall have a maintenance-free bearing, designed for 40000 hour B10 life. The alternator shall be directly connected to the flywheel housing with a semi-flexible coupling between the rotor and the flywheel.
- .3 The generator shall be inherently capable of sustaining at least 300% of rated current for at least 10 seconds under a 3-phase symmetrical short circuit without the addition of separate current-support devices.
- .4 Motor starting performance and voltage dip determinations shall be based on the complete generator set. The generator set shall be capable of supplying 231.00 LRKVA for starting motor loads with a maximum instantaneous voltage dip of 35%, as measured by a digital RMS transient recorder in accordance with IEEE Standard 115. Motor starting performance and voltage dip determination that does not account for all components affecting total voltage dip, i.e., engine, alternator, voltage regulator, and governor will not be acceptable. As such, the generator set shall be prototype tested to optimize and determine performance as a generator set system.

## **2.4 Vibration Isolation**

- .1 Vibration isolators shall be provided between the engine-alternator and heavy-duty steel base.

## **2.5 Controller**

- .1 The controller shall include an alarm horn as required by NFPA and shall meet the requirement of CSA-282-19
- .2 UL 508 listed.
- .3 Alarms, shutdowns and indications as per Table 2 of CSA-282-19
- .4 Shall include a key switch to meet local code requirements and shall be removable only in the AUTO position.
- .5 Advanced Power Management 402 (APM402) Generator Set Controller
  - 1. The generator set controller shall be a microprocessor-based control system that will provide automatic starting, system monitoring, and protection.
  - 2. The controller shall be mounted on the generator set and shall have integral vibration isolation. The controller shall be prototype and reliability tested to ensure operation in the conditions encountered.
- .6 Codes and Standards
  - 1. The generator set controller shall meet NFPA 110 Level 1 requirements and shall include an integral alarm horn as required by NFPA.
  - 2. The controller shall meet NFPA 99 and NEC requirements.
  - 3. The controller shall be UL 508 recognized.

.7 Applicability

1. The controller shall be a standard offering in the manufacturer's controller product line.
2. The controller's environmental specification shall be: -40°C to 70°C operating temperature range and 5-95% humidity, non-condensing.

.8 Controller Buttons, Display, and Components

1. The generator set controller shall include the following features and functions:
  1. Master Control Push Buttons – the buttons shall be tactile-feel membrane with an indicator light to initiate the following functions:
    1. Run Mode – when in Run mode the generator set shall start.
    2. Off/Reset Mode – when in Off/Reset mode, the generator set shall not accept any remote start commands and shall be capable of resetting all faults, allowing for the restarting of the generator set after a shutdown.
    3. Auto Mode – when in Auto mode, the generator set shall be ready to accept a signal from a remote device.
  2. Emergency Stop Switch – the latch type stop switch shall be red in color with a “mushroom” type head. Depressing the stop button will immediately stop the generator set and lockout the generator set for any automatic remote starting.
  3. Alarm Horn – the horn sounds when any faults or warnings are present. The horn shall also sound when the controller is not in the Auto mode.
  4. Push Button/Rotary Selector Dial – the dial shall be used for selection of all menus and sub-menus. Rotating the dial moves through the menus, pushing the dial selects the menu and function/features in the menu.
  5. Display – the digital display shall be alphanumeric, with 2 lines of data and approximately 24 characters. The display shall have back lighting for ease of operator use in high and low light conditions. The display shall enter a sleep mode to reduce the demand on the battery when the generator set is not running, and the rotary dial is not in use for a period of time. The generator will wake up from sleep mode when the generator set starts, or the rotary dial is in use.
  6. Fault Light – the controller shall have an annunciator fault light that glows red for faults and yellow for warnings. The warning light will also illuminate when not in Auto.
  7. Alarm Silence/Lamp Test Button – when this button is held, it shall test all controller lamps. This button will also silence the alarm horn when the unit is not Auto or has a fault.
  8. Mini-USB Connection – the controller shall have a mini-USB connection port for a PC connection that is accessible on the front of the control panel without having to open any electrical enclosure panels on the generator. This connection shall allow a certified technician to service the generator controller using a dedicated PC program. The program shall allow for servicing of generator set parameters, faults diagnostics and viewing of controller information. The program shall allow for uploading of software and firmware as well as downloading of parameter settings and the event log.

.9 Controller Engine Control Features and Functions

1. User-programmable time delay for engine start.
2. User-programmable time delay engine cool down.

3. Capability to start and run at user-adjustable idle speed during warm-up for a selectable time-period until engine reaches preprogrammed temperature.
  4. The idle function including engine cooldown at idle speed.
  5. Output with adjustable timer for an ether injection starting system.
  6. Programmable cyclic cranking that can adjust on time, off time, and number of cycles.
- .10 Controller Alternator Control Features and Functions
1. Patented High-speed RMS Digital Voltage Regulation – the system shall have integral microprocessor-based voltage regulator system that provides + 0.5% voltage regulation no-load to full load with three phase sensing. A separate voltage regulator is not acceptable. The digital voltage regulator shall be applicable to single- or three-phase systems. The system shall be prototype tested and control variation of voltage to frequency. The voltage regulator shall be adjustable at the controller with maximum + 10% adjustable of nominal voltage.
  2. Alternator Thermal Overload Protection – the system shall have integral alternator overload and short circuit protection matched to each alternator for the particular voltage and phase configuration.
- .11 Other Control Features and Functions
1. Event Logging – the controller keeps a record of up to 1,000 events with date and time locally for warning and shutdown faults. This event log can be downloaded onto a PC through the service program.
- .12 Control Monitoring Requirements
1. The generator controller shall display and monitor the following engine and alternator functions.
    1. The following generator set functions shall be monitored:
      1. All output voltages - single phase, three phases, line to line, and line to neutral
      2. All single phase and three phase currents
      3. Output frequency
      4. kVA total and per phase
      5. kW hours
    2. Engine parameters listed below shall be monitored (engine dependent):
      1. Engine Speed
      2. Oil Pressure
      3. Coolant Temperature
      4. Battery Voltage
      5. Runtime Hours
    3. Operational records shall be stored in the control beginning at system start-up
      1. Total Run Time Hours
      2. Total Loaded Hours
      3. Total kW Hours
      4. Number of Starts
- .13 Generator Set Warning, Shutdown Alarm and Status
1. The generator set shall have alarms and status indication lamps that show Non-Automatic Status, Warning, and Shutdown conditions. The controller shall indicate with a warning lamp and/or alarm, and on the digital display

- screen any shutdown, warning, or engine fault condition that exists in the generator set system.
  - 2. All shutdowns and alarms to meet CSA-282-19
  - 3. Conditions, as a minimum, resulting in generator shutdown (engine dependent):
    - 1. AC Sensing Loss
    - 2. Alternator Protection
    - 3. ECM Address Conflict
    - 4. ECM Communications Loss
    - 5. ECM DTCs
    - 6. Emergence Stop
    - 7. Overspeed
    - 8. Underspeed
    - 9. High Coolant Temperature
    - 10. kW Overload
    - 11. Locked Rotor
    - 12. Loss of Fuel
    - 13. Low Coolant Level
    - 14. Low Engine Oil Level
    - 15. Low Fuel Level
    - 16. Low Oil Pressure
    - 17. No Coolant Temperature Signal
    - 18. No Oil Pressure Signal
    - 19. Overcrank
    - 20. Overfrequency
    - 21. Underfrequency
    - 22. Overvoltage
    - 23. Undervoltage
  - 4. Conditions, as a minimum, resulting in generator warning (generator will continue to operate) (engine dependent):
    - 1. AC Sensing Loss (short period of time)
    - 2. Battery Charger Communication Loss
    - 3. Battery Charger Fault
    - 4. Battery Fault
    - 5. Low Fuel Pressure
    - 6. High Battery Voltage
    - 7. Low Battery Voltage
    - 8. Low Cranking Voltage
    - 9. High Coolant Temperature
    - 10. Low Coolant Temperature
    - 11. Low Engine Oil Level
    - 12. Low Oil Pressure
    - 13. Not in Auto
    - 14. Speed Sensor Fault
- .14 Inputs and Outputs
- 1. Standard Dedicated User Inputs – the controller shall have dedicated inputs for:
    - 1. Two-Wire Input
      - 1. Remote Engine Start
    - 2. Digital Input - Fixed
      - 1. Auxiliary Fault (Shutdown)
      - 2. Remote Emergency Stop
    - 3. Digital Input – Programmable



- 1. 3 Dry Contact
  - 2. Standard Dedicated User Outputs – the controller shall have dedicated outputs for:
    - 1. Relay Driver Output - Programmable
      - 1. 1 Relay
  - 3. Optional Configurable User Inputs and Outputs
    - 1. User Configurable Inputs
      - 1. 2 Dry Contact Digital
    - 2. User Configurable Relay Outputs
      - 1. 5 NO/NC Relays
- .15 Communications
- 1. CAN
    - 1. If the generator set engine is equipped with an ECM, the controller shall communicate with the ECM for control, monitoring, diagnosis, and meet SAE J1939 standards.
  - 2. Modbus®
    - 1. Isolated for Modbus devices
    - 2. Generator Overcurrent and Fault Protection

## 2.6 Accessories

- .1 Air Restriction Indicator. The air cleaner restriction indicator shall indicate the need for maintenance of the air cleaners.
- .2 Battery Charger. A 6-ampere automatic float to equalize battery charger with the following features:
  - 1. 12 VDC output
  - 2. 1% steady-state voltage regulation from no load to full load over 10% AC input line voltage variation
  - 3. LED lamps for charge state indication
  - 4. Temperature compensated for ambient temperatures for -40°C to 70°C
  - 5. Potting for durability
  - 6. Short-circuit and reverse polarity protection
  - 7. UL 1236 listed
- .3 Battery Rack and Cables. Battery rack and battery cables capable of holding the manufacturer's recommended batteries shall be supplied.
- .4 Circuit Breaker. The generator shall come with a primary, factory installed, 100% rated line circuit breaker of 200 amperes that is UL2200 listed. Line circuit breakers shall be sized for the rated ampacity of the genset. Load side lugs shall be provided from the factory. The line circuit breaker shall include auxiliary contacts, shunt trip, undervoltage trip, alarm switch, and overcurrent switch functionality. Load side breaker connections made at the factory shall be separated from field connections. When GFI breakers are required, additional neutrals shall be factory installed.
- .5 Dry Contact Kits. The 10 Dry Contact Kit shall provide normally open and normally closed, gold-plated contacts in a form C configuration to activate warning devices and other customer-provided accessories allowing remote monitoring of the generator set. Typically, lamps, audible alarms, or other devices signal faults or status conditions.

- .6 Failure Relay.
  - 1. The common failure relay shall remotely signal auxiliary faults, emergency stop, high engine temperature, low oil pressure, over-crank, and overspeed via one single-pole, double-throw relay with 10 amps at 120 VAC contacts.
  - 2. The relay contacts shall be gold flashed to allow use of low current draw devices (100ma @ 28VDC min.).
  - 3. Once energized the relay shall remain latched until the system is reset by the main controller switch.
- .7 Remote Annunciator Panel. The remote annunciator shall meet CSA-282-15 Table 2 requirements and enable remote viewing of the generator status. The panel shall be connected to the generator controller via either network communication wires or via hard wired connections. Options shall be available to provide ATS source availability, contactor position, and loaded or unloaded test for up to four transfer switches. The panel shall have the capability to be either flush- mounted or surface-mounted. The annunciator shall meet UL508 requirements.
- .8 Rodent Guards. Generator rodent guards shall prevent intrusion and protect internal components.
- .9 Run Relay. The run relay shall provide a three-pole, double-throw relay with 10-amp/ 250 VAC contacts to indicate that the generator is running. The relay provides three sets of dry contacts for energizing or de-energizing customer devices while the generator is running (e.g. louvers, indicator lamps, etc.)
- .10 Skid End Caps. The generator shall include skid end caps.
- .11 Standard Air Cleaner. The air cleaner shall provide engine air filtration which meets the engine manufacturer's specifications under typical operating conditions.
- .12 Block Heater. The block heater shall be thermostatically controlled and sized to maintain manufacturers recommended engine coolant temperature to meet the start-up requirements CSA-282-15

## **2.7 Sound Enclosure**

- .1 The enclosure shall be constructed from high strength, Aluminum Sound Attenuated Enclosure, providing a sound level of 69 dB(A) while the generator is operating at 100% load at 7 meters (23 feet) using acoustic insulation and internally mounted and insulated muffler.
- .2 The enclosure shall be finish coated with powder baked paint for superior finish, durability and appearance. Enclosures will be finished in the manufacturer's standard color.
- .3 The enclosure shall allow the generator set to operate at full load in an ambient of 40°C - 45°C with no additional de-rating of the electrical output.
- .4 The enclosure shall be equipped with sufficient side and end doors to allow access for operation, inspection, and service of the unit and all options.

Minimum requirements are two doors per side. When the generator set controller faces the rear of the generator set, an additional rear facing door is required. Access to the controller and main line circuit breaker must meet the requirements of the Ontario Electric Code.

- .5 Doors shall be equipped with lockable latches. Locks must be keyed alike.
- .6 A duct between the radiator and air outlet shall be provided to prevent re-circulation of hot air.
- .7 The complete exhaust system shall be internal to the enclosure.
- .8 All acoustical insulation shall be fixed to the mounting surface with pressure sensitive adhesive or mechanically fastened. In addition, all acoustical insulation mounted on a horizontal plane shall be mechanically fastened. The acoustical insulation shall be flame retardant.
- .9 The enclosure shall include an exhaust scoop to direct the cooling air in a vertical direction.
- .10 The enclosure shall include a mounted load centre to be fed from the buildings normal electrical supply. The load centre shall include individual feeder breakers pre-wired to all engine and enclosure electrical devices requiring normal supply power including, but not limited to: block heater, battery heater, battery charger, enclosure space heater, enclosure dampers, and 2-hour battery back-up emergency light pack (as specified in CSA-282-15.)
- .11 The enclosure dampers and space heater shall be configured so as to keep the interior space of the enclosure at 10°C at all times when the engine is not running. Dampers shall be installed in a fail-safe to open configuration. The dampers shall be configured to open upon failure of normal power. Dampers shall also be configured to open upon engine running, regardless of the condition of normal supply power.
- .12 If the plans show the generator is not being installed on a solid concrete pad and will be elevated in any way such the bottom of the generator set enclosure will be open to the elements, provide a solid sheet metal bottom to the enclosure. The solid bottom shall be installed in such a way that it does not compromise the enclosure heating, engine cooling, or sound emissions of the unit, while also preventing rodent intrusions.

## 2.7 Source Quality Control

- .1 Non-Conforming Work
  - 1. To ensure that the equipment has been designed and built to the highest reliability and quality standards, the manufacturer and/or local representative shall be responsible for three separate tests: design prototype tests, final production tests, and site tests.
- .2 Design Prototype Tests. Components of the emergency system, such as the engine/generator set, transfer switch, and accessories, shall not be subjected to prototype tests because the tests are potentially damaging. Rather, similar design prototypes and preproduction models shall be subject to the following tests:

1. Maximum power (kW)
  2. Maximum motor starting (kVA) at 35% instantaneous voltage dip.
  3. Alternator temperature rise by embedded thermocouple and/or by resistance method per NEMA MG1-32.6.
  4. Governor speed regulation under steady-state and transient conditions.
  5. Voltage regulation and generator transient response.
  6. Harmonic analysis, voltage waveform deviation, and telephone influence factor.
  7. Three-phase short circuit tests.
  8. Alternator cooling air flow.
  9. Torsional analysis to verify that the generator set is free of harmful torsional stresses.
  10. Endurance testing.
- .3 Final Production Tests. Each generator set shall be tested under varying loads with guards and exhaust system in place. Tests shall include:
1. Single-step load pickup
  2. Safety shutdown device testing
  3. Rated Power @ 0.8 PF
  4. Maximum power
  5. Upon request, a witness test, or a certified test record sent prior to shipment.
- .4 Site Tests. The manufacturer's distribution representative shall perform an installation check, startup, and building load test. The engineer, regular operators, and the maintenance staff shall be notified of the time and date of the site test. The tests shall include:
1. Fuel, lubricating oil, and antifreeze shall be checked for conformity to the manufacturer's recommendations, under the environmental conditions present and expected.
  2. Accessories that normally function while the set is standing by shall be checked prior to cranking the engine. These shall include: block heaters, battery chargers, alternator strip heaters, remote annunciators, etc.
  3. Generator set startup under test mode to check for exhaust leaks, path of exhaust gases outside the building, cooling air flow, movement during starting and stopping, vibration during operation, normal and emergency line-to-line voltage and frequency, and phase rotation.
  4. Automatic start by means of a simulated power outage to test remote-automatic starting, transfer of the load, and automatic shutdown. Prior to this test, all transfer switch timers shall be adjusted for proper system coordination. Engine coolant temperature, oil pressure, and battery charge level along with generator set voltage, amperes, and frequency shall be monitored throughout the test.
  5. Perform all tests required by CSA-282-15.

**END OF SECTION**

## **PART 1 - GENERAL**

### **1.1 Qualifications**

- .1 Transfer switch producer shall be ISO 9001 certified and have produced this type of equipment for at least 10 years.
- .2 The manufacturer must have a service organization available 24 hours per day, 365 days of the year.

### **1.2 Reference Standards**

- .1 UL Standards
  - .1 UL 1008 – Standard for Transfer Switch Equipment
- .2 CSA International
  - .1 CSA C22.2 No.5-09, Moulded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures (Tri-national standard with UL 489, NMX-J-266-ANCE-2010).
  - .2 CSA C22.2 No.178.1-2007, Automatic Transfer Switches.
  - .3 CAN/CSA C60044-1-07, Instrument Transformers.
  - .4 CSA/C282 (current edition) Emergency Electrical Power Supply for Buildings.
- .3 National Electrical Manufacturers Association (NEMA)
  - .1 NEMA ICS 2-1996(R2009), Controllers, Contactors, and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC, Part 8: Disconnect Devices for Use in Industrial Control Equipment.
  - .2 NEMA Standard ICS-2005, Electromechanical AC Transfer Switch Equipment
- .4 IEC Standards
  - .1 IEC 947-6-1 Low-Voltage Switchgear and Control Gear; Multifunction equipment; Automatic Transfer Switching equipment EN55011, Limits and Methods of Measurement of Radio Interference Characteristics of Industrial, Scientific and Medical Equipment.

### **1.2 Action And Informational Submittals**

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for transfer switches and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
  - .1 Submit drawings.
    - .1 Indicate on drawings:
      - .1 Make, model and type.
      - .2 Load classification:
        - .1 Tungsten lamp load: kW.

- .2 Ballast lamp load: kW.
    - .3 Motor load: kW.
    - .4 Restricted use: resistance and general loads, 0.8 pf or higher kW.
  - .3 Single line diagram showing controls and relays.
  - .4 Description of equipment operation including:
    - .1 Automatic starting and transfer to standby unit and back to normal power.
    - .2 Test control.
    - .3 Manual control.
    - .4 Automatic shutdown.
- .4 Sustainable Design Submittals:
  - .1 Construction Waste Management:
    - .1 Submit project Waste Management Plan highlighting recycling and salvage requirements.

### 1.3 Closeout Submittals

- .1 Submit in accordance with Section 01 77 00 – Project Closeout.
- .2 Operation and Maintenance Data: submit operation and maintenance data for transfer switches for incorporation into manual.
- .3 Detailed instructions to permit effective operation, maintenance and repair.
- .4 Technical data:
  - .1 Schematic diagram of components, controls and relays.
  - .2 Illustrated parts lists with parts catalogue numbers.
  - .3 Certified copy of factory test results.

### 1.4 Delivery, Storage And Handling

- .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
  - .1 Store materials off ground indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Store and protect transfer switches from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan Waste Reduction Workplan related to Work of this Section.
- .5 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding, and packaging materials as specified in Construction Waste Management Plan Waste Reduction Workplan in accordance with Section 01 74 19 - Waste Management and Disposal.

### 1.5 Manufacturer's

- .1 A factory trained service organization shall be maintained by the manufacturer that is on call 24 hours a day, 365 days per year.
- .2 Records of the transfer switch shall be maintained by serial number for a minimum of 20 years.
- .3 The transfer switch manufacturer shall be responsible for the design, coordination, and testing of the complete system.

## **PART 2 - PRODUCTS**

### **2.1 System Description**

- .1 Automatic load transfer equipment to:
  - .1 Monitor voltage on phases of normal power supply.
  - .2 Initiate cranking of standby generator unit on normal power failure or abnormal voltage on any one phase below preset adjustable limits for adjustable period of time.
  - .3 Transfer load from normal supply to standby unit when standby unit reaches rated frequency and voltage pre-set adjustable limits.
  - .4 Transfer load from standby unit to normal power supply when normal power restored, confirmed by sensing of voltage on phases above adjustable pre-set limit for adjustable time period.
  - .5 Shut down standby unit after running unloaded to cool down using adjustable time delay relay.

### **2.2 Materials**

- .1 Instrument transformers: to CAN/CSA C60044-1.
- .2 Contactors: to NEMA ICS2.

### **2.3 Circuit Breaker Type Transfer Equipment**

- .1 Circuit Breaker Type Transfer Equipment: to CSA C22.2 No.5.
- .2 Rated: 208 V, 60Hz, 400 A, 4 wire, solid neutral.
  - .1 Fault withstand rating: 25 kA symmetrical for 3 cycles with maximum peak value of 25 kA.
  - .2 Double-throw, mechanically interlocked design (break before make power contacts)
  - .3 NEMA type 1 enclosure
  - .4 IBC and OSHPD seismic certification.
  - .5 Electrically operated, mechanically held mechanism.
  - .6 Silver alloy main contacts
  - .7 Operated by a momentarily energized solenoid driven mechanism.
  - .8 Standard transition operation with either automatic or non-automatic control.
  - .9 Front Accessible contacts for easy inspection
  - .10 Internal manual operating handle.
  - .11 Designs utilizing components of moulded-case circuit breakers, contactors, or parts thereof, which are not intended for continuous duty, repetitive switching or transfer between two active power sources, are not acceptable.
  - .12 Provide Kohler Model KCS, Transfer Switch

- .13 The ATS shall be the same manufacturer as the generator set for maximum compatibility and single source supply.
- .14 Auxiliary contact: to initiate emergency generator start-up on failure of normal power.

## **2.4 Controls**

- .1 LCD Display, 4 lines x 20 characters, backlit
- .2 Complete programming and viewing capability at the door using the keypad and LCD display.
- .3 LED Indicator: source available, transfer switch position, service required (fault), and 'not-in-auto'
- .4 Programmable voltage and frequency pickup and dropout settings.
- .5 Programmable time delays
- .6 Time-based load control
- .7 Two programmable inputs and two programmable outputs.
- .8 Able to accept up to four I/O extension modules
- .9 Modbus communication
- .10 RS-485 communication
- .11 Ethernet communication
- .12 Kohler Decision Maker MPAC 1200 Controller

## **2.5 Accessories**

- .1 Programmable Exerciser: A programmable exerciser shall be supplied to allow programming of up to 56 on/off events.

## **2.6 Equipment Identification**

- .1 Identify equipment in accordance with Section 26 05 00 - Common Work Results for Electrical.

## **2.7 Warranty**

- .1 Manufacture Warranty
  - .1 The ATS shall include a standard warranty covering two (2) years or 2000 hours, whichever occurs first, to guarantee against defective material and workmanship in accordance with the manufacturer's published warranty from the date of initial startup.
  - .2 The ATS manufacturer and its distributor shall maintain a 24-hour parts and service organization. This organization shall regularly engage in maintenance contract programs to perform preventive maintenance and service on equipment



similar to that specified. A service agreement shall be available and shall include system operation under simulated operating conditions; adjustment to the generator set, transfer switch, and switchgear controls as required, and certification in the owner's maintenance log of repairs made and functional tests performed on all systems.

## **PART 3 - EXECUTION**

### **3.1 Examination**

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for transfer switches installation in accordance with manufacturer's written instructions.
  - .1 Visually inspect substrate in presence of York Region Representative.
  - .2 Inform York Region Representative of unacceptable conditions immediately upon discovery.
  - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from York Region Representative.

### **3.2 Installation**

- .1 Locate, install and connect transfer equipment as indicated.
- .2 Check relays solid state monitors and adjust as required to ensure correct operation.
- .3 Install and connect battery and remote alarms.

### **3.3 Field Quality Control**

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Energize transfer equipment from normal power supply.
- .3 Set selector switch in "Test" position to ensure proper standby start, running, transfer, retransfer. Return selector switch to "Auto" position to ensure standby shuts down.
- .4 Set selector switch in "Manual" position and check to ensure proper performance.
- .5 Set selector switch in "Engine start" position and check to ensure proper performance. Return switch to "Auto" to stop engine.
- .6 Set selector switch in "Auto" position and open normal power supply disconnect. Standby should start, come up to rated voltage and frequency, and then load should transfer to standby. Allow to operate for 10 minutes, then close main power supply disconnect. Load should transfer back to normal power supply and standby should shutdown.
- .7 Repeat, at 1 hour intervals, times, complete test with selector switch in each position, for each test.

### **3.4 Cleaning**

- .1 Progress Cleaning:
  - .1 Leave Work area clean at end of each day.

- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment.
- .3 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 19 - Waste Management and Disposal.
  - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

### **3.5 Source Quality Control**

- .1 Test and Inspection
  - .1 Upon request, the manufacturer shall provide a notarized letter certifying compliance with all of the requirements of this specification including compliance with the above codes and standards. The certification shall identify, by serial number(s), the equipment involved. No exceptions to the specification, other than those stipulated at the time of the submittal, shall be included in the certification.
  - .2 The ATS manufacturer shall be certified to ISO 9001 International Quality Standard and the manufacturer shall have third party certification verifying quality assurance in design/development, production, installation and servicing in accordance with ISO 9001

**END OF SECTION**

## **PART 1 - GENERAL**

### **1.1 Reference Standards**

- .1 American National Standards Institute (ANSI)
  - .1 ANSI C82.1-04, Lamp Ballasts-Line Frequency Fluorescent Lamp Ballast.
  - .2 ANSI C82.4-02(R2007), Ballasts for High-Intensity-Discharge and Low-Pressure Sodium Lamps Multi Supply Type.
- .2 American National Standards Institute/Institute of Electrical and Electronics Engineers (ANSI/IEEE )
  - .1 ANSI/IEEE C62.41-1991, Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits.
- .3 ASTM International Inc.
  - .1 ASTM F 1137-00(2006), Standard Specification for Phosphate/Oil and Phosphate/Organic Corrosion Protective Coatings for Fasteners.
- .4 CSA Group (CSA)
- .5 ICES-005-07, Radio Frequency Lighting Devices.
- .6 Underwriters' Laboratories of Canada (ULC)

### **1.2 Action And Informational Submittals**

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Provide manufacturer's printed product literature, specifications and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.
  - .2 Provide complete photometric data prepared by independent testing laboratory for luminaires where specified, for approval review by York Region Representative.
  - .3 Photometric data to include: VCP Table where applicable spacing criterion.
- .3 Quality assurance submittals: provide following in accordance with Section 01 45 00 - Quality Control.
  - .1 Manufacturer's instructions: provide manufacturer's written installation instructions and special handling criteria, installation sequence, and cleaning procedures.

### **1.3 Quality Assurance**

- .1 Provide mock-ups in accordance with Section 01 45 00 - Quality Control.

### **1.4 Delivery, Storage And Handling**

- .1 Deliver, store and handle materials in accordance with manufacturer's recommendations.
- .2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.

- .3 Packaging Waste Management: remove for reuse and return by manufacturer of pallets crates padding and packaging materials in accordance with Section 01 74 19 - Waste Management and Disposal.
- .4 Divert unused metal materials from landfill to metal recycling facility.

## **PART 2 - PRODUCTS**

### **2.1 LED Fixtures**

- .1 3500K CCT
- .2 Minimum 85 Colour Rendering Index (CRI)
- .3 Exterior LED fixtures shall have a minimum warranty of 5 years for LED and driver and a minimum L70 of 70,000 hours when tested to IESNA LM 79 standard at ambient temperature of 25 degrees C.

### **2.2 Finishes**

- .1 Light fixture finish and construction to meet ULC listings and CSA certifications related to intended installation.

### **2.3 Optical Control Devices**

- .1 As indicated in luminaire schedule.

### **2.4 Luminaires**

- .1 As indicated in luminaire schedule.

## **PART 3 - EXECUTION**

### **3.1 Installation**

- .1 Locate and install luminaires as indicated.
- .2 Provide adequate support to suit ceiling system.

### **3.2 Wiring**

- .1 Connect luminaires to lighting circuits:
  - .1 Install flexible or rigid conduit for luminaires as indicated.

### **3.3 Luminaire Supports**

- .1 For suspended ceiling installations support luminaires independently of ceiling.

### **3.4 Luminaire Alignment**

- .1 Align luminaires mounted in continuous rows to form straight uninterrupted line.

- .2 Align luminaires mounted individually parallel or perpendicular to building grid lines.

### **3.5 Cleaning**

- .1 Cleaning:
  - .1 Remove surplus materials, excess materials, rubbish, tools and equipment.
- .2 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 19 - Waste Management and Disposal.

**END OF SECTION**

## **PART 1 - GENERAL**

### **1.1 Reference Standards**

- .1 CSA Group (CSA)
  - .1 CSA C22.2 No.141-10, Emergency Lighting Equipment.

### **1.2 Action And Informational Submittals**

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for emergency lighting and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Sustainable Design Submittals:
  - .1 Construction Waste Management:
    - .1 Submit project Waste Management Plan highlighting recycling and salvage requirements.

### **1.3 Closeout Submittals**

- .1 Submit in accordance with Section 01 77 00 – Project Closeout.
- .2 Operation and Maintenance Data: submit operation and maintenance data for emergency lighting for incorporation into manual.

### **1.4 Delivery, Storage And Handling**

- .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
  - .1 Store materials off ground, indoors, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Store and protect emergency lighting from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan, related to Work of this Section.
- .5 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding, and packaging materials as specified in Construction Waste Management Plan Waste Reduction Workplan in accordance with Section 01 74 19 - Waste Management and Disposal.

## **2 PRODUCTS**

### **2.1 Equipment**

- .1 Emergency lighting equipment: to CSA C22.2 No.141.
- .2 Supply voltage: 120 V, AC.
- .3 Output voltage: 12 V DC.
- .4 Operating time: 30 minutes.
- .5 Battery: sealed, maintenance free.
- .6 Charger: solid state, multi-rate, voltage/current regulated, inverse temperature compensated, short circuit protected with regulated output of plus or minus 0.01 V for plus or minus 10% input variations.
- .7 Solid state transfer circuit.
- .8 Low voltage disconnect: solid state, modular, operates at 80% battery output voltage.
- .9 Signal lights: solid state, for 'AC Power ON' and 'High Charge'.
- .10 Lamp heads: integral on unit and remote, 345 degrees horizontal and 180 degrees vertical adjustment. Lamp type: LED, 5W.
- .11 Cabinet: suitable for direct or shelf mounting to wall and c/w knockouts for conduit. Removable or hinged front panel for easy access to batteries.
- .12 Finish: white.
- .13 Auxiliary equipment:
  - .1 Test switch.
  - .2 Time delay relay.
  - .3 Battery disconnect device.
  - .4 AC input and DC output terminal blocks inside cabinet.
  - .5 Shelf or Bracket.
  - .6 Cord and single twist-lock plug connection for AC.
  - .7 RFI suppressors.

## **2.2 Wiring Of Remote Heads**

- .1 Conduit: type EMT, in accordance with Section 26 05 34 - Conduits, Conduit Fastenings and Conduit Fittings.
- .2 Conductors: RW90 type in accordance with Section 26 05 21 - Wires and Cables (0-1000 V), sized as indicated in accordance with manufacturer's recommendations.

## **PART 3 - EXECUTION**

### **3.1 Examination**

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for emergency lighting installation in accordance with manufacturer's written instructions.
  - .1 Visually inspect substrate in presence of York Region Representative.
  - .2 Inform York Region Representative of unacceptable conditions immediately upon

- discovery.
- .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from York Region Representative.

### **3.2 Installation**

- .1 Install unit equipment and remote mounted fixtures.
- .2 Direct heads.
- .3 Connect exit lights to unit equipment.

### **3.3 Cleaning**

- .1 Progress Cleaning:
  - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment.
- .3 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 19 - Waste Management and Disposal.
  - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

### **3.4 Protection**

- .1 Protect installed products and components from damage during construction.
- .2 Repair damage to adjacent materials caused by emergency lighting installation.

**END OF SECTION**



## **PART 1 - GENERAL**

### **1.1 Reference Standards**

- .1 CSA Group
  - .1 CSA C22.2 No.141-15, Emergency Lighting Equipment.
  - .2 CSA C860-11(R2016), Performance of Internally-Lighted Exit Signs.
- .2 National Fire Protection Association (NFPA)
  - .1 NFPA 101-2015, Life Safety Code.
- .3 International Organization for Standardization (ISO)
  - .1 ISO 3864-1 2011, Graphical symbols - Safety colours and safety signs - Part 1: Design principles for safety signs and safety markings.
  - .2 ISO 7010 2011, Safety colours and safety signs - Registered safety signs.

### **1.2 Action And Informational Submittals**

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's printed product literature, specifications and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Submit WHMIS MSDS - Material Safety Data Sheets.
- .4 Quality Assurance Submittals: submit following in accordance with Section 01 45 00 - Quality Control.
  - .1 Instructions: submit manufacturer's installation instructions and special handling criteria, installation sequence, and cleaning procedures.

### **1.3 Waste Management And Disposal**

- .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 19 - Waste Management and Disposal.

## **PART 2 - PRODUCTS**

### **2.1 Self-Powered Units**

- .1 Exit lights: to CSA C22.2 No.141 and CSA C860.
- .2 Housing: extruded aluminum housing.
- .3 Face and back plates: extruded aluminum.
- .4 Lamps: LED-3W, 100,000 hours.
- .5 Green Pictogram 'Running Man' type.
- .6 Supply voltage: 120 V, ac.

- .7 Operating time: 120 minimum.
- .8 Recharge time: 12 hours
- .9 Battery: sealed, maintenance free, nickel-cadmium.
- .10 Charger: solid state, voltage/current regulated, inverse temperature compensated, short circuit protected, with regulated output of plus or minus 0.01 V for plus or minus 10% V input variation.
- .11 Solid state transfer circuit.
- .12 Signal lights: solid state, for 'AC Power ON' and 'High Charge' condition.
- .13 Mounting: suitable for universal mounting directly on junction box and c/w knockouts for conduit.
  - .1 Removable or hinged front panel for easy access to batteries.
- .14 Cabinet: finish: white.
- .15 Auxiliary equipment:
  - .1 Lamp disconnect switch.
  - .2 Test switch.
  - .3 AC/DC output terminal blocks inside cabinet.
  - .4 Cord and single twist-lock plug connection for AC power supply.

## **2.2 Design (X1)**

- .1 wall, end to wall, ceiling mounting.
- .2 Single or Double face as indicated on drawings.
- .3 Arrow: right, left knock-outs.

## **PART 3 - EXECUTION**

### **3.1 Manufacturer's Instructions**

- .1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheets.

### **3.2 Installation**

- .1 Install exit lights to manufacturer's recommendations, listing requirements, NFPA standard and local regulatory requirements.
- .2 Connect fixtures to exit light circuits.
- .3 Connect emergency lamp sockets to emergency circuits.
- .4 Lock exit light circuit breaker in on position.

### **3.3 Cleaning**

- .1 On completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

**END OF SECTION**

## **PART 1 - GENERAL**

### **1.1 Reference Standards**

- .1 National Research Council Canada (NRC)
  - .1 National Building Code of Canada 2015 (NBC).
- .2 Treasury Board of Canada Secretariat (TBS), Occupational Safety and Health (OSH)
  - .1 Fire Protection Standard-10.
- .3 Underwriter's Laboratories of Canada (ULC)
  - .1 CAN/ULC-S524-06, Standard for the Installation of Fire Alarm Systems.
  - .2 CAN/ULC-S526-07, Visible Signal Devices for Fire Alarm Systems, Including Accessories.
  - .3 CAN/ULC-S527-99, Standard for Control Units for Fire Alarm Systems.
  - .4 CAN/ULC-S528-05, Manual Stations for Fire Alarm Systems, Including Accessories.
  - .5 CAN/ULC-S529-09, Smoke Detectors for Fire Alarm Systems.
  - .6 CAN/ULC-S530-91(R1999), Heat Actuated Fire Detectors for Fire Alarm Systems.
  - .7 CAN/ULC-S531-02, Standard for Smoke Alarms.
  - .8 CAN/ULC-S537-04, Standard for the Verification of Fire Alarm Systems.
  - .9 CAN/ULC-S1001, Integrated System Testing of Fire Protection and Life Safety Systems.

### **1.2 Action And Informational Submittals**

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for multiplex fire alarm system and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
  - .1 Submit drawings.
  - .2 Indicate on shop drawings:
    - .1 Detail assembly and internal wiring diagrams for control units. Consoles Auxiliary cabinets.
    - .2 Overall system riser wiring diagram identifying control equipment initiating zones signaling circuits; identifying terminations, terminal numbers, conductors and raceways.
    - .3 Details for devices.
    - .4 Details and performance specifications for control, annunciation and peripherals with item by item cross reference to specification for compliance.
    - .5 Step-by-step operating sequence, cross referenced to logic flow diagram.
- .4 Sustainable Design Submittals:
  - .1 Construction Waste Management:
    - .1 Submit project Waste Management Plan highlighting recycling and salvage requirements.

### **1.3 Closeout Submittals**

- .1 Submit in accordance with Section 01 77 00 – Project Closeout.
- .2 Operation and Maintenance Data: submit operation and maintenance data for fire alarm system for incorporation into manual.
- .3 Include:
  - .1 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 approved shop drawings with corrections completed and marks removed except review stamps.
  - .4 List of recommended spare parts for system.

### **1.4 Maintenance Material Submittals**

- .1 Submit maintenance materials in accordance with Section 01 77 00 – Project Closeout.

### **1.5 Delivery, Storage And Handling**

- .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
  - .1 Store materials off ground, indoors, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Store and protect materials from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan related to Work of this Section.
- .5 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding, and packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 19 - Waste Management and Disposal.

## **PART 2 - PRODUCTS**

### **2.1 Description**

- .1 Fully supervised, microprocessor-based, fire alarm system, utilizing digital techniques for data control and digital, and multiplexing techniques for data transmission.
- .2 System to carry out fire alarm and protection functions; including receiving alarm signals; initiating general alarm; supervising components and wiring; actuating annunciators and auxiliary functions; initiating trouble signals and signaling to monitoring agency fire department.

- .3 Zoned, non-coded single stage.
- .4 Modular in design to allow for future expansion.
- .5 Operation of system shall not require personnel with special computer skills.
- .6 System to include:
  - .1 Central Control Unit in separate enclosure with power supply, stand-by batteries, central processor with microprocessor and logic interface, main system memory, input-output interfaces for alarm receiving, annunciation/display, and program control/signaling.
  - .2 Data Gathering Panels/Transponders with stand-alone capabilities.
  - .3 Power supplies.
  - .4 Initiating/input circuits.
  - .5 Output circuits.
  - .6 Auxiliary circuits.
  - .7 Wiring.
  - .8 Manual and automatic initiating devices.
  - .9 Audible and visual signaling devices.
  - .10 End-of-line resistors.
  - .11 Local and Remote annunciators display.
  - .12 Printer Event log memory chip.
  - .13 Historic event recorder.
  - .14 Y2K compliancy.
- .7 Equipment and devices: ULC listed and labelled and supplied by single manufacturer.
- .8 Power supply: to CAN/ULC-S524.
- .9 Audible signal devices: to CAN/ULC-S524.
- .10 Visual signal devices: to CAN/ULC-S526.
- .11 Control unit: to CAN/ULC-S527.
- .12 Manual pull stations: to CAN/ULC-S528.
- .13 Thermal detectors: to CAN/ULC-S530.
- .14 Smoke detectors: to CAN/ULC-S529.
- .15 Smoke alarms: to CAN/ULC-S531.
- .16 Regulatory Requirements:
  - .1 To TBS Fire Protection Standard.
  - .2 Subject to Fire Commissioner of Canada (FC) approval.
  - .3 Subject to FC inspection for final acceptance.
  - .4 System components: listed by ULC and comply with applicable provisions of NBC Local Provincial Building Code, and meet requirements of local authority having jurisdiction.

## **2.2 System Operation: Single Stage - Signals Only**

- .1 Actuation of any alarm initiating device to:
  - .1 Cause electronic latch to lock-in alarm state at central control unit and data

- gathering panel/transponder.
- .2 Indicate zone of alarm at central control unit and remote annunciator display.
- .3 Cause audible signaling devices to sound continuously throughout building and at central control unit.
- .4 Transmit signal to fire department via central station.
- .5 Cause air conditioning and ventilation fans to shut down or to function to provide required control of smoke movement.
- .6 Cause fire doors and smoke control doors, if normally held open, to close automatically.
- .2 Acknowledging alarm: indicated at central control unit.
- .3 Ensure that it is possible to silence signals by "alarm silence" switch at control unit, after 60 seconds period of operation.
- .4 Subsequent alarm, received after previous alarm has been silenced, to re-activate signals.
- .5 Actuation of supervisory devices to:
  - .1 Cause electronic latch to lock-in supervisory state at central control unit and data gathering panel/transponder.
  - .2 Indicate respective supervisory zone at central control unit and at remote annunciator.
  - .3 Cause audible signal at central control unit to sound.
  - .4 Activate common supervisory sequence.
- .6 Resetting alarm supervisory device not to return system indications/functions back to normal until control unit has been reset.
- .7 Trouble on system to:
  - .1 Indicate circuit in trouble at central control unit.
  - .2 Activate "system trouble" indication, buzzer and common trouble sequence. Acknowledging trouble condition to silence audible indication; whereas visual indication to remain until trouble is cleared and system is back to normal.
- .8 Trouble on system: suppressed during course of alarm.
- .9 Trouble condition on any circuit in system not to initiate alarm conditions.

## 2.3 Control Panel

- .1 Central control unit (CCU).
  - .1 Suitable for DCLA communication style: to CAN/ULC-S524.
  - .2 Features specified are minimum requirements for microprocessor-based system with digital data control and digital multiplexing techniques for data transmission.
  - .3 Minimum capacity of 250 addressable monitoring and 250 addressable control/signal points. Points may be divided between 2 communication channels in distributed system, each channel operating independently of other. Faults on one communication channel not to affect operation of other channel.
  - .4 System to provide for priority reporting levels, with fire alarm points assigned highest priority, supervisory and monitoring lower priority, and third priority for troubles. Possible to assign control priorities to control points in system to guarantee operation or allow emergency override as required.
  - .5 Integral power supply, battery charger and standby batteries.
  - .6 Basic life safety software: retained in non volatile Erasable Programmable

Read-Only-Memory (EPROM). Extra memory chips: easily field-installed.  
Random-Access-Memory (RAM) chips in panel to facilitate password-protected field editing of simple software functions (i.e. zone labels, priorities) and changing of system operation software.

- .7 Circuitry to continuously monitor communications and data processing cycles of microprocessor. Upon failure, audible and visual trouble indication to activate.
- .8 Support up to 2 RS-232-C I/O ports. CCU output: parallel ASCII with adjustable baud rates to allow interface of any commercially available printer, terminal or PC.
- .9 Equipped with software routines to provide Event-Initiated-Programs (EIP); change in status of one or more monitor points, may be programmed to operate any or all of system's control points.
- .10 Software and hardware to maintain time of day, day of week, day of month, month and year.
- .11 Software to operate variable sensitivity addressable smoke detectors and announce their status and sensitivity settings at control panel.

## **2.4 Power Supplies**

- .1 120 V, 60 Hz as primary source of power for system.
- .2 Voltage regulated, current limited distributed system power.
- .3 Primary power failure or power loss (less than 102 V) will activate common trouble sequence.
- .4 Interface with battery charger and battery to provide uninterruptible transfer of power to standby source during primary power failure or loss.
- .5 During normal operating conditions fault in battery charging circuit, short or open in battery leads to activate common trouble sequence and standby power trouble indicator.
- .6 Standby batteries: sealed, maintenance free.
- .7 Continuous supervision of wiring for external initiating and alarm circuits to be maintained during power failure.

## **2.5 Initiating/Input Circuits**

- .1 Receiving circuits for alarm initiating devices such as manual pull stations, smoke detectors, heat detectors and water flow switches, wired in DCLA configuration to central control unit DGP's/transponders.
- .2 Alarm receiving circuits (active and spare): compatible with smoke detectors and open contact devices.
- .3 Actuation of alarm initiating device: cause system to operate as specified in "System Operation".
- .4 Receiving circuits for supervisory, N/O devices. Devices: wired in DCLA configuration to central control unit DGP's/transponders.
- .5 Actuation of supervisory initiating device: cause system to operate as specified in "System Operation".

## **2.6 Alarm Output Circuits**



- .1 Alarm output circuit: connected to signals, wired in class A configuration to central control unit DGP's/transponders.
  - .1 Signal circuits' operation to follow system programming; capable of sounding horns continuously at 20 spm. Each signal circuit: rated at 2 A, 24 VDC; fuse-protected from overloading/overcurrent.
  - .2 Manual alarm silence, automatic alarm silence and alarm silence inhibit to be provided by system's common control.

## **2.7 Auxiliary Circuits**

- .1 Auxiliary contacts for control functions.
- .2 Actual status indication (positive feedback) from controlled device.
- .3 Alarm and or supervisory trouble on system to cause operation of programmed auxiliary output circuits.
- .4 Upon resetting system, auxiliary contacts to return to normal or to operate as pre-programmed.
- .5 Fans: stagger-started upon system reset; timing circuit to separate starting of each fan or set of fans connected to auxiliary contact on system.
  - .1 Timing circuit: controlled by CCU.
- .6 Auxiliary circuits: rated at 2 A, 24 Vdc or 120 Vac, fuse-protected.

## **2.8 Wiring**

- .1 Twisted copper conductors: rated 120 300 600 V.
- .2 To initiating circuits: 18 AWG minimum, and in accordance with manufacturer's requirements.
- .3 To signal circuits: 16 AWG minimum, and in accordance with manufacturer's requirements.
- .4 To control circuits: 14 AWG minimum, and in accordance with manufacturer's requirements.

## **2.9 Manual Alarm Stations**

- .1 Manual alarm stations: pull lever, glass rod, wall mounted semi-flush surface type, non-coded single pole normally open contact for single stage and general alarm key switch for two stage system bilingual English French signage.
- .2 Addressable manual pull station.
  - .1 Pull lever, break glass rod, surface semi-flush wall mounted type, single double action, single stage, electronics to communicate station's status to addressable module/transponder over 2 wires and to supply power to station. Station address to be set on station in field.

## **2.10 Automatic Alarm Initiating Devices**

- .1 Heat detectors, fixed temperature, non- restorable, rated 57 88 degrees C.
- .2 Thermal fire detectors, combination fixed temperature and rate of rise, non-restorable

- fixed temperature element, self-restoring rate of rise, fixed temperature 57 88 degrees C, rate of rise 8.3 degrees C per minute.
- .3 Addressable thermal fire detectors, combination fixed temperature and rate of rise, non-restorable fixed temperature element, self-restoring rate of rise, fixed temperature 57 88 degrees C, rate of rise 8.3 degrees C per minute.
  - .1 Electronics to communicate detector's status to addressable module/transponder.
  - .2 Detector address to be set on detector base head in field.
- .4 Smoke detector: ionization photo-electric type air duct type with sampling tubes with protective housing.
  - .1 Twist-lock Plug-in type with fixed base.
  - .2 Wire-in base assembly with integral red alarm LED, and terminals for remote relay alarm LED.
- .5 Addressable smoke detector.
  - .1 Photo-electric type.
  - .2 Electronics to communicate detector's status to addressable module/transponder.
  - .3 Detector address to be set on detector base head in field.
- .6 Addressable variable-sensitivity smoke detectors.
  - .1 Photo-electric type.
  - .2 Electronics to communicate detector's status to addressable module/transponder.
  - .3 Detector address to be set on detector base head in field.
  - .4 Sensitivity settings: 3 7 settings, determined and operated by control panel. No shifting in detector sensitivity due to atmospheric conditions (dust, dirt) within certain parameters.
  - .5 Ability to annunciate minimum of 2 levels of detector contamination automatically with trouble condition at control panel.

### **2.11 Audible Signal Devices**

- .1 Horns: 98 dB, weatherproof mounting, 24 V dc.

### **2.12 Visual Alarm Signal Devices**

- .1 Strobe type: flashing 24 V dc.
- .2 Designed for surface mounting on ceiling or walls as indicated.

### **2.13 End-Of-Line Devices**

- .1 End-of-line devices to control supervisory current in alarm circuits and signaling circuits, sized to ensure correct supervisory current for each circuit. Open, short or ground fault in any circuit will alter supervisory current in that circuit, producing audible and visible alarm at main control panel and remotely as indicated.

### **2.14 Remote Annunciators**

- .1 LED and remote alphanumeric type, with designation cards to indicate zones.
- .2 Display:

- .1 Alarms and troubles for alarm initiating circuits.
- .2 Supervisory alarms and troubles common supervisory alarm for supervisory initiating circuits.
- .3 Common system trouble.
- .3 Trouble buzzer:
  - .1 Acknowledging trouble at main panel to silence trouble buzzers in system.
- .4 Supervised, with LED test button and alarm trouble acknowledge button.
- .5 Minimum wiring configuration with main panel and other remote annunciators.

### **2.15 Graphic Display**

- .1 Provide Passive type display beside remote annunciator.

### **2.16 As-Built Riser Diagram**

- .1 Fire alarm system riser diagram: in glazed frame on black lamincoid sheet with beveled edges, white lettering and designations, minimum size 600 x 600 mm.

### **2.17 Ancillary Devices**

- .1 Remote relay unit to initiate fan shutdown.

### **2.18 Smoke Alarms and Carbon Monoxide Detectors**

- .1 Combination smoke/carbon monoxide alarm are not to be connected to the fire alarm system.
- .2 120 Volt hardwired combination smoke/carbon monoxide alarms shall have photoelectric type detection. The unit shall be equipped with a solid state 'Power On' indicator, sensory test button, horn with output providing 85 dB at 3 meters. The unit shall have temporal patterns, visual and voice warnings. Complete with 10 year sealed lithium battery backup.
- .3 Kidde Model P4010A CLEDSC0-2 or equivalent.

## **PART 3 - EXECUTION**

### **3.1 Examination**

- .1 Verification of Conditions: verify conditions of substrates previously installed under other Sections or Contracts are acceptable for fire alarm installation in accordance with manufacturer's written instructions.
  - .1 Visually inspect substrate in presence of York Region Representative.
  - .2 Inform York Region Representative of unacceptable conditions immediately upon discovery.
  - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from York Region Representative.

### **3.2 Installation**

- .1 Install systems in accordance with CAN/ULC-S524 and TB Fire Protection Standard.
- .2 Install central control unit and connect to ac power supply, ac dc standby power.
- .3 Install manual alarm stations and connect to alarm circuit wiring.
- .4 Locate and install detectors and connect to alarm circuit wiring. Mount detectors more than 1 m from 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.
- .5 Connect alarm circuits to main control panel.
- .6 Install signal bells chimes horns and visual signal devices and connect to signaling circuits.
- .7 Connect signaling circuits to main control panel.
- .8 Install end-of-line devices at end of alarm and signaling circuits.
- .9 Install remote annunciator panels and connect to annunciator circuit wiring.
- .10 Install door releasing devices.
- .11 Install remote relay units to control fan shut down.
- .12 Sprinkler system: wire alarm and supervisory switches and connect to control panel.
- .13 Room detection system.
  - .1 Install detectors. Make necessary connections between room detection panel and main fire alarm panel.
  - .2 Locate and install audible signals visual alarms.
  - .3 Locate and install detectors under raised floor. Fasten to steel brackets approximately 300 mm above sub-floor level to clear cables and conduits.
- .14 Connect fire suppression systems to control panel.
- .15 Splices are not permitted.
- .16 Provide necessary raceways, cable and wiring to make interconnections to terminal boxes, annunciator equipment and CCU, as required by equipment manufacturer.
- .17 Ensure that wiring is free of opens, shorts or grounds, before system testing and handing over.
- .18 Identify circuits and other related wiring at central control unit, annunciators, and terminal boxes.

### 3.3 Field Quality Control

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrical and CAN/ULC-S537.
- .2 Fire alarm system:
  - .1 Test such device and alarm circuit to ensure manual stations, thermal and smoke detectors sprinkler system transmit alarm to control panel and actuate first stage

- alarm general alarm ancillary devices.
- .2 Check annunciator panels to ensure zones are shown correctly.
- .3 Simulate grounds and breaks on alarm and signaling circuits to ensure proper operation of systems.
- .4 Addressable circuits system style DCLA:
  - .1 Test each conductor on all DCLA addressable links for capability of providing 3 or more subsequent alarm signals on each side of single open-circuit fault condition imposed near midmost point of each link. Operate Acknowledge/Silence switch after reception of each of the 3 signals. Correct imposed fault after completion of each series of tests.
  - .2 Test each conductor on all DCLA addressable links for capability of providing 3 or more subsequent alarm signals during ground-fault condition imposed near midmost point of each link. Operate Acknowledge/Silence switch after reception of each of the 3 signals. Correct imposed fault after completion of each series of tests.
- .5 Addressable circuits system style DCLB:
  - .1 Test each conductor on all DCLB addressable links for capability of providing 3 or more subsequent alarm signals on line side of single open-circuit fault condition imposed near electrically most remote device on each link. Operate Acknowledge/Silence switch after reception of each of the 3 signals. Correct imposed fault after completion of each series of tests.
  - .2 Test each conductor on all DCLB addressable links for capability of providing 3 or more subsequent alarm signals during ground-fault condition imposed near electrically most remote device on each link. Operate Acknowledge/Silence switch after reception of each of the 3 signals. Correct imposed fault after completion of each series of tests.
- .3 Provide final PROM program re-burn for system York Region Representative incorporating program changes made during construction.
- .4 Provide Integrated Systems Testing in accordance with CAN/ULC-S1001. Testing shall be completed by a Professional Engineer licensed in the Province of Ontario and certified by ULC for performing this type of work.

### 3.4 Cleaning

- .1 Progress Cleaning:
  - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment.
- .3 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 19 - Waste Management and Disposal.
  - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.
  - .2 Place materials defined as hazardous or toxic waste in designated containers.

### 3.5 Protection

- .1 Protect installed products and components from damage during construction.
- .2 Repair damage to adjacent materials caused by fire alarm system installation.

### **3.6 Closeout Activities**

- .1 Provide on-site lectures and demonstration by fire alarm equipment manufacturer to train operational personnel in use and maintenance of fire alarm system.

**END OF SECTION**